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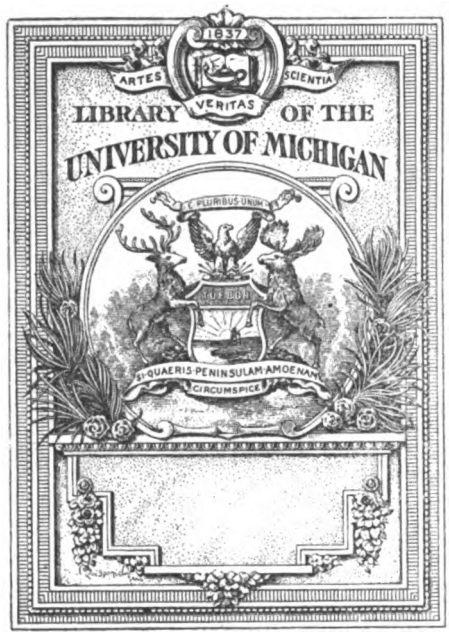

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THE

ELECTRICAL ENGINEER.

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NOTES.

Royal Institution.—The general monthly meeting of the Royal Institution of Great Britain will be held on Monday, the 4th inst., at 5 p.m.

Waterloo and City Railway.—The formal opening of the Waterloo and City Railway, to which we refer elsewhere, is fixed to take place on July 11 by H.R.H. the Duke of Cambridge.

Halifax.—We understand that the electric trams are practically ready to run, and before these words are in print the Board of Trade will have done the needful, so that running will not be long delayed.

Junior Engineers.—An excursion will take place on the 9th inst. down the Thames by the ss. "Alexandra." Members will leave Westminster at 2.15 p.m., calling at Temple, Old Swan, and Woolwich piers.

Erratum.—We regret that under the portrait of Councillor Wigham in our description of the Wakefield station he was designated as resident engineer. This, of course, was an error which the text would partly remedy.

Will London Follow?—Budapest tramways are now wholly worked by electricity, and the city, which has 600,000 inhabitants, is the only one in Europe where animal traction over lined way has been entirely given up.

Honours.—Geh. Rath. Prof. Dr. Slaby, who is the lecturer on electrotechnics at the Berlin Charlottenburg College has been appointed to represent that school in the Prussian Upper House. Profs. Launhardt, of Hanover, and Intze, of Aachen, have been similarly honoured.

Electric Cabs.—One of the Berlin companies has rented the space under 36 of the arches of the street railway for the electric cabs which they intend to introduce. The spaces will be connected with the electricity works, and will serve as charging stations, workshops, etc.

Reduced Telephone Charges.—The increase in the use of telephones in New South Wales, since two years ago the Postmaster-General decided to reduce the rates, is phenomenal. During last quarter ending March 31, 344 new connections were made. The demand does not seem to be abating.

Electricity for Main Lines.—The directors of the Orleans Railway propose to expend £1,600,000 in the establishment of an electric line in order to bring their trains from their present station at Paris to a more central one. This is the beginning of a combination of electric and steam traction which has undoubtedly a great future before it.

Motor Carriages.—It is quite certain that our resident engineers will have carefully to consider the supply of current for accumulators for carriage work. Again and again the question is put to us, How can I charge accumulators for a carriage? Business men are looking into the question of cost, and as many doctors have to keep a couple of horses, so that one may be available at any moment, the question is not the cost as against one horse, but as against two.

Electric Railways.—The inability of the promoters of the Great Northern and City scheme to get the capital required is the occasion of a somewhat scathing article in a financial contemporary. It states that the line is useful and urgent, but that the want of success in getting the money is due to the promoters. Further, it asks for official explanations, pointing out that a "double fiasco like this cannot stand alone." Failure in one reacts upon other similar undertakings.

Telephones and Telegraphs in Australia.—The long-distance telephone line between Sydney and Bathurst is being rapidly pushed forward, the necessary wire and stores being obtained from England. It seems probable that the Postmaster-General will eventually decide to construct a line to Goulburn. The great success of the Newcastle line is certainly encouraging, and, although neither the population of Bathurst nor Goulburn may be sufficient to support the line at present, the intermediate towns will help to make the enterprise pay.

Cable Steamer.—Messrs. Vickers, Sons, and Maxim, Limited, last week launched from their Naval Construction Works at Barrow-in-Furness the "Anglia," a large four-masted twin-screw steamship, adapted for carrying and laying submarine telegraph cables. The vessel is built to the order of the Telegraph Construction and Maintenance Company, Limited, and she is the largest cable steamer afloat. A powerful engine has been fitted for the raising of cables when in search of a break or fracture. If desirable, the "Anglia" can be converted into a cargo vessel of 8,000 tons. She is lighted throughout with electricity.

Poetic Fire.—Our Transatlantic contemporary the *Western Electrician* bursts into poetry in its raptures over the development of artificial light. The last stanza which Mr. A. A. Atkinson fathers in its columns is as follows:

But the climax of the wonders
Of the age
Far surpassing wildest dreams of
Wisest sage,
Fairest rival of the sunshine
In its might
Or a thousand stars of heaven,
Gorgeous, bright,
Is the mystic incandescent's
Globe of light.

Life Stories.—This is the short title of a series of biographies about successful men now appearing in the pages of our contemporary *Answers*. The life story in its issue of July 2 is of Mr. W. H. Preece, C.B., F.R.S. A biographical sketch of three columns length, with portrait, makes the readers of *Answers* acquainted with the per-

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sonality of Mr. Preece. The leading incidents of his life are given, showing how earnest he has been in his labours of love, and how much the English public is indebted to him for early and trustworthy information upon the great modern discoveries in applied electricity. We agree with almost every word of *Answers* in its appreciative biography of Mr. Preece.

Greenwich.—In his report, the Astronomer Royal writes: "Small agitations due to the running of trains on the South London Electric Railway, the nearest point of which is at a distance of 4½ miles from the Observatory, can be seen in the horizontal force and vertical forces synchronising with the disturbances in the earth current registers. These small effects can be traced from the year 1890, but owing to the distance of this electric railway they do not seriously intefere with the magnetic registers. A proposal which has been recently made in a Bill before Parliament to use electricity for a proposed tramline in the neighbourhood of the Deptford Cattle Market, at a much less distance from the Observatory (1¼ miles), would probably, if carried out, have destroyed the value of our magnetic records, and it has been successfully opposed."

Obituary.—The death is announced of Captain William Henry Davies, the managing director of the Exchange Telegraph Company, Limited, at the age of 73. Captain Davies had been managing director of the company since its inception in 1872, and, with the late Sir James Anderson and Mr. Cyrus Field, was one of its founders. Prior to his connection with the company he had an eventful career in the service of the Pacific Steam Navigation Company and the Peninsular and Oriental Steamship Company. While acting in the capacity of agent to the last-named company at Aden he rendered important services to the Government in coaling the transport ships of the Abyssinian expedition in 1868, and in acknowledgment received from the Lords of the Admiralty the gift of a service of plate. He was the chief officer of the "Great Eastern" on her maiden voyage to New York.

Workmen's Compensation Act.—The Vestry of Islington have raised an interesting point. They have apparently come to the conclusion that, although it does not conclusively appear from the reading of the Act and the Acts incorporated therewith that it affects the employés at the electric lighting station, the Vestry will be liable to pay compensation for accidents, etc., in accordance with the scale and conditions set out in the first schedule to the Act to persons engaged in same. They have made enquiries in connection with the matter, and obtained quotations from some insurance companies of the rates of premium they would require to be paid to insure the Vestry in respect of its liability under the Act. Owing to the high rates of premium required by the insurance companies, the Vestry's risks under the Act will be not insured until further experience is obtained of the working of the Act. A circular has been issued by the Vestry of Westminster suggesting a conference of local authorities with a view to discussing the advisability of forming an assurance fund from which claims under the Act could be met.

Tesla and Old Age.—According to the *Public Health Journal* of New York, Nikola Tesla has made a somewhat amusing contribution to medicine. He has found a way of warding off the ravages of time from the surface of the body. This is of especial interest to the ladies. He tells us that between 4,000 and 7,000 microbes fall on every square foot of the human body and settle there in 24 hours. If we could see the surface of the body with a microscope, we would see it swarming with millions of germs. This would not only, he says, be a hideous sight (he evidently pictures them in his mind's eye with heads and long claws), but they would be seen to be eating the skin and destroying its freshness at a rapid rate. The reason that old people are yellow and wrinkled is because the microbes have for years fed upon their skins. Tesla recommends, in the first place, thorough washing of the skin once a day with alcohol, and has invented a battery which shoots the microbes off into space with great violence, sometimes to the distance of 4ft. or 5ft. If this discovery of Tesla's leads people to wash who would otherwise not do so, it would be a boon indeed. We are afraid it will appeal more to those over-sensitive people who are already tottering under the weight of many more or less senseless fads.

Some Experiments with the Telephone.—Such was the title of the last lecture of the season delivered at the Royal Institution recently by Lord Rayleigh, D.C.L., LL.D., F.R.S. Beginning with the statement that by means of the telephone currents of the delicacy of one millionth of an ampere can be made audible, and quoting figures from Mr. Preece and Prof. Tait, the lecturer proceeded to show some experiments by means of flames, which were arranged so as to increase the ordinary 4in. pressure to 10in., by means of a chamber around the burner covered with tissue paper, which excluded air but not sound; the flame was then carried up a brass chimney, and thus rendered more sensitive at its ultimate contact with the air. The action of the sound upon the ear or the telephone was described as push-and-pull action. The action of self-induction was shown by inserting a bundle of iron wires into a coil which made the connection to the supply. This rendered the light dimmer at once, showing the increased self-induction although the resistance remained the same. Speaking affected the flame visibly; clapping of hands or sharp sounds extinguished it altogether. An index showing the variation of pressure caused by sound was thrown on the screen. An improvement on Prof. Hughes's induction balance showed how a shilling piece placed on one side of the balance reduced the flame, while another shilling placed on the opposite side restored the balance. Even a threepenny piece produced a visible effect.

Mica Mining in India.—Mr. Robert W. Thompson, A.M.I.C.E., sent a most interesting article to the *Journal* of the Society of Arts on mica mining in the district of Nellore, India. The author states that mica exists in the western parts of the district, where the land begins to rise to the ghâts. The surface indication of it is the outcrop of quartz and felspar, with which minerals it is usually associated, being sometimes integrated with them so as to form a coarse-grained granite, or else occurring in large separate masses. It is not unusual to find distinct masses of mica, of quartz, and of felspar, lying contiguous to each other; the idea which they convey being that Nature intended manufacturing granite on the spot, but after collecting the necessary materials had changed her mind about it. But the surface indication above mentioned is not always present: in some cases mica occurs in insolated blocks. There are mica mines in operation at Inikurti, Utukur, Chaganum, Sydapuram, and Khandali, all lying from W.S.W. to S.S.W. of the town of Nellore, at from 20 to 30 miles distance. Indications of mica are met with further north, but no mines have yet been started; the industry is, in fact, in its infancy, the first mine, the one at Utukur, having only been started in 1888. The mineral is found near the surface, and those hitherto engaged upon the getting of it not being professional miners, but mere diggers, the only method of working yet adopted has been that of quarrying—no subterraneous mining has yet been attempted. The mica occurs in masses of from 100 to 200 cubic feet; these masses have been found from near

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the surface to a depth of 70ft., the method employed for detaching the stuff being blasting with gunpowder or dynamite.

Connecting Alternators in Parallel.—The following is an abstract of an article by Mr. Frisch appearing in the *Zeitschrift fuer Elektrotechnik*. The abstract is taken from Mr. Carl Hering's digest, and is an illustrated description of the method used by a Viennese company for bringing an alternator into synchronism with others; the method has been in use since 1893, has been satisfactory, and is now used in a number of central stations. To bring an alternator into synchronism by first connecting it to the mains through a resistance is not as simple as might at first appear; it is necessary at first to bring the alternator to approximately the correct speed, after which a slight amount of power will bring it into synchronism. The alternator to be connected is first switched on a pair of auxiliary 'bus wires, which are arranged so that any alternator can be connected with them; the ends of these are connected to the primary of a transformer, the secondary of which is connected in series with the thick winding of another identical transformer through an adjustable resistance, and the fine wire coil of the second transformer is connected to the mains; the resistance is then gradually cut out; the whole operation requires but three or four minutes. With alternators of 440 kw. the two transformers should have a capacity of about 10 kw. each. This method is not directly applicable to starting all the alternators in the case of a complete stoppage when the circuit is loaded, but this can be done by bringing the machines to their full speed, connecting them with the mains, but without exciting their field, and then starting and gradually increasing the exciting current; at about half the normal voltage they will be in complete synchronism; but it is necessary that all the engines have the same steam pressure and that the excitation is the same in all the alternators.

English Plant in Canada.—A pleasing fact in connection with the electrical plant recently installed at the McGill University, of Montreal, is that it is of English manufacture. In this way students will get a fair idea of our electrical practice. Thus we glean from the *Canadian Engineer* that the university has again to thank Mr. W. C. McDonald for generously defraying the cost of extensive alterations and additions to the light and power station, connected with the faculty of applied science. The equipment is now installed in a handsomely finished, well-lighted room, and consists of a 30-kw. Edison-Hopkinson dynamo and a 30-kw. Siemens dynamo, each driven by a Willans high-speed engine. The dynamos are direct connected to the shafts of the engines. These two machines are capable of lighting the different buildings of the university, supplying current for more than 3,000 lights. The dynamos are run in series on the three-wire system, or if the load is light, one can run on the two-wire system. In addition there are installed a 100-h.p. Goldie and McCulloch engine, directly coupled to a 75-kw. General Electric dynamo. This machine is set apart for power purposes, the motors in the building averaging about 110 h.p. It may be also used for lighting purposes when the demand exceeds the capacity of the two former dynamos. The switchboard is made of dark slate in panel form, and it is said to be one of the finest in Canada. The accumulator-room, standing beside the dynamo-room, possesses two batteries of Crompton-Howell storage cells of a united capacity of 800 ampere-hours. These batteries would, says the editor, discourage the antagonism of the adversaries of accumulators, for they are subjected to all kinds of discharges, and after a usage of over six years have an all-round efficiency of 72 per cent. An ingenious arrangement, devised by Louis A. Herdt, lecturer in electrical engineering, enables one battery to be taken out of circuit, and the other one to be put in circuit during the night, as soon as one of the batteries shows signs of being discharged.

The German Press and Szczepanik.—The German and the Austrian Press, both technical and otherwise, are now discussing the gentleman with the jaw-breaking name. A very able and profusely illustrated article in the *Technische Rundschau* reviews what has been said about the subject in the *Reichswehr*, the *Neue Freie Presse*, and the *Neue Wiener Tageblatt*. From this it appears that a Vienna banker, Mr. Ludwig Kleinberg, is finding the cash for the models, etc. An interesting fact is also elicited, namely, that two other Austrians—viz., E. von Taund and W. von Szigyarto—claimed to have solved the same problem in 1884, and the former writes that he discontinued his experiments because he found practical application impossible, for the reasons pointed out previously in these columns — namely, the impossibility to get the selenium cell to act with absolute reliability. As we know, selenium is affected by light in two ways. Firstly, there is a change in the electric resistance, such as the operator intended to produce, but then there follows a spontaneous change in the conductivity which is beyond calculation, and which is caused by molecular and chemical changes in the selenium which arise as soon as the current passes through the cell. But now we come to the crux of the thing. The article, after describing the invention in almost glowing terms, finishes thus: "An additional inducement to criticise the invention with great reserve is the fact that, although it is stated that the apparatus has been ready for the last two years, it has not been exhibited before a single scientific authority," and that is exactly what we have been contending all along. The *Technische Rundschau* continues: "There is a rumour that a Mr. Habrecht, an architect of Hagen, showed the apparatus, but nobody could get to know anything definite about it. This incomprehensible proceeding of keeping the apparatus secret, and at the same time publishing the minutest details of its construction, suggests the idea that the design stage is about as far as they have got at present, although we should be exceedingly glad if this view should prove to be an erroneous one."

The Invincible Rival.—The evidence of gas engineers as to the relative cost of gas and electricity is amusing reading. Two instances recently came to our notice of this. In both cases the gas engineers were opposing the application of their local authority for an electric lighting provisional order. The first gentleman declared on oath that electricity at 6d. per unit was exactly equivalent to gas at 16s. 8½d. per 1,000ft. The exactitude of the engineer is most admirable. The other gas expert had given somewhat similar views in the witness-box, but unfortunately had to be cross-examined. The counsel asked him where he got his figures from for the cost of gas-lighting by the Welsbach burners. "From the advertisements of the company," was the prompt reply. "But do you," asked the counsel, "believe all you see in advertisements?" The gas engineer did, but was then asked if he believed that Beecham's pills were really worth a guinea a box, but was compelled to admit that he would not give that price for the pills. A case in point where the Welsbach gas lamp and electric lamp have competed is given in the columns of our New York namesake. It seems that about a year ago, Welsbach burners were introduced in the Federal Building at Toledo, O., and a saving over electricity of £200 a year by the return to gas was expected. But the Welsbachs are now coming out, and the Toledo

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Consolidated Electric Light Company has the contract for the ensuing year. In the post office the effect of the Welsbachs was particularly disagreeable. In the mailing room the burners are said to have raised the temperature several degrees above the ordinary, and the general inflence on the workers was bad. Now that the summer is coming on, such ill-effects would be accentuated, but the reversion to electricity is made in good time, and the men will not only enjoy a healthy method of illumination but be able to avail themselves of electric motors from the same circuits. There is no question that the Welsbach is an improvement over the ordinary naked gas jet, but when it comes to permanent competition with electricity it is not in the race at all. It is a makeshift that has been chiefly recommended by its alleged superior economy.

A Long Land Line.—The Canadian Pacific Railway Company copper telegraph line, from Montreal to Vancouver, is now being rapidly pushed forward. The line passes *vid* Vaudreuil and the short line to Ottawa, and thence by the main line to the coast. It will be erected under the general superintendency of W. J. Camp, the Canadian Pacific Railway electrician, in three divisions. The first one will reach from Montreal to Fort William. The next division will reach from Fort William to Donald, B.C., and the final division will reach from Donald to the coast. About 10 gangs of men are now at work on the line in different parts of the route. A great deal of trouble has been experienced by telegraphic companies through wires coming in contact with each other, through the breaking of the glass insulators by which the wires are attached to the poles. A test was, therefore, made at McGill University with a view to ascertaining the comparative resistance of glass and porcelain insulators, with the result that it was found that porcelain resisted much heavier and a greater number of blows than the glass. Tests were also made with a 32-calibre revolver from a distance of 8ft. The glass flew to pieces at nearly every shot, while the porcelain frequently showed no mark, save the lead from the bullet, and when they did break it was in such a way that had they been attached to the pole, the wire would not have been affected. The testing of the wire is also going on at the Applied Science Department of McGill, under the care of Mr. Drinkwater. Each day he selects at random a sample of wire from each lot of 10 bundles being turned out by the Dominion Wire Manufacturing Company, and subjects them to tests in order to insure that they come up to the requirements of the contract. The wire is to be ·137in. in diameter, $\frac{1}{1000}$in. only of a variation being allowed above or below this gauge. It must be perfectly cylindrical and weigh 300lb. to the mile. Frequent electrical tests are made upon pieces one one-hundredth of a mile in length to determine the purity of copper used, which must be 97 per cent. When completed there will be a length of about 2,900 miles of wire. The above details are taken from the *Canadian Engineer*.

A New Method of Determining the Mechanical Equivalent of Heat.—A communication on the above subject prepared by Messrs. J. B. Baille and C. Féry for the Académie des Sciences of France, was presented by Mr. Cornu on the 23rd ult. The method is electrical, and is based on the principle employed in the revolving-field alternate-current motors. It is well known that when a metallic mass is placed in a revolving magnetic field it tends to turn at the same rate as the field. The authors then conceived the idea of fixing the metallic mass and measuring the force exerted, and also the gain in temperature. From these data the mechanical equivalent of heat can be deduced after the necessary corrections have been made. The apparatus constructed consists of a cylinder of copper, pivoted and provided with a lever arm. This cylinder was drilled to receive a thermometer giving the temperature at any instant. An iron ring placed concentric with the cylinder provides the revolving field, the currents being taken from a small Gramme alternator. A double envelope of ebonite between the ring and cylinder is used as a water-jacket to prevent radiant heat passing from the one to the other. A balance having been obtained, the switching on of the current causes a deflection of the lever arm. The weight necessary to bring this back to zero, multiplied by the length of arm, gives the mechanical force. The speed of the revolving field is obtained from a counter on the alternator. To determine the quantity of heat corresponding to this, the rise of temperature is taken through a time so short that the radiation from the cylinder may be constant during the time. Afterwards the time taken for the cylinder to cool down over the same range is taken, and from this the cooling equivalent determined. The following typical results were obtained with a cylinder which, as regards specific heat, was equivalent to 55·5grm. of water. After a five minutes' trial with a weight of 3·270 on the arm, which was 22·5cm. long, the temperature was 1·74deg. C., the cooling correction was 1·07deg., making a total rise of 2·81deg. From this and the specific heat of the cylinder the figure 425 was deduced for the mechanical equivalent. Trials made at further intervals of five minutes gave 422, 424, 426, and 426 respectively. The speed of the revolving field was 2,778 per minute, corresponding to a frequency of 46·3. The authors point out causes of errors, and amongst these is that due to movements of the cylinder. This must not be allowed to oscillate much if good results are to be obtained.

Ophthalmological.—Two papers of interest to electricians were recently read before one of the medical societies. We are indebted to the *Lancet* for our abstract: "Mr. Simeon Snell related two cases in which splinters of steel were removed from the eye with the electromagnet—(1) From the retina with preservation of excellent sight The piece was observed with the opthalmoscope as fixed in the retina in the outer and lower quadrant. The fragment had passed through the cornea close to the sclero-corneal junction, and when the patient was first seen four days after the accident the glistening of the steel was distinct, but the foreign body was partially covered with exudation. The patient could count fingers. The electromagnet was inserted eight days after the accident between the inferior and internal recti, and the fragment was removed. Later the vision equalled $\frac{6}{24}$. (2) From the vitreous, the foreign body being localised by the X-rays. The patient was not seen for several weeks after the accident. The foreign body was diagnosed as having entered the upper part of the cornea, passing through the lens into the vitreous. Dr. McKenzie Davidson used the X-rays and localised the splinter in the upper part of the vitreous. A skiagram showed it to be needle-shaped, measuring 8mm. in length, and placed obliquely. The electromagnet (15 weeks after the accident) was introduced through a scleral incision between the inferior and internal recti, and the splinter was at once removed. The patient could afterwards count fingers. Dr. Tatham Thompson spoke of the difficulty sometimes experienced in withdrawing the foreign body through a small wound, which he had overcome by approaching the body from another direction so as to get it end on. He thought one of the chief advantages in using the X-rays was the power of excluding foreign bodies in doubtful cases. Mr. W. Lang described two cases illustrating the value of the X-ray examination in instances of old injury to the eye with

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defect of vision. The first patient consulted him for failure of vision going on to total amblyopia in whom there was a small corneal scar with corresponding openings in the iris and lens. Though there was no history of injury a foreign body was suspected, and a skiagram by Dr. McKenzie Davidson revealed one in the lowest part of the vitreous covered up by opaque tissues. The second had a recent wound of the cornea, iris, and vitreous, but no foreign body could be seen. This was subsequently located in the sclerotic at the fundus. There was a small hole in the choroid. No operation was attempted in either as the eyes were quiet."

Diamagnetism.—Mr. Albert P. Wills contributes a most valuable article to the *Physical Review* of New York on the susceptibility of diamagnetic and weakly magnetic substances. In the first series of experiments determinations of κ (the coefficient of magnetic susceptibility) were made for five samples of marble. Special attention was thus bestowed upon the study of the magnetic properties of marble, since it has been often used as the means of support for coils in standard apparatus. The results obtained seem to indicate that almost any variety of marble can be relied upon to be diamagnetic and free from iron, and to have a magnetic susceptibility of about $-\cdot8\times10^{-6}$. Therefore, it would seem that a free use of marble in magnetic apparatus is allowable. The author then gives the data and results for aluminium, glass, and tin. It will be noticed from these that the coefficient of susceptibility for tin is positive, that is, the present experiments would seem to indicate that tin is magnetic. Now, previous experiments upon tin have clearly shown it to be diamagnetic, and the conclusion to be drawn in the present case is that the sample used must have contained traces of iron. The glass used was a piece of fine optical glass. The value of κ obtained for this piece of glass is four or five times the value usually given. Aluminium is seen to have a positive valve of κ, and quite large. The results obtained for wood show, in general, that the greater the density of the wood the greater is the coefficient of magnetic susceptibility. Besides these quantitative experiments there were made a large number of qualitative experiments upon a great many different kinds of wood. Only one kind out of about 20 different kinds tried proved to be magnetic, the rest were diamagnetic; the exception was butternut. There has been in the past a difference of opinion among physicists as to whether diamagnetic substances are or are not less susceptible under the application of large magnetising forces. Most of the earlier experimenters, among them Tyndall, Joule, and Becquerel, found reason to believe that κ is constant for diamagnetic substances. Plücker, however, believed that in some cases, as the magnetising force is increased the coefficient of susceptibility for diamagnetic bodies decreases in a similar way as in iron. Plücker also thought he observed in some cases an increase in κ with an increase in the magnetising force up to a certain point, after that a decrease; that is, for a certain value of the magnetising force κ has a maximum. Silow (1880) published results which indicate that κ for ferric chloride increases for a while with the magnetising force, reaches a maximum, and decreases. The fields used in the last series of experiments varied between the limits of 1,610 and 10,450 lines per square centimetre. The results show that within these wide limits κ is constant for bismuth. A similar series of experiments upon white wax indicated that for this substance κ is constant within wide limits of the field strengths, and in the light of these results it would seem probable that for solids, at any rate, κ is constant. The method for the study of magnetic and diamagnetic phenomena in solid bodies, described in the paper, is easily adapted to the study of liquids, and of gases under different pressures. At various intervals during the present century many different physicists have been interested in the study of diamagnetism. But, notwithstanding the fact that many have worked upon the problems which a study of diamagnetism offers, there seem to be yet some things in connection with the subject which merit more careful investigation. For instance, the question as to whether or not a diamagnetic body, after being under the influence of a magnetising force, and this force withdrawn, requires, if left mechanically undisturbed, a "coercive force" to bring it to the neutral magnetic state again, is still an open one. Of course, the extreme smallness of the action to be measured is the great difficulty encountered in any quantitative work in diamagnetism.

The Selection of the Speed for Railway Motors. A short but interesting article appears in our New York namesake on the selection of the proper speed for railway motor equipments. The author points out that, "among the many questions that are apt to be lost sight of when purchasing motors for an electric road, is that of the proper speed of motors. By this is meant the maximum speed at which the motors will run, as well as the schedule speed for which they are intended. It is very often the case that in selecting high-speed motors the purchasers are acting on the adage that speed is a good thing, therefore 'while your a gittin' git a plenty.' The result of this policy has been to handicap numerous roads with motors which are much too fast for the service, resulting in excessive repairs and an unnecessary consumption of power. It may sound strange, but it is true that one set of motors may take twice the current and heat twice as badly in maintaining a given schedule as another set of motors geared lower but of the same dimensions otherwise. This of course is rather an extreme case, but it is not far from some conditions which exist in actual practice to-day. The reason for this may be more apparent after thoroughly understanding the following principles: (1) to produce a given torque or acceleration, the current required varies directly according to the maximum speed for which a motor equipment is geared; (2) the heating of a motor (C^2 R) when producing a given torque or acceleration, varies directly as the maximum speed for which a motor is geared. When it is remembered that in nearly all classes of electric railway service the principal work done by the motors is acceleration, it will be seen how important it is to select a motor of a speed which will give a high torque per ampere of current. These principles applied in practice mean that it will take twice as much energy to get a car up to a speed of 20 miles an hour if equipped with motors geared to 40 miles an hour as it will to get the same car up to 20 miles an hour if it is equipped with 20-mile-an-hour motors, the rate of acceleration being the same in both cases. Furthermore, the 40-mile motors will heat twice as much as the 20-mile equipments during the process. Of course, the higher speed equipments can be made to maintain a much faster schedule than the slower provided there is enough traction on the rails to permit of a faster acceleration, or provided there is distance enough between stations to admit of a higher maximum speed than the 20 miles an hour being attained. But this does not alter the fact that in some cases high-speed motors are selected when slower-speed motors at much less expense for power and repairs should be used. When these principles are more generally understood there will not be such a cry as there has been for several years past for high-speed motors, and when high-speed motors are selected they will be of ample size to correspond with the increased horse-power taken by the faster speed.

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MORLEY ELECTRICITY WORKS.

The authorities at Morley on Friday, the 24th ult., were somewhat busy. In the first place, memorial stones at the new baths had to be laid, and then the electricity works had to be formally opened. Morley is nothing if not go-ahead. It likes to be in the forefront of progress, and certainly during the last 10 years or so its ratepayers have had nothing to complain of as regards the enterprise of their representatives. Morley and ourselves are old acquaintances, and on our visit many friends therein endeavoured to prove that the centre of Yorkshire hospitality rested in Morley. However, in due course we witnessed the laying of the memorial stones, saw the Mayor (Councillor C. Scarth) in his state array, heard speeches filled with allusions to cleanliness and healthiness, and then wended our way to the electricity works, where Alderman Stockdale ousted the Mayor from supreme command and presided at the proceedings.

The CHAIRMAN, in giving a short history of the undertaking, pointed out that the committee had built and equipped a station at a not extravagant price, and that the pecuniary success of the work now depended upon the citizens, whom he urged to take the light and so make the labours of the Council a complete success. He then formally declared the works open.

In the unavoidable absence of Mr. Hammond, his assistant, Mr. SPENCER HAWES, briefly described the works.

Alderman HORSFALL, in moving a vote of thanks to the committee, referred to the enterprise of that committee in carrying out the work, and not following the example of Leeds, Birmingham, and other places in allowing private enterprise to establish itself and then buy it out at a high price.

Councillor GLOVER seconded the resolution, and Alderman STOCKDALE briefly replied.

Votes of thanks to the engineers and to the contractors followed, and were duly responded to, after which the large number of visitors partook of light refreshments provided by the contractors.

This concluded the formal proceedings, and Mr. Clayden was left to make ready for his evening's load, but the Mayor was not satisfied, and invited the visitors to view the Mayor's parlour and the interior of the splendid town hall. The visit was highly appreciated, as was the Mayor's hospitality. Long let Morley flourish.

The following is a description of the works:

EARLY HISTORY.

The history of municipal electricity supply in Morley dates practically from July, 1893, when the Council appointed a committee to consider the whole question. The Leeds electricity works had been opened in the early part of that year, and the immediate success which attended the inauguration of the supply in that city afforded especial encouragement to the members of the Council of the smaller but none the less progressive town of Morley to give their ratepayers the benefit of a supply of electricity. Following the precedent established in the case of the palatial town hall, the first step of the committee was to advertise for competitive schemes—one for the lighting of the whole borough, and the other for the lighting of the town hall—a premium of £100 being offered for the accepted scheme. In January of 1894 the scheme submitted under the *nom de plume* of "Lux et Felicitas" was awarded the first honours, the author of which was then ascertained to be Mr. Robert Hammond, M.I.E.E. The committee then decided to pay visits of inspection to the electricity works in the neighbourhood, and the matter was allowed to remain in abeyance for a couple of years until February, 1896. At this date the Morley Tradesmen's Association expressed their desire to have a supply of electricity provided without delay, and communicated this desire formally to the Corporation, while at the same time the Co-operative Society intimated that they had decided to light their premises by electricity, and had provided a room for the machinery, but that if the Corporation would undertake the work, they would refrain from putting down their own plant, and take their supply from the municipal works. Meanwhile, the scheme for lighting the town hall had been carried out, and several small plants had been laid down in various parts of the borough, and a feeling was prevalent that if the Corporation did not take definite steps towards the realisation of the townspeople's desire a private company would be promoted to undertake the duty. The committee thereupon again took the matter in hand, and came to the conclusion that the time had arrived when a public supply of electricity was essential, and that such supply could profitably be undertaken by the Corporation. They reported to the Council that it was desirable that the ratepayers as a whole should derive any profit that was to be obtained from the business, and that no company should be allowed to secure statutory rights. The Council endorsed these views, and Mr. Robert Hammond was appointed as consulting engineer to carry out the scheme embodied in his report. To ensure that no delay should be occasioned a license was applied for, and this was granted by the Board of Trade in July, 1896, to be subsequently replaced by a provisional order confirmed by Parliament in 1897. In the meantime it had been decided to adopt the high-pressure system, generating at 2,000 volts and distributing by six sub-stations at a pressure of 200 volts at consumers' terminals, and the consulting engineer was instructed to prepare plans and specifications of the works, and in September, 1896,

Mr. H. W. Clayden, borough electrical engineer, whose portrait we give above, was with the Brighton and Hove Company for 2½ years, going there as improver. He was with the Yorkshire House-to-House Company at Leeds for six months, and also with the Eastbourne Company for the same period, after leaving the Brighton works. From Eastbourne he went as assistant electrical engineer to the Coventry Corporation, and occupied this post for nearly two years, and from there was appointed borough electrical engineer of Morley, being chosen from 130 applicants.

tenders were invited. The contracts were eventually allotted as under:

Boiler-House Plant.—Two Lancashire boilers, mechanical stokers, feed pumps, economiser, electric motor, feed tank, and accessories, Holdsworth and Son, Bradford.

Engine-House Plant.—Two 100-kw. steam alternators, motor-alternator, direct-current dynamo, accumulators, pipe work and valves, and oil filter, also switchboard and instruments, the Electric Construction Company, Limited.

Overhead Travelling Crane.—The Bedford Engineering Company, Bedford.

Mains.—Stoneware culverts, H. Doulton and Co., Limited, Lambeth; cables and boxes, Callender Cable and Construction Company, Limited.

Sub-Station Equipment and Transformers.—The Electric Construction Company, Limited.

Public Lamps.—Arc and incandescent lamps, posts, and brackets, the Electric Construction Company, Limited.

Meters.—The Westinghouse Electric Company, Limited.

The capital expenditure to date is about £22,000. Mr. Harold W. Clayden was appointed borough electrical engineer in April, and he has acted as superintending engineer during the construction of the works. Although the works were not formally opened till Friday, June 24, a continuous 24 hours' supply has been given since March 1, a temporary

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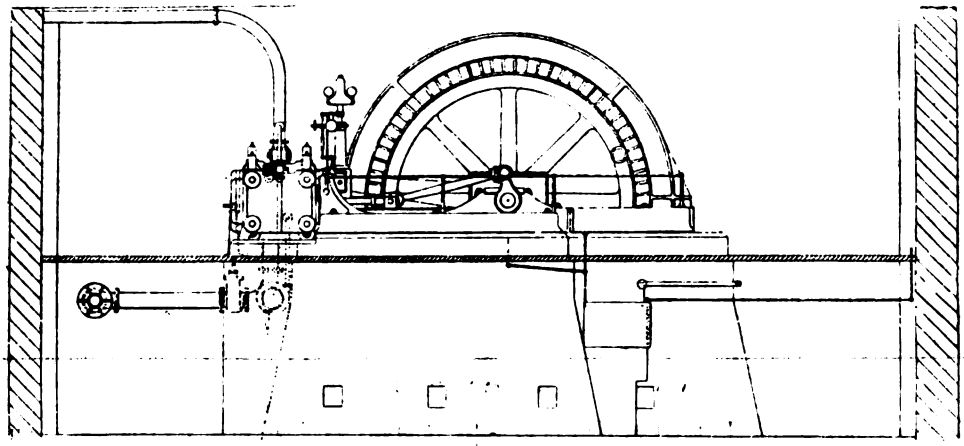
supply having been commenced a fortnight previous to this date. At present there are 40 consumers connected to the mains, with an equivalent of 3,080 8-c.p. lamps, this number being inclusive of the town hall.

Buildings.

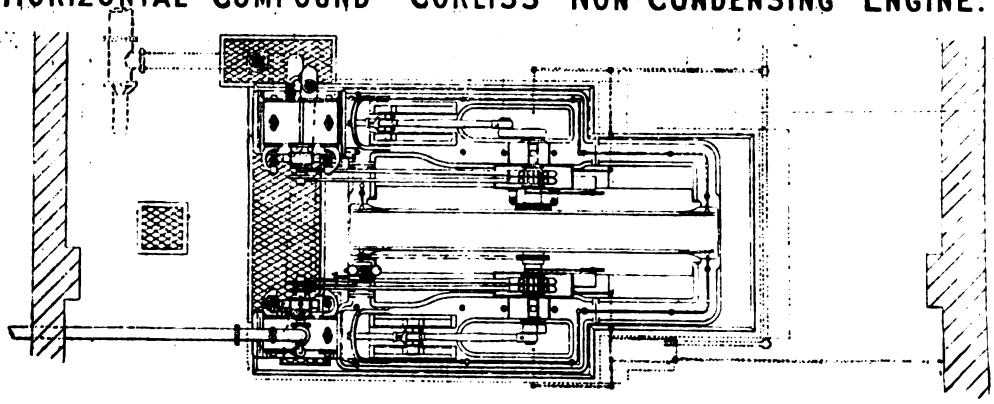
The site of the generating station is on the west side of Corporation-street, between the new public baths and the Corporation depôt, and is situated in the centre of the town. The buildings, which were designed by the late borough surveyor, Mr. M. H. Sykes, are placed on the south side of the land reserved for the generating works, and are so arranged that a considerable area of land is reserved for future extensions. The total area of the site consists of 4,132 square yards, which the Corporation, with commendable foresight, purchased some years ago at the very moderate price of 3s. 8d. per square yard. The buildings are of a substantial and commodious character, and are specially designed with a view to future extensions. The main front of the buildings is faced with pitch-faced local stone lined with brickwork, the remainder of the buildings being of brickwork covered with blue slates. The engine-house is 40ft. wide by 68ft. long, with switchroom at one end elevated 3ft. 4in. above floor in engine-house, having open front between it and engine-house. The walls of engine-house are lined with white glazed bricks to a height of 5ft., and above that height with pressed white bricks, the flooring being laid with ornamental tiled pavements. At a height of 20ft. above the floor an overhead travelling crane runs along steel rails the full length of the engine-house. This room is excellently ventilated and lighted by means of ground clerestorey windows, skylights and ventilators in roof. The test-room is conveniently situated at the east side of the switch-room, the floors of which room are laid with wood-block flooring. The accumulator-room, 40ft. by 12ft. 6in., is placed over the switch and test room, and is approached by a staircase near the main entrance. The boiler-house is placed parallel with the engine-house on the west side thereof, and is 68ft. long by 48ft. wide. Along the west side of the boiler-house are placed the coal-bunkers, 10ft. wide, and the pump-room, 10ft. by 12ft. At present there are two Lancashire boilers 30ft. by 8ft. diameter, and accommodation is provided for other two of equal size. In the centre of the north end of the boiler-house is placed the chimney stack; it is 45 yards high and 14ft. square at its base, and 8½ft. square at the top. One of Green's economisers, containing 96 tubes, is fixed between the boilers and chimney stack, and is so arranged as to be capable of enlargement as required when extensions are carried out. Ample workrooms and store-rooms are provided at the south end of the boiler-house. The offices are situated over the work and store rooms, and are approached by two staircases—one being from main entrance hall, and the other being a spiral staircase from boiler-house to chief engineer's private office. The whole of the floors throughout are fireproof, being constructed of steel joists and concrete, finished on the surface with cement face. Sufficient lavatory accommodation is provided in convenient positions on both ground and upper floors. The various contracts for the buildings have been carried out entirely by local firms. The total cost of the buildings was £4,500.

Boilers.

In the boiler-house there are at present erected two Lancashire boilers, 30ft. long by 8ft. diameter, each capable of evaporating 7,000lb. of water per hour at 125lb. per square inch, under a natural draught with the feed water at a temperature of 60deg. F. All the plates are of mild steel of uniform thickness, having a tensile breaking load of 30 tons per square inch. The boilers are made by Messrs. Holdsworth and Sons, of Bradford, and are fitted with Bennis mechanical stokers driven by electric motor. The boilers are fed by a vertical double-acting Worthington pump, working in conjunction with a "Korting" injector.



HORIZONTAL COMPOUND CORLISS NON-CONDENSING ENGINE.



Generating Plant.

The generating plant at present erected comprises the following: two sets of 120-kw. flywheel alternators, one motor-alternator of 20 kw., one direct-current exciting plant of 30 kw. The whole of this plant has been laid down by the Electric Construction Company, the flywheel alternators being excellent specimens of modern electrical generating machinery. The two main engines are made by Messrs. Pollit and Wigzell, Limited, of Sowerby Bridge. They are of the horizontal compound non-condensing type, with cylinders 14in. and 23½in. diameter, 30in. stroke, running at a speed of 100 revolutions per minute, with a working pressure of 130lb. per square inch. The cylinders are arranged side by side, the alternators being between the

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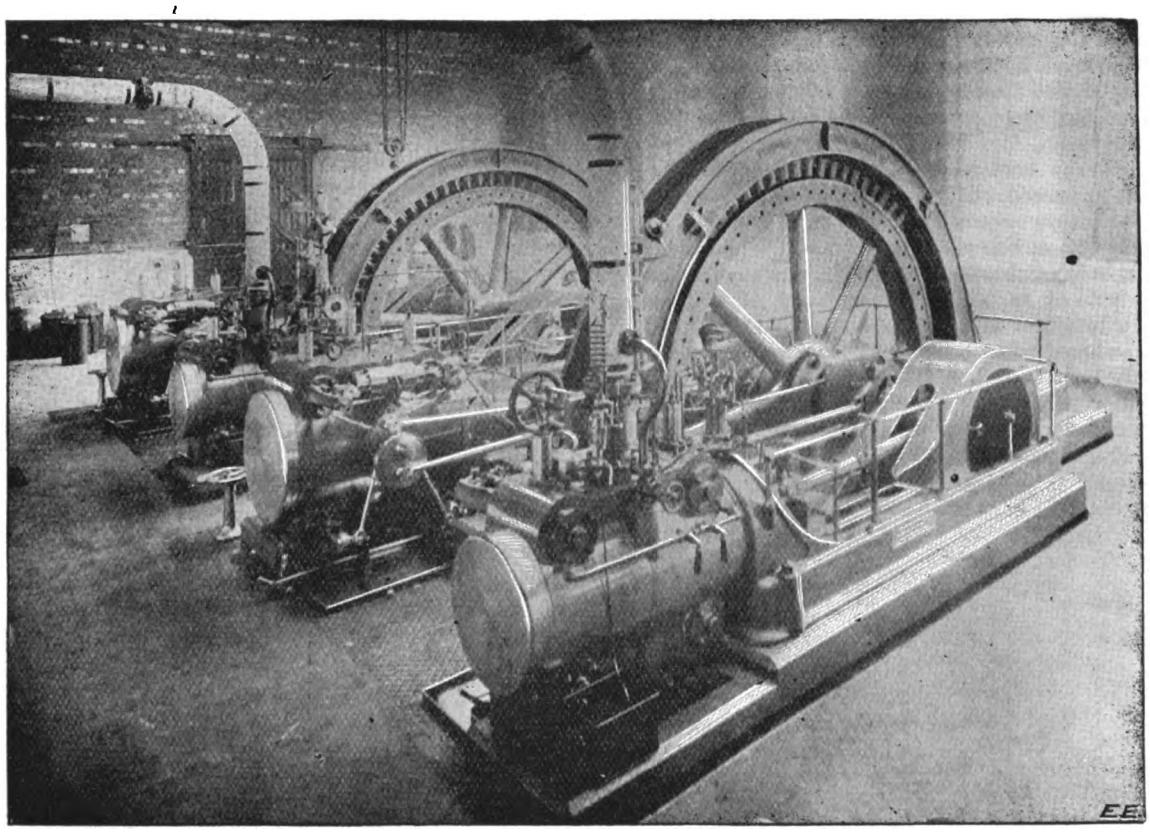
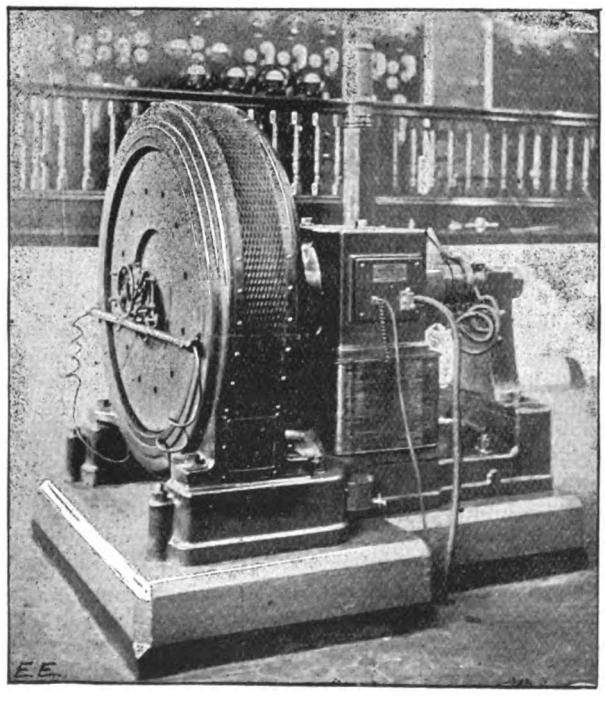
cylinders. Both the high and low pressure cylinders are fitted with Corliss valves, actuated by the firm's patent automatic trip gear specially designed to suit high speeds. The steam-valves on the high-pressure cylinder are controlled by a spring governor of the Hartnell type; the low-pressure cylinder has a hand regulation to give a variable expansion. Both cylinders, and also the receiver pipe between the cylinders, are steam-jacketed. The cranks are enclosed with neat planished steel casings to prevent oil being thrown off. The eccentrics are also guarded so that no oil can get on the alternators. Special attention has been given to the continuous lubrication of the working parts, and all the waste oil from the crank and eccentric races passes into a tank at the side of the engine, and is pumped from there into filters to be used again.

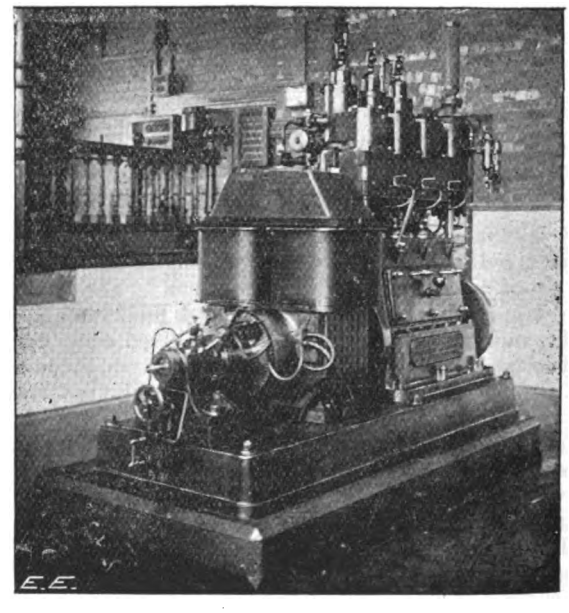


View of Engine-Room at Morley Electricity Works.



Motor-Alternator at Morley Electricity Works.

Messrs. Pollit and Wigzell have also erected the whole of the steam and water pipes in the engine and boiler house. The two alternators are the well-known E.C.C. flywheel machines, each having a normal output of 125 kw. at 100 revolutions, and an emergency output of 135 kw., the voltage being 2,000 to 2,200. The armature conductor is wound into special slots cut in the laminated charcoal iron core in such a manner that, if necessary, a coil can be rewound in about two hours. The core is composed of 36 separate segments, each consisting of a double coil, the laminated stampings being bolted to and supported by two cast-iron flange pieces, which latter are bolted to the massive cast iron rings forming the framing. Each segment was tested with 6,000 volts between coil and frame, and both machines were tested with a pressure of 4,000 volts after running for 10 hours at full load. The field magnets consist of 72 steel poles, each wound with a separate magnetising coil. The poles are of circular cross-section, and are fitted into holes recessed in the rim of the cast-



Exciting Plant at Morley Electricity Works.

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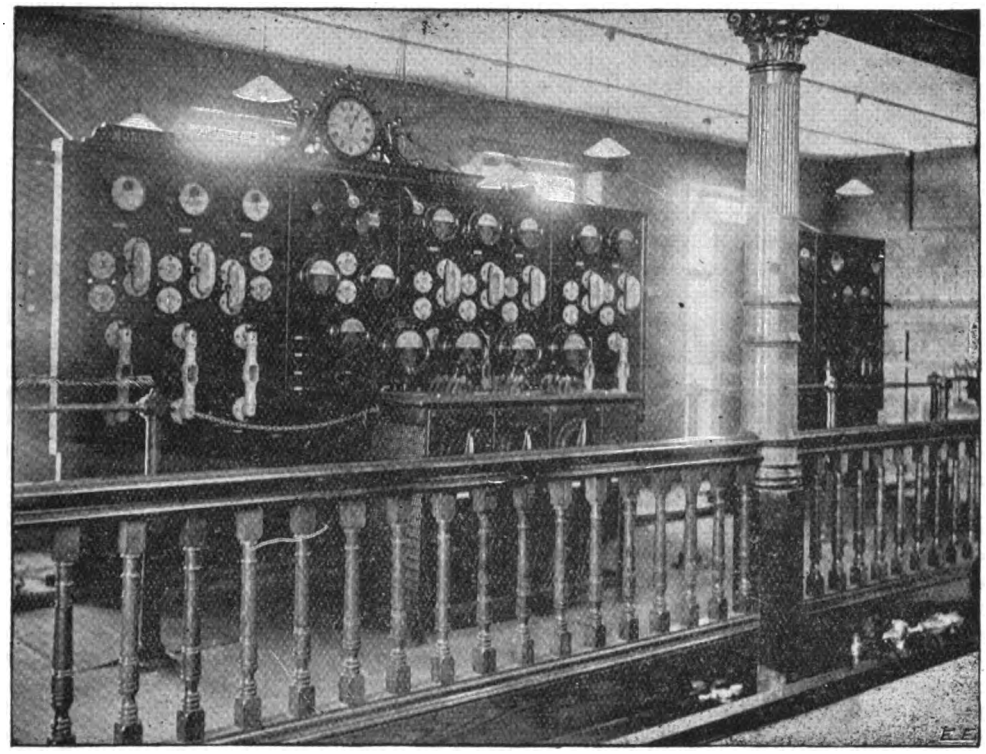
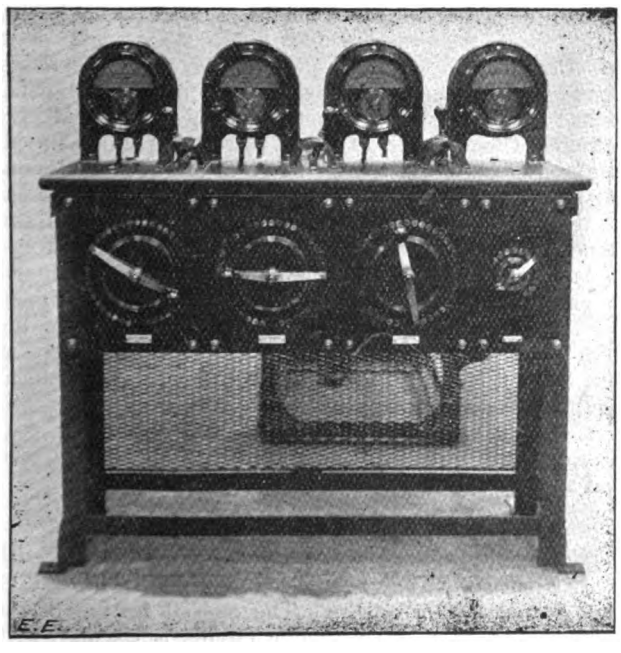
iron flywheel, being securely held by steel bolts passing through the centres of the poles and the wheel rim. The flywheel is of cast iron, in halves, the half centres being bolted together, while the rims are secured by shrinking on circular steel hoops let into circular recessed grooves, so that the rings are flush with the wheel rim. The



View of the Main Switchboard at Morley Electricity Works.

diameter over the poles is 13ft., and the total weight of the wheel and magnets about 10 tons. Each machine has a combined efficiency of 82 per cent. at full load, and over 83 per cent. at an overload of 135 kw. The exciting energy at full load is 22 amperes at 86 volts. Under the specification it was provided that the temperature rise should not be more than 50deg. F., but the makers



Regulator Table at Morley Electricity Works.

have managed to keep the temperature considerably below this limit. After a 10 hours' full load run the rise was under 40deg. F. on any part of the armature, and only 15deg. F. on the magnet coils. The exciting current for the alternators is supplied by a separate direct-current plant of 30 kw. capacity. It consists of an Electric Construction Company's standard bipolar-type inverted continuous-current dynamo, direct coupled to a Peache high-speed engine, and mounted, as usual, on an extension of the engine-bed. The armature is bar wound, and is arranged to give the necessary extra volts for charging the battery of accumulators. The motor-alternator is to run the lights during the times of light load. It has an output of 20 kw the speed being 600 revolutions per minute. The alternator has a slot-wound armature, and is similar to the large machines, except that instead of being built in segments the core stampings break joint, forming a continuous ring. The continuous-current portion of this apparatus is built precisely on the same lines as the exciter previously described, with the exception that it is of the standard E.C.C. upright type.

The whole of the steam-pipes are made of lap-welded steel suitably arranged to allow for expansion. The pipes in the main range and branches to the boilers are 6in. in diameter, and the branches to the engines 5in. diameter. A drain pocket is fixed at the end of the main range, and steam separators on the branches to each engine. The exhaust steam is carried to the main exhaust pipe by a 12in. pipe placed underground. A 3in. pipe connects the engine drain to the sump. The feed pipes are erected in duplicate, a by-pass to the economiser being arranged on both pipes. A feed-water tank holding 3,000 gallons has been placed underground.

The accumulators were supplied by the Chloride Electrical Storage Syndicate, and consist of 57 R-type cells in glass boxes, capable of giving a discharge of 250 amperes for two hours, or 100 amperes for six hours, or 70 amperes for 10 hours, with a terminal E.M.F. of 100 volts. This battery can be used for supplying current to the motor-alternator or for exciting both the alternators.

Main Switchboard.

The switching and regulating arrangements at the generating station are divided into three sections as follows: (1) high-tension switchboard for alternating circuits; (2) low-tension switchboard for exciter and battery circuits; (3) regulating apparatus from which the field circuits of all machines are controlled. The accompanying illustration shows the main high-tension board. The regulating table is in front. The panel on the left hand contains switching gear for three alternators, each machine having one ammeter, two single-pole switches of the plug type, and one fuse. The machine switches are provided with guides additional to those for the contacts, so that the switches

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can be carried in the guides without making contact, and so can be placed in readiness for finally pushing home after synchronising. The fuse consists of a porcelain case with glass tube let into it so that through an opening in the porcelain in the centre the condition of the fuse can be seen. On the right is the circuit panel exactly similar to the alternator panel, with the exception that the switches are not fitted with guides. Two 'bus bars are provided, and there are two switches on each alternator and feeder circuit, so that the machines or the feeders can be put on to either of the two 'bus bars. The centre panel has mounted on it synchronising lamps and plugs, voltmeters with voltmeter switch, and also a plug switch similar to the main switches for connecting 'bus bars. The panels are of slate, and the framework carrying them is built up of steel angle and T irons, while the panels are surrounded by a narrow teak moulding for appearance. The lower portion of the switchboard is covered in with sheet steel. Switches are only provided in one pole of the circuits, the 'bus bar for the other pole being connected to an earth-plate through a plug fuse which is mounted behind the switchboard. There is also fixed behind the switchboard the five small transformers for synchronising and for supplying the voltmeters. The regulating table carries on the front of it four multiple-contact regulating switches, three of these being for the alternator field and the smaller one for the exciter field. Another regulating switch on the end of the table is connected in the field of the motor-alternator, and is used for varying the speed of this machine when synchronising. The top of the table is of slate, and has mounted on it field-breaking switches for the three alternators, with ammeters for reading the field currents. A voltmeter is also provided for the exciter, this one being in parallel with one on the main switchboard. The framework of the table is made of steel angles. The resistances to which the regulating switches are connected are fixed in the space below the switchboard.

The low-tension board is arranged to connect up the exciter, the batteries, the motor of motor-alternator, the fields of the alternators, and the works circuit. Two sets of 'bus bars are provided, and the switches of the exciter and motor fields can be thrown on to either of these bars. By this arrangement the batteries can be charged from one 'bus bar at 135 volts, and at the same time discharge on to the other bar at 100 volts to supply various circuits. This switchboard is divided into two panels. The left-hand panel carries the main switches for the exciter and station circuit. These are double-pole two-way, of the throw-over type before mentioned, and are arranged to quick-break into the middle position from either side. Seven other circuit switches are provided on this panel—three being for the alternator fields, three spare, and one for the motor of the motor-alternator circuit. These switches are two-way, of the double-pole throw-over type, but they are not quick-break—in the case of the field circuits the breaking being done on the switches before mentioned on the regulating table, and in the case of the motor by the starting switch. On the right-hand panel are the switches and instruments for controlling the battery circuits, and also for the motor of the motor-alternator. In connection with the motor there is a nine-way starting switch and two single-pole two-way change-over switches—one for the armature circuit and one for the field circuit. The object of these latter two switches being to enable (in the case of an accident to the exciter) the motor-alternator to be reversed, converting it into an alternator-dynamo, the alternator being run as a motor from the large alternators, and the dynamo used for charging the batteries. In the ordinary use the batteries will be charged all in series, but should such an emergency occur, the alternator-dynamo would give current at 100 volts only, and the charging done by paralleling the batteries. At the top of the switchboard is provided a switch, which enables the batteries to be changed from series to parallel. When charging the batteries in parallel, two five-way switches and resistances and ammeters are connected in each circuit for regulating the current. The battery circuit is provided with an automatic battery cut-out and cut-in switch. This is set so as to cut in when the pressure in the machine exceeds that of the batteries, and also to prevent the current reversing. A current alarm is fixed on the board to indicate by the ringing of a bell should the rate of discharge from the batteries be excessive. Two voltmeters are also fixed on this board. The construction of this switchboard is exactly similar to that of the high-tension board, and has the same vertical dimensions, so that when the additional circuit panels are erected on the high-tension board they will form one complete board and be uniform in appearance.

Underground Mains.

The contract for the whole of the work in connection with the system of mains outside the station was placed in the hands of the Callender Cable and Construction Company. The type of cable employed both for the high-tension feeder mains supplying the sub-stations, and for the low-pressure network from which consumers are connected, consists of concentric conductors, each one insulated by a dielectric of bitumenised fibre, the outer dielectric being sheathed with a very heavy covering of lead, and finished by a yarn braid and compounded. These cables were drawn into the stoneware ducts or pipes. In certain instances it was found more convenient to armour the low-pressure distributors, and they were then laid direct in the ground in the usual way. Prior to the commencement of the operations in connection with the electric supply, certain alterations were made in the main thoroughfares of Morley, and advantage was then taken of the ground being open to lay wherever possible a conduit consisting of six-way Doulton casing and 4in. earthenware pipes. This system has been continued throughout the whole of the business portion of the town, with the exception that in crossing roadways strong cast-iron pipes have been substituted for the earthenware pipes or casing. There are four high-pressure feeder cables which supply the sub-stations direct from the generating station. These are: No. 1 feeder, which runs to the Park-street sub-station, with an extension to the Bruntcliffe-road sub-station for supplying Bruntcliffe; No. 2 feeder supplies the Fountain-street and town hall sub-stations; No. 3 feeder loops into the town hall sub-station, and supplies Morley Bottoms and Church-street sub-station; No. 4 feeder runs to South Queen-street. The sectional area of the conductor used for Nos. 1, 2, and 3 is $^{19}/_{16}$, and for No. 4 $^{7}/_{16}$. The cables are all drawn into the ways of the Doulton casing. Spare ways have been provided in the casing for future feeder extension. The low-pressure network throughout consists of $^{37}/_{14}$ concentric cable, and except where laid as armoured cable, these mains have been drawn into the 4in. stoneware pipe previously referred to. Mains have been laid in the following streets: Queen-street, South Queen-street, Morley Bottoms, Chapel-hill, Church-street, Victoria-road, Fountain-street, Park-street, St. Andrew's-avenue, Bruntcliffe-road, Hope-street, and part of Commercial-street. Arc lighting mains are laid on each side of Queen-street, extending from South Queen-street to Morley Bottoms. The lamps are supplied from the low-pressure system, and the cables used are twin $^{7}/_{16}$, with vulcanised bitumen dielectric lead-sheathed and braided. The whole of the cables were manufactured by the Callender Company at their factory at Erith, and the work of laying them, including excavation, supplying and laying of casing and pipes, and the various connections at the sub-stations, etc., was carried out under the charge of Mr. F. B. Collard, who acted as their resident engineer.

Sub-Stations.

There are at present six sub-stations for dealing with the distribution. They have been equipped with E.C.C. switch-gear and transformers. The special feature of the transformers is that the magnetic circuit is circular, with only one joint, thus giving the least magnetic resistance for a given area of winding. The stampings are also arranged in two sizes to increase the effective cooling surface, the temperature rise of the iron being kept under 40deg. F. The 20-kw. transformers give a drop of 1·6 per cent., the open-circuit loss being 215 watts at 60. The cases are of cast iron, with large cooling surface, and are made quite watertight.

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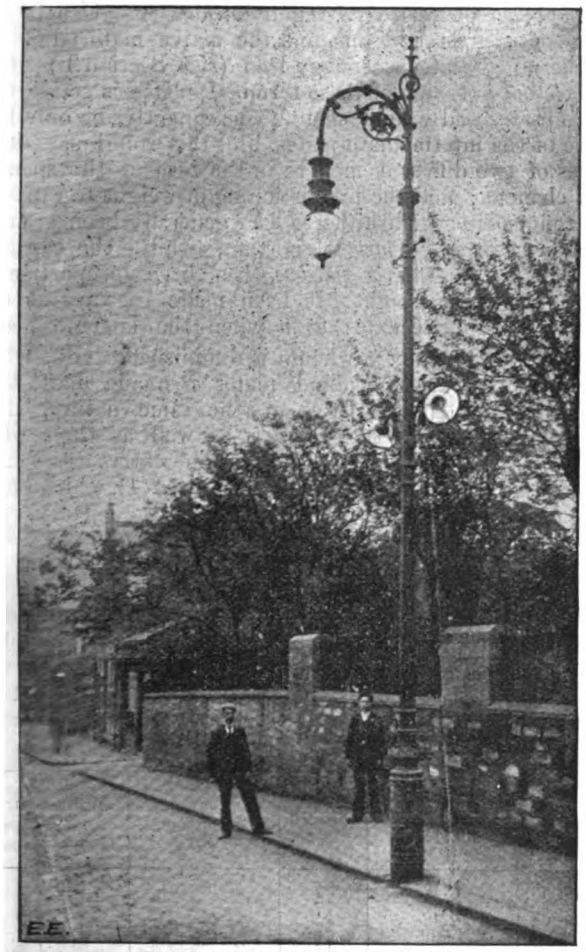
Public Lighting.

The Corporation has adopted a small scheme of street-lighting by electricity. Arc lamps are used up to midnight, and are then replaced by two incandescents erected half-way up the pillars. The arc lamps in use are 11 in number, of the E.C.C. improved type, in which the feed is controlled by a brake wheel, which is provided both with ratchet teeth and also a plain surface on its periphery, where two brakes are applied, one striking the arc and the other giving such regulation as to allow the carbons to feed almost imperceptibly. The lamp is so constructed that it burns satisfactorily without a choking coil being inserted in the circuit. The lamps take 500 watts at a pressure of 39 volts, the current being supplied from a transformer for each lamp, reducing the voltage from 200 to that required by the lamp. A low-tension double-pole switch and fuse is fixed with the transformer in the base of each of the columns, also a change-over switch, which is for cutting out the arc lamps and putting in 200-volt incandescent



View of Arc Lamp Column at Morley.

lamps. The columns, which are 20ft. high to centre of arc, were supplied by Messrs. James Allen, sen., and Son, of Glasgow, and are of an ornamental design, fitted with overhanging bracket to carry the arc lamp, and with two brackets about 13ft. from the ground for the incandescent lamps.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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In the interval of delay—due to temporary indisposition—which has occurred in writing these notes, I have been requested from several quarters to be as explicit as possible in regard to the formulæ in which unit surface is taken as a basis in the design of a cell to suit any given requirements. These formulæ are more especially applicable in the use of an *embedded* lead grid or perforated conducting plate, embodying a method of construction which necessitates a very perfect adherence of the active material to the lead conductor, and also a very perfect coherence of its own particles under the stress of successive charges and discharges. Until recently this adherence and coherence of the active material could not be obtained with certainty in the case of *both* elements of a lead secondary cell; nor could they be obtained at all in conjunction with certain economic requirements of importance from a manufacturing point of view. Assuming that the difficulties in this direction have been practically overcome—which is confidently stated to be the case—the data and formulæ given in the following section (CXII.) are of considerable interest; since they will certainly be employed in designing, on scientific lines, accumulators to run for specified periods of time, under given limitations in regard to normal and maximum rates of discharge. Accumulators so designed will be of the *minimum* weight compatible with the requirements—the lightest batteries practically possible for certain specified work done at a specified rate. In other words, they will be batteries adapted for *traction*.

[Erratum.]

A little mistake or slight oversight at the commencement of a calculation will, of course, invalidate the whole of it. Such a mistake was made in Problem 3 under Section CXI., p. 593. The weight of active material required per square inch of plate is not $\Delta\ \theta$, as there stated, this being the capacity in ampere-hours per unit surface. It should be ·7oz. $\times \Delta\ \theta$; ·7oz. being taken as the weight of active material required per ampere-hour. I have, therefore, to rewrite that portion of the section commencing with "Problem 3."

Problem 3.—The required density of (discharge) current in a given accumulator is $\Delta = ·07$—*i.e.*, this fraction of an ampere per square inch of surface is the current of discharge. The time of discharge is θ = six hours, the specific gravity of the active material (peroxide) is taken as 8, and its weight per ampere-hour (III.) is taken as $·6 \times 1·155 = ·7$oz. nearly. It will be seen that the weight of active material required per square inch is $·7 \times \Delta\ \theta = ·7 \times ·07 \times 6 = ·294$oz. What will be the thickness (τ) of the active material in the case of a plain support?

The volume of active material per square inch will be

$$\therefore\ v = \frac{·294\ (\text{oz.})}{·577 \times 8} = ·064 \text{ cubic inch.}$$

And the same numerical value will be the fraction of an inch expressing the thickness of the layer of active material.

Thus, $\tau = ·064\text{in.} = 64$ mils. . . (*Answer.*)

Problem 4.—The weight of active material per square inch of surface being ·294oz., as above, it is required to know what will be the thickness of the layer if, instead of a plain lead support, a perforated sheet of lead 75 mils thick, and weighing 129 grains per square inch, constitutes the embedded conductor.

It must here be borne in mind that—excepting in the case of the terminal plates—the perforated conductor is coated on both sides with the active material, and that consequently only one-half of the active material contained within the perforations belongs properly to each surface.

The weight of a solid plate of lead 1in. square and ·075in. thick is $6·56 \times ·075 = ·492$oz. $= ·492 \times 435·5 = 214$ grains. The weight per square inch of the perforated support being $w = 129$ grains, the space cleared by the perforation is—

$$v = ·075 - \frac{129}{2{,}870} = ·03 \text{ cubic inch.}$$

Half of this volume, or ·015 cubic inch, properly belongs to the layer of active material on each side of the square inch of perforated lead. Subtracting this from the ·064 cubic inch of active material per square inch of area on each side of the plate (in Problem 3), the remaining ·049 cubic inch will be distributed above the surface of the plate; and the same numerical value will now express, as a fraction of an inch, the thickness of the layer above the plane of the surface.

Thus, instead of 64 mils, the thickness of the outside layer will be in this case

$$\tau = ·049\text{in.} = 49 \text{ mils.}$$

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CXII.

Some Data and Formulæ.

$$\text{Weight of one cubic inch of Pb} = \begin{cases} 2{,}870 \text{ grains.} \\ 6{\cdot}56\text{oz.} \\ {\cdot}41\text{lb.} \end{cases}$$

$$\left.\begin{matrix}\text{Weight of one square inch of} \\ \text{sheet lead of thickness } t\end{matrix}\right\} = 6{\cdot}56{\cdot}t \text{ (oz.).}$$

If w = weight of one square inch of perforated sheet lead, and w_1 the weight of metal removed by perforating or recessing, etc.,

$$w_1 = 6{\cdot}56\,t - w \quad . \quad . \quad . \quad . \quad . \quad \text{(I.)}$$

If v be the volume of w_1 (which will be the volume of the active material to be contained within the perforations) then, since the volume in cubic inches of one square inch of lead plate is numerically expressed by its thickness in inches, whilst the volume of the perforated plate, in cubic inches, is expressed by the ratio of its weight to that of unit volume of Pb (CX.):

$$v = t - \frac{w\text{ (oz.)}}{6{\cdot}56}\text{ (cubic inches)} \quad . \quad . \quad . \quad \text{(II.)}$$

Calling p (or s) the weight of the peroxide (or spongy lead) active material within the perforations, this will be the weight of an equal volume of water* multiplied into the specific gravity of the active material:

$$p = v \times {\cdot}577 \times \text{sp. g. (oz.).} \quad . \quad . \quad . \quad \text{(III.)}$$

Or the weight (p) will be that of the lead removed multiplied into the ratio of the specific gravity of the active material to that of metallic lead:

$$p = w_1 \frac{\text{sp. g.}}{11{\cdot}4} \quad . \quad . \quad . \quad . \quad . \quad \text{(IIIA.)}$$

If v_1 be the volume of the active material per square inch outside the perforations, or in which the support is embedded, p_1 the weight of this portion of active material, and τ the thickness of the layer of active material on the surface of the support:

$$\tau = v_1 = \frac{p_1}{{\cdot}577 \text{ sp. g.}}\text{ (in.)} \quad . \quad . \quad \text{(IV.)}$$

whence

$$p_1 = v_1 \times {\cdot}577 \text{ sp. g. (oz.)} \quad . \quad . \quad . \quad \text{(V.)}$$

Calling P the total weight of active material allowed per square inch of *surface* (not of grid),

$$\text{P} = p_1 + \frac{p}{2} = p_1 + \sqrt{(6{\cdot}56\,t - w)\frac{\text{sp. g.}}{22{\cdot}8}} \quad . \quad \text{(VI.)}$$

(22·8 being twice the specific gravity of Pb, since p is halved),

whence

$$p_1 = \text{P} - (6{\cdot}56\,t - w)\frac{\text{sp. g.}}{22{\cdot}8} \quad . \quad . \quad \text{(VA.)}$$

CXIII.

In problem 4 (CXI.), P is given as ·294oz, t as ·075in., w as 129 grains = ·295oz., and specific gravity as 8. The thickness, τ, of the layer of insulating material is required. Solving by formulæ (VA.) and (IV.):

$$p_1 = \text{P} + \sqrt{(6{\cdot}56\,t - w)\frac{\text{sp. g.}}{22{\cdot}8}}$$

$$= {\cdot}294 - (6{\cdot}56 \times {\cdot}075 - w)\frac{8}{22{\cdot}8}$$

$$= {\cdot}294 - {\cdot}197\frac{8}{22{\cdot}8}$$

$$= {\cdot}294 - {\cdot}07 = {\cdot}224 \text{ (oz.)},$$

and

$$\tau = \frac{{\cdot}224}{{\cdot}577 \times 8} = {\cdot}049 \text{ (in.)}.$$

Or the thickness of the layer of active material is 49 mils. (*Answer.*)

Problem 5.—In the case of a lead grid 1ft. square and ¼in. (t) thick, weighing 4lb. 14oz., it is required to know what weight of active material (specific gravity 6·82) must be allowed per square inch of *surface* (not square inch of grid) to give a layer of thickness (τ) ·05in. above the surface of the metal.

The average weight (w) of one square inch of grid $= \frac{\text{4lb. 14oz.}}{144} = {\cdot}542\text{oz.}$

By (VI.) $\quad \text{P} = p_1 + \sqrt{(1{\cdot}64 - {\cdot}542)\frac{6\,82}{22{\cdot}8}}.$

And since $\quad v_1 = \tau,$

By (V.) $\quad p_1 = {\cdot}05 \times 577 \times 6{\cdot}82 = {\cdot}19\text{oz.}$

Then $\quad \text{P} = {\cdot}19 + 1{\cdot}098 \times {\cdot}3.$

$$= {\cdot}19 + {\cdot}329 = {\cdot}52\text{oz.} \quad (\textit{Answer.})$$

CXIV.

The weights, w, w_1, etc., being given, and also the values N and n (CVI.), it should be easy to calculate approximately, by means of a simple formula, what should be the total weight—exclusive of the containing vessel—of any battery containing a known number (n) of plates of a given area (a). The only difficulty or, rather, complication in making this calculation arises from a slovenly neglect on the part of manufacturers to make the weight of every plate proportionate to its required capacity. Usually the number (n) is an odd one, and the active material of the two terminal plates is spongy lead (*vide* Section I.). One surface only of each of these terminal plates is active, and the capacity and weight should, consequently, be only half those of the intermediate plates. But this would necessitate plates of two different models, in the case of the spongy-lead element; and the proportioning of weight to capacity is a refinement which hitherto has generally been scouted as unnecessary. Thus it is that, whilst the capacity of the plates, *cæteris paribus*, has been proportionate to $(n-1)$, their weight has been made to vary as (n). Now $n-1$ approximates to n when the latter value is increased, and to $n \times {\cdot}6$ when n is diminished.* But when the weight of the terminal plates is made half that of the intermediates plates of the same nature, then the total weight of these plates, as well as their total capacity, varies as $n-1$. And this value enters as a factor into all the other products, besides $w \,.\, a\,(n-1)$, which make up the sum total of the weight of the storage battery.

CXV.

"The results of tests on a seven-plate cell," says Mr. R. Kennedy,† "cannot be compared with the results of tests on a 17-plate cell; the table shows this clearly." The table here referred to is one given by Prof. Ayrton for the "capacity in watt-hours per 1lb. gross weight of certain traction cells when discharged in eight hours." It includes the following results:

Name of cell.	Type.	No. of plates.	Box material.	Watt-hours capacity per pound (gross).
Chloride.	T.B.	7	Ebonite.	5·7
,,	,,	17	,,	7·2
I.E.S.	A.	7	Teak and lead.	6·4
,,	,,	17	,,	7·4
,,	,,	7	Vulcanite.	9 2
,,	,,	17	,,	10·5
E.P.S.	Faure-King.	7	Ebonite.	8·6
,,	,,	19	,,	10·2

The weight of the containing box is, of course, included in the gross weight; but the fact that this would be comparatively greater in the case of the batteries having the smaller number of plates would not account for the greatly increased capacity per pound of the cells with the greater number of plates. The main reason is no doubt that the terminal plates were the same in weight as the intermediate

* Strictly speaking, at the temperature of 4deg. C., which is that of maximum density, nearly.

* A favourite method of demonstrating the superiority of one cell over another is to take, say, a three-plate cell of a well-known standard make, and compare its output per pound of plate or per pound of battery with a five or seven plate cell—plates of same size and weight—of a new manufacture; by this little exercise of ingenuity immense improvement can be shown.

This is how it works out: "Take a three-plate cell, each plate weighing 2lb.; total weight 6lb. of plate, output 20 ampere-hours. Now take a five-plate cell, total weight 10lb.; we have not doubled the weight, but we have doubled the output, for we have two positives in place of one; so a five-plate 10lb. cell gives 40 ampere-hours, whereas a three-plate 6lb. cell gives only 20 ampere-hours."—*Electrical Review*, Dec. 17, 1897.

† *Loc. cit.*, Jan. 7, 1898, p. 7.

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ones of the same nature, and that consequently the total weight of these plates varied simply as (n), whereas their effective capacity varied as $n-1$. When the scientific (and common-sense) rule, that the weight of a plate should be made proportionate to its required capacity, is applied, then the results obtained with a cell having a small number of plates may be compared with those obtained with any larger cell, provided the rate of discharge be approximately the same in both cases. The weight as well as the capacity of a battery will then be proportionate to $n-1$.

ELECTRIC SIGNALLING WITHOUT CONNECTING WIRES.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

(Continued from page 679, Vol. XXI.)

We have now found that the conditions necessary for the production of electrical oscillations involve the existence of two important properties in electricity—viz., a property akin to *inertia*, which has been termed the *self-induction* of the current; and another property, to which the name of *electrostatic capacity* has been given, which resembles in many points the *inverse of the elasticity* of a substance. It was mainly to point out as clearly as possible the analogy between these physical quantities that the last article was written.

Water flowing through a pipe possesses inertia, which is often exhibited when a tap through which it is freely flowing is suddenly closed by the bursting of the pipe. At the time when Faraday published his researches the properties of electrical currents which appear to bear some analogy to the inertia of moving bodies were little known; to-day dynamos and transformers have rendered such properties the commonplaces of the workshop. One cannot help being lost in admiration, on reading the ninth series of Faraday's *Researches*, at the clearness of insight which renders the conclusions there drawn as potent to-day as when they were written. The inertia possessed by moving water resides in the water itself, Faraday points out, whilst the inertia of electricity depends, not alone on the electrical current, but on the form of the circuit, and the presence of other conductors or magnetisable bodies in the neighbourhood. Hence, he asks, may not this property be due to the motion of something in the space surrounding the circuit?

Optical experiments have led us to postulate the existence of an universal, all-pervading medium which we term ether, with an assurance scarcely less than that with which we believe in the existence of ordinary matter. Though we are not directly cognisant of this medium with our senses, its properties are becoming day by day clearer to our apprehension—much clearer, indeed, than the ultimate properties of atoms or molecules as the basis of the constitution of ponderable matter. It was the crowning glory of Maxwell to have invented a theory which, whilst giving a first approximation to an ultimate theory of electrical phenomena, showed the connection of these phenomena with the ordinary properties of light waves.

As previously mentioned, the variation of a current flowing round a coil of wire may produce observable electrical phenomena in another coil, the two being perfectly insulated the one from the other, and placed at a great distance apart. The work of Hertz has shown us that the two phenomena are not coincident in time, that a certain appreciable, though very small, interval elapses before the variation of the current in the first coil is followed by the induced current in the second. Further, this interval is found to be that which light would take to travel over the distance between the two coils. Light, we are bound to suppose, consists of waves propagated through the ether; perhaps, then, electrical phenomena are intimately connected with motions of the same medium. Might it not be possible even to produce electrical waves which would differ only from light waves in having greater wave-lengths? Such questions might have been considered speculative 15 years ago; to-day, they are well known to have been answered most emphatically in the affirmative.

The following analogy may help to give some idea of the way in which, according to Maxwell, electromagnetic disturbances are propagated through the ether. Imagine a chain (Fig. 1), consisting of alternate links of iron and copper, insulated the one from the other. Let a current be suddenly started in the right-hand copper link. This current will magnetise the iron link which is threaded through it, and, on the now well-known transformer principle, an E.M.F. will be generated in the next copper link, due to the variation of the magnetic induction passing through it. The resulting current will magnetise the next iron link, and so on. Thus, it would be possible to transmit signals to a great distance without any electrical connection, as generally understood, being established between the sending and receiving stations.

Now, suppose that each copper link, instead of being continuous, was broken at a point, the two ends being connected to adjacent plates of a condenser. Further, imagine the copper itself to be a perfect conductor, so that no energy will be dissipated as heat when a current flows through it, and that no hysteresis losses occur in the iron. When the magnetisation of one of the iron rings is altered, the E.M.F. induced in the copper links which are threaded through it will produce a transitory electrical current which will charge the condensers; these currents will affect the magnetisation of the succeeding iron links, and the electrical signal will be propagated along the chain as before. In this case no energy is dissipated in heating the copper links, the whole of the original energy being transmitted along the chain. The electrostatic (potential) energy accumulated in each condenser will in its turn be given up to the next condenser through the agency of the connecting iron ring.

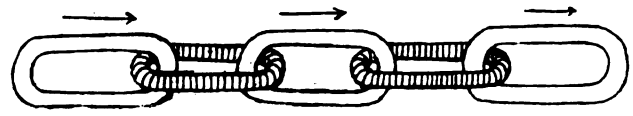

FIG. 1.—Shaded links are iron, unshaded ones copper. On suddenly starting a clock-wise current in the right-hand link; currents in the direction of the arrows will be induced in the succeeding links.

An infinite number of such chains stretching along different paths between two points would form a rough model of Maxwell's ether. The transitory currents flowing round the copper links and charging the several condensers would represent his "displacement currents"—currents whose flow is resisted by an elastic force (that due to the increase of the potential of the condensers), but unattended by dissipation of energy. Further, the permeability of the iron links must be supposed equal to unity. The velocity with which disturbances will be transmitted along such a system can be found in a manner similar to that used to determine the rate of propagation of elastic strains in a material medium. Here, also, the velocity will be given by

$$\sqrt{\frac{\text{Elasticity}}{\text{Density}}},$$

when a suitable meaning is given to the terms elasticity and density. Density, as previously pointed out, will be connected with the self-induction of each circuit, which will obviously be proportional to μ, the permeability of the magnetisable links. The elasticity of each circuit will be inversely proportional to the capacity, κ, of the condenser in each circuit. Finally, the velocity, v, with which disturbances are transmitted through the ether will be given by

$$v = \sqrt{\frac{1}{\kappa\,\mu}}.$$

κ is termed the dielectric constant of the ether, or sometimes, less admissably, the specific inductive capacity of a vacuum. v has been determined with considerable accuracy from purely electrical experiments, and has been found to be equal to the velocity of light, as deduced from optical experiments.

We have now got some idea of the conditions under which electrical oscillations may be produced in a circuit, and of the mechanism by means of which such oscillations, according to Maxwell's theory, are capable of influencing another conducting circuit placed at a distance, no ordinary electrical connection existing between the two. In fact, we have determined roughly the conditions necessary for

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the existence of the so-called "wireless telegraphy." The electrical arrangements used in any system will vary considerably with the qualities which are considered to be of most importance. In this, as in many other practical applications of scientific principles, it is found that a considerable gain in one direction is generally attended with a drawback in another direction. Two conditions, mutually exclusive to a greater or less extent, have generally been sought. Some have attempted to produce very short electrical waves, whilst others have considered that the production of as large a number of synchronous continuous vibrations as possible was the condition of greatest importance. The general principles underlying these rival methods will be considered in my next paper.

(To be concluded.)

ROYAL INSTITUTION.

The exhibits in the library at the Royal Institution are certainly a very attractive feature at the usual Fridays' soirées, but their connection with the evening's lecture in the adjacent theatre is sometimes not equally apparent. At a recent lecture Dr. Flinders Petrie—we may well say *the* authority upon Egyptian tombs—gave a clear and concise history of the origin of these monuments. On the same evening we noticed in the library exhibits from the General Electric Company, electric steering gear by Messrs. Siemens Bros., an electric motor by Mr. Orme Bastien, an automatic welder by the Electric Welding Company, Limited, and an exhibit showing what is called the natural process of welding or joining cycle frames, patented by the firm of Felsche, Roderwald, and Co., Magdeburg (Felsche's patent), the object of which is to avoid the tedious and expensive process of brazing. What bicycles and electricity have to do with Egyptians dead and buried 5,000 years ago is somewhat difficult to imagine, unless it was intended to show that in spite of all the recondite wisdom of these ancients we have something to show which they had not.

revolutions per minute, periodicity = 50 complete cycles per second. The armature consists of six coils of the flat pancake type, suitable for resisting the sudden strains thrown upon it when the welding circuit is made and broken. The core is built up of sheets of stamped iron. The current is collected by means of strip copper brushes from the two collector rings mounted on and insulated from the shafts. The field magnets consist of six coils forming six poles.

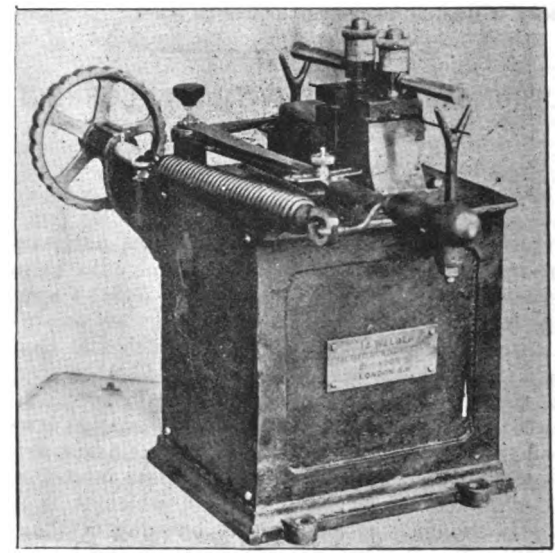

FIG. 1.—Electric Welding Gear.

The field is excited by means of a separate exciter, shunt wound, 110 volts 40 amperes, belt-driven from the end of the dynamo shaft. The method of operating the dynamo and exciter for welding is as follows: A circuit is run from the exciter to a spot alongside the welder, where a circular rheostat is fixed and worked by the smith. This rheostat is in series with the field coils of the alternator and exciter main circuit. The only electrical knowledge needed by the smith is that on turning the handle of the rheostat one way he can get the metal to be treated hot, and can increase the heat by moving further in the same direction or decrease or stop the heat altogether by moving it in the opposite direction. The actual welding voltage is, as is well known, about one volt. The welder itself consists of a specially-designed transformer having many turns on the primary circuit and one solid copper turn for the secondary. The ends of the secondary terminate in clamps in which the metal to be

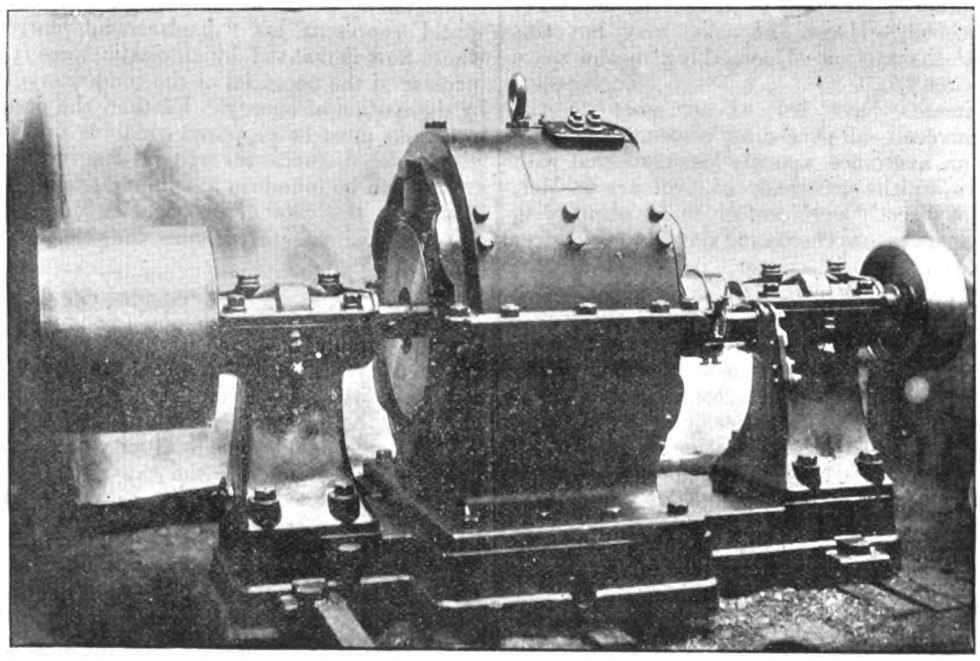

FIG. 2.—Separately-Excited Alternator for Electric Welding.

The illustration (Fig. 1) shows the electric welding machine referred to above. It is a simple contrivance and does easily the work for which it is intended—*i.e.*, that of welding together pieces of iron, steel, brass, and copper—and is capable of welding iron wire up to No. 00 size and copper wire No. 4 size for intermittent working. For continuous working the same machine will weld up to No. 2 iron and No. 6 copper.

The alternator (Fig. 2) is designed to give an output of 300 volts and 200 amperes (maximum) at a speed of 1,000

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welded is held, with the ends firmly abutting. On connecting the primary circuit with the source of supply, heat is generated at the points of contact of the metal in the secondary circuit. One clamp is a fixture, but the other is provided with suitable traversing gear either operated by hand or power, and the soft metal is squeezed together at the proper moment, thus enabling a perfect weld to be made. In the smaller types the operation of welding is made quite automatic, the current being cut off from the primary by means of a switch which comes into operation directly the metal has become soft enough to be squeezed up a predetermined amount. This amount can be varied by altering the adjustment of the automatic switch.

Amongst the exhibits were many welded pieces of various metals, broken, bent, and twisted with great force after the welding. They were all broken outside, sometimes quite near, the weld. The ratio of weld to solid given varied from 91 per cent. to 92½ per cent.

What was shown for the first time in England was a complete cycle frame electrically welded, and a complete collection of parts which make up a bicycle which had been manufactured solely by the welding process. The pieces were made out of sheet-steel stampings, bent up and welded at the long seam. All the parts of the frame were there—headposts, heel-lugs, bottom brackets, pedals, etc. We also saw some steel tyres made by the Electric Welding Company's process and intended for omnibus wheels, and were informed by Mr. Wallis-Jones that while it takes a good man and his striker to turn out five to seven of these in an hour in the fire, 25 have been welded with the electric welding machine, and an average of 20 per hour was kept up during a whole working day. Such an economy in time must necessarily mean a corresponding reduction of the cost of the finished article.

HIGH-VOLTAGE ACCESSORIES.

The Edison-Swan United Electric Light Company, Limited, have kindly forwarded us some advance details of their new high-voltage accessories which they are now placing on the market. These are new types, and hence worthy of a special reference in our columns as tending towards the standard article for 220-volt pressure.

The first of these is a high-voltage tumler switch, having an extra long break and an increased space between the terminal blocks. The form of contact is the patent spring copper channel, and the terminals are of the direct-wiring barrel type with clamping screw. This switch is supplied in two sizes—8 and 15 amperes—and can be fitted with fluted brass or bronzed covers, porcelain covers, or fluted metal covers fitted with the company's anti-shock liner. This pattern switch is also supplied with a small roller wheel at the foot of the actuating lever handle, which has the effect of decreasing the friction between the lever and the closer when switching on or off, this making the movement somewhat easier.

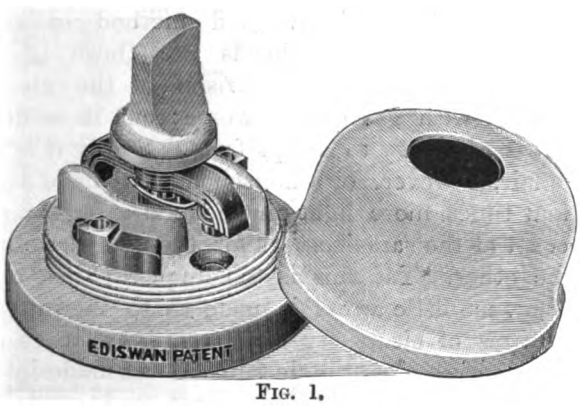

FIG. 1.

Another form of Ediswan high-voltage single-pole porcelain switch is illustrated in Fig. 1. The principal features of this switch are that the porcelain cover entirely protects all the metal parts, and the handle being of porcelain there is no chance of getting a shock. The terminals are of the direct-wiring or barrel type with side clamping screws, and are separated from each other and from the central spindle by porcelain walls, which fit right on to the porcelain cover when it is screwed on, thus preventing any possibility of an arc forming between the contacts. The contact bar is laminated, and makes a good rubbing contact. This form of switch is made in black or white porcelain in two sizes, 5 and 10 amperes.

Fig. 2 illustrates a high-voltage double-pole switch. This form of switch has been specially designed for use on branch circuits for motors, arc lamps, etc. The opposite poles are separated by a high porcelain wall, which practically forms two separate chambers when the cover is in position. The distance between the contact terminals and the length of break is ample

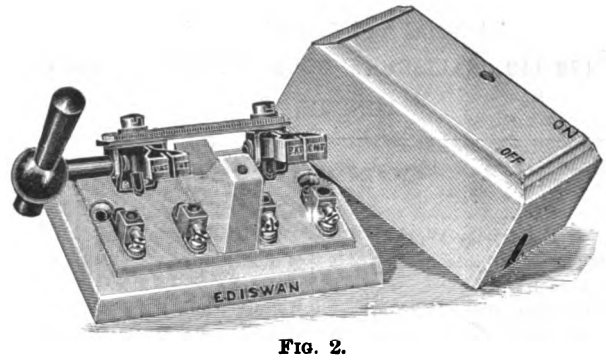

FIG. 2.

for voltages up to 250. The handle projects through the side of the cover, and being entirely of ebonite prevents any chance of a shock. This switch is made in three sizes—8, 15, and 25 amperes.

The high-voltage two-pin wall plug, shown in Fig. 3, is also a new type. The opposite poles are embedded in porcelain and the terminal connections are separated by means of porcelain walls, the long-break fuse being passed through one of the walls. The terminals in the two-pin plug are of the direct-wiring type, the wires being fixed by side clamping screws, and a special device is provided for taking the strain off the terminals. This

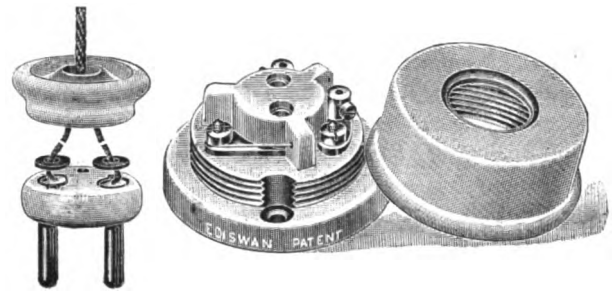

FIG. 3.

plug is made in one size only, five amperes, in black or white porcelain.

Fig. 4 illustrates the new Ediswan high-voltage "anti-shock" lampholder. This form of lampholder has now been on the market for some time, and is too well known to need description; the interior is of the well-known Ediswan patent "S" type, and the whole of the working parts are entirely surrounded by an enamelled liner, thus preventing any stray wires or dirt making contact with the metal exterior. This liner can be fixed to any of the company's "S" holders without increasing the size.

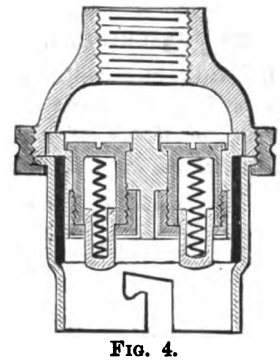

FIG. 4.

In addition to the articles illustrated above, the company has brought out a number of new designs for high voltage—main switches, branch switches, cut-outs, ceiling roses, switchboards, etc.—amongst which may be specially mentioned a cheap spring copper contact chopper switch up to 50 amperes on porcelain base, both single and double pole, and a two-way or change-over ratchet type five-ampere tumler switch with porcelain cover. Full particulars of all the above articles will be contained in the new high-voltage catalogue which will be ready for distribution in a few weeks.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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HAVE COURAGE.

Underlying the speeches made at the opening of the Morley electricity works were two dominant ideas, one of which is fairly accurate; the other is merely a touch of human nature. In the first place, the idea which firmly held sway in the mind of each speaker was that electricity works should be under the control of the authorities from the start. Alderman Horsfall pointed out the great cost to municipalities that let their opportunity slip and had to purchase back again after private venture had proved the necessity—we will not even say success—of the undertaking. For the moment we have no means except memory of checking the statement of Alderman Horsfall, but, at any rate, his figures are, even if not absolutely, approximately correct. He stated that at Leeds a company had spent one hundred and eighty thousand pounds, and the Corporation had agreed to pay, in order to obtain control, double that amount, or three hundred and sixty thousand pounds. Again, Birmingham was satisfied to buy out for four hundred and twenty thousand pounds a private company that had spent some two hundred and twenty thousand pounds. Sheffield, also, was cited, and Liverpool might have been in a similar strain. These figures were given and other statements made to show that the Morley authorities had some good ground for themselves undertaking the work of electrical generation and distribution. But all this set forth in clearer light the other idea, which showed that every man was fearful of failure; and, as we stated in a recent leader, the Morley authorities are not alone in this feeling. Stations that are equipped, in fear and trembling, with a view to possible failure mean far too often too little initial expenditure. We do not for one moment intend to infer that such is the case at Morley. We rather want to strengthen the backs of the various authorities, and get them to start on the work with the idea that failure is almost impossible and success as certain. In this world there will always be failures. In electric lighting work the failures are the exception which prove the rule, that a properly designed and equipped station must be successful. The counting of heads is a good method of comparison only when the heads are those of the dead, and the direct comparison of the electric light bills with gas bills is worse; but it is done, and it is necessary to accept facts. Surely it is not quite fair, however, for a householder to have three or four times more light in the one instance and expect it at the same cost as for the lesser amount in the other. Yet this is too frequently the case. Further, too little stress is made as to the indirect advantages of electricity over gas. So far as our memory serves, not a single allusion was made in the speeches to indirect advantages, yet these certainly have a money value, and when bills are compared should come into the comparison. The refrain of more than one speech was to the effect that there was the station, and to make it successful commercially the householders must take the light. It needs no prophetic instinct here to asseverate most emphatically that ere long the advantages of electric over

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gas light will commend themselves to consumers, and that there will be no lack of connections. "Rome was not built in a day" is a statement often made to moderate the speed of a man's expectations, and it may well be applied to central-station work. The authorities should not expect an instantaneous success. They should allow for a little lapse of time ere the old is put off in favour of the new. Their haste to make both sides of the balance-sheet meet is often detrimental to the best interests of the station, and it is especially hard upon the resident engineer, who is too frequently held to be responsible for the monetary condition of affairs. Some engineers feel the weight of this responsibility more than others; and recollecting the two ways of arriving at a satisfactory money result, the increase of revenue or the decrease of expenditure, too often tamper too far with the latter. There is too much hedging for a loss, and too small show of courage of convictions. The latter is wanted, and we trust the late and costly actions of the big towns mentioned will have their due effect.

WINCHESTER ELECTRICITY WORKS.

The works of the Winchester Electric Light and Power Company, Limited, situated in Hyde Abbey-road, were formally opened yesterday by Mr. T. F. Kirby, the chairman of the company.

Mr. J. C. WIGHAM, the consulting engineer for Edmundsons' Electricity Corporation, Limited, who had carried out the whole of the work, conducted the party through the boiler-house, engine-room, etc., explaining the different machinery, and remarking that everything was duplicated.

The MAYORESS (Miss Alice Bowker, sister of the mayor) then started the engines and switched on the current, being presented at the same time by Mr. Kirby with a gilt replica switch of H.M. waiting-room at Windsor, for use as a paper-weight in commemoration of the event.

The MAYOR (Alderman Alfred Bowker) having suitably replied, the party adjourned for luncheon provided by the directors of the company at the Grand Hotel.

Mr. KIRBY, who occupied the chair, proposed "The Mayor and Corporation."

The MAYOR, in responding, said they had already applications for about 3,000 lamps. They had been very fairly treated by the company throughout the construction of the station. He begged to propose "Success to the Winchester Company."

Mr. F. E. GRIPPER, managing director, replied, giving a history of the works since their commencement.

Mr. WIGHAM also replied.

Alderman SHENTON proposed the health of "The Visitors," to which Colonel HAMILTON, of Ryde, responded, expressing a hope that the municipal authorities of that town would soon follow suit by introducing the electric light.

Other laudatory speeches having been made, a vote of thanks to the chairman terminated the proceedings

A Large Storage Battery.—Mr. C. E. Kammeyer describes in the *Electrical Review* of New York what he says is the largest battery of accumulators in the world. It is used at the works of the Chicago Edison Company. The battery has a capacity of 22,400 ampere-hours, at an eight-hour rate, and is able to discharge 11,000 amperes for about 1¼ hours. It consists of 166 cells (60 of which are end cells), 83 on each side of the three-wire system. This large number of end cells is required to meet the wide variation of pressure. The battery is called upon to deliver 140 volts on each side at the end of discharge, and in case of an emergency must deliver current at a maximum of 120 volts on each side, when fully charged.

MUNICIPAL ELECTRICAL ASSOCIATION.

THIRD ANNUAL MEETING.

THIRD DAY'S PROCEEDINGS.

(Continued from page 751, Vol. XXI.)

The two following papers were next read in abstract by their respective authors:

Electric Traction.

BY J. E. STEWART, BOROUGH ELECTRICAL ENGINEER, DERBY.

The paper I venture to lay before this association will, I fear, be disappointing to my engineering brethren, as it will more concern the chairmen of committees, and gentlemen who have the responsibility of leading the policy to be pursued by corporations, and of voting the necessary funds for the purpose of carrying out such schemes; and what I have to say is with a view of promoting discussion, and to obtain the advice of these gentlemen so that other or all towns may see for themselves what is the best policy to be pursued with regard to street railways or tramways that this association can recommend. I do not wish it to be understood that I necessarily recommend or advise upon any of the points I lay before you, but do so solely with a view of gaining myself the knowledge of what you consider the best course to follow. There are several towns which are now considering the question as to the advisability of buying up the existing horse tramlines, and are wondering what is to be done with them if they become corporate property, and some are trying to arrive at that stage when they are prepared to vote for an electrical equipment, and then further on what scheme of electrical traction shall be adopted; after that, whether a separate power-house shall be laid down, or the current taken from their existing plant in the electricity supply works.

Starting with the assumption that the electricity supply works is now in the hands of the corporation, and that the tramways are also the property of the corporation, and that it has been decided to equip the same with electric motorcars, the first consideration is, Shall the current be supplied from the existing works? This, I believe, should be answered in the affirmative, for the sufficient reasons that the same buildings, boiler, power, and plant will answer the purpose, and the necessary spare plant will not be augmented, but, on the contrary, considerably reduced in proportion to the output, as accumulators would be introduced to, as far as possible, reduce the necessity of adding plant to take the load over the lines when the maximum load for the ordinary supply occurs at the same time as the traction load.

Secondly, the cost of keeping accounts will be very much reduced, as the work that is necessary to keep the electricity works accounts will not be added to as would be the case when a separate power-house is laid down. The power used would be metered as for an ordinary consumer and charged for as such. The interest and sinking fund on the capital outlay on buildings will not be increased, or only slightly so, which would not be the case if a separate power-house were decided upon. The same staff of men practically would do, or in any case with a small increase only necessary. The same engineer would in consequence control the whole supply, and would, of course, be handsomely recompensed for the added responsibility. I recommend Glasgow Corporation as a pattern to all our esteemed chairmen of committees. There they have raised the engineer's salary by £250 per annum to begin with.

Having decided so far that the one works should do all the work necessary to supply electrical energy for whatever purpose it may be required, it cannot too carefully be considered as to what arrangements should be made to save confusion and friction between committees or the various departments into which the work of corporations is divided. The committee, I think, should be composed of a definite number of gentlemen, which should be divided into two sub-committees: one to be responsible for the supply of electricity, arranging of prices, and managing the supply works; the second to be responsible for the tramways equipment and management, and each should report its recommendation to the ordinary committee meetings. The necessity for this or some similar method of working is as follows: Where tramways are laid down certain mains will have to be laid; at the same time arrangements could and should be made, where they have not already been made, for laying mains or ducts for the purpose of supplying current to the ordinary consumers along the line of route, and the apportionment of the work would be made by the committee as to how the capital charges should be allotted, and incidentally save the cost of opening the streets a second time. All the posts, where any are used, should be arranged for the purpose of the electric lighting of the streets, and the charges treated in the same manner as before. These considerations are reasons also why the engineer of the one concern should

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also be the engineer of the other. This arrangement of committees would save any troubles as to difference of opinion as to the charges that are too likely to occur when one committee is or may be trying to force the hands of another committee. At the same time each sub-committee would be powerful enough to have the charges reconsidered at any time that was considered necessary, and also they would have all the information at their hands to come to a fair conclusion in the matter. The charges of supplying service mains to the tramway premises should be borne by the electric supply works, and the current meters there and the feeders for the tramway system should be, of course, a charge against the tramway concern. It will be apparent by this arrangement that the tramways will be in a far better position to pay its way than if it had to supply all the necessary buildings, plant, and staff to run a system of its own; and the electricity works would be in a far better position to turn out energy at a cheap rate if its machinery is working all day at a full or considerably increased rate of output, and consequently this would mean reduced charges for current all round. The town would be the richer in every way from this arrangement. Where the electric supply works are the property of a company, it is much to be desired that the whole supply should be controlled from the same works, as in the course of time most of these works will undoubtedly become the property of the corporation; but the price per unit must be arranged and the supply given to the corporation with safeguards, in this direction: that the corporation shall not be called upon to pay (should they desire to purchase before the license expires) more for the machinery and plant used than that which it originally cost, less the sinking fund paid on same, and that the company's capital shall be valued less the profit made upon the supply to the corporation; that is, supposing the corporation supply increased the dividend of the company by 1 per cent. this would naturally enhance the value of the shares in the market, and the corporation without the safeguard would be required to find this amount should they determine to purchase before the license expires. There are difficulties in this arrangement, but it would be idle to say that they cannot be overcome. The difficulties will chiefly be those of apportionment of the cost of generating the current for the tramway supply, and of the apportionment of the profit made on this supply.

Conduit Systems.—The opinions expressed almost universally is that they are for various reasons undesirable—more especially where an ordinary system of horse traction is now laid down—as the cost of the conversion is so great that it practically makes it impossible to make any adequate return upon the capital outlay, perhaps with the exception of where the traffic is so great that there is practically a continuous stream of cars passing, but it certainly would be out of the question in outlying districts. The enormous disturbance necessary to the streets is also a very serious matter and the dislocation of the traffic during the course of the works, leaving out altogether the question of the cost. Drainage is also a difficult matter—the cleaning of the conduit a constant source of expense. Children's hoops and such like matter getting into the conduit are causes that make for damage to the collectors and stoppage of the cars. Cushion-tyred and solid-tyred bicycles would be wrecked and personal damage done to the riders, not to speak of the modern narrow-tyred carriage wheel.

Accumulator System of Traction.—The great advantages of this system are that any car is self-contained, the speed can be varied considerably, not necessarily necessitating any disturbance of the existing road, although I fear there are few roads in the country that it would be economical or upon which it would be safe to run accumulator cars without relaying the rails for these reasons: the great weight of the cars and also the necessity of much stouter rails when vehicles are self-propelled—this is common to any sort of electric traction, of course, but more so with accumulator cars owing, as before said, to the great weight of the cars—and also the average tramway groove is not deep enough for self-propelled traffic. The disadvantages are: Great weight—about 30 per cent. of the total weight being taken up in the weight of the accumulators, which have to be carried whether the cars is carrying one passenger or is fully loaded. The fact that this is practically impossible with our present experience to work satisfactorily on hilly roads, and the inability of attaching trailing cars, owing to the rapid deterioration of the accumulators. The necessity of having to take the cars off the road for the purpose of having another set of cells put on board the car. Smell of acid, which will certainly get into the car; and it is very objectionable, it having the tendency of causing sneezing and consequent large absorption of whisky to keep off the influenza which people are inclined to believe they have caught in consequence. Rapid deterioration of the plates, and consequent heavy cost to keep up. This item alone is the principal cause of the want of success. The course of construction is somewhat on a par with the overhead system, varying with the number of cars run per hour. Systems depending upon automatic devices for the purpose of making contact at stated places as the car passes over, or on which one has to rely for the purpose of making the disconnection, are for obvious reasons out of the question—even if the only reason was the great number of such automatic devices necessary and the likelihood or possibility at any time of one not acting properly, thereby causing a pressure of 500 volts to be exposed on the road for all and sundry to come in contact with.

The Overhead System.—This system is by far the most economical to work, and the up-keep is also the lowest. The greatest argument in its favour is that with this system it can readily be charged to accommodate itself to any great or small improvement that may be made from time to time in the system of electric traction in the future, with the least waste of installed plant. But I anticipate that these improvements are only likely to be made in details. The maximum degree of flexibility is obtained by this system also. Trailing cars can be added and the average speed kept up. This also applies to the conduit system; and perhaps the strongest reason for adopting this system is that every town which has sent deputations around to gather information has reported in its favour, and that it is found cheaper to work, completely under control, and that the overhead equipment is not considered or found to be an eyesore in the towns where it has been properly installed. The argument that the overhead line is in the way of fire-escapes is got over by the fact that most modern escapes are made for transport in a horizontal position, and a pair of pliers and rubber gloves is a simple way of overcoming the difficulty if the fire occurs on the route of the line, and it becomes necessary to stop the service before the engine and staff can arrive to switch off at the stated section.

Additional Reasons why Mechanical Traction should be adopted.—Three electric cars can carry as many passengers and travel the same mileage as four horse cars, with a consequent saving of the wages of one driver and conductor; or, putting it another way, with the same number of cars costing the same for drivers' wages, and conductors' also, 30 per cent. more miles can be run with quite 30 per cent. more customers, as what has been proved in every case with both railways and street traction is, that the faster and greater the service, the faster the receipts go up.

A Few Considerations why Local Authorities should have the Control of the Tramway System.—Firstly, all streets and work carried out under or upon them should be under the local authority. It is common knowledge and experience that whenever a street has been carefully laid and repaired, there the gas company, etc., come along and begin cutting it about—whereas if the whole of the matters concerning the streets and what is below was under the corporation control, these matters could in fifty or sixty times out of a hundred be done just before or whilst the repairs were under way, thereby saving great expense, and criticism from the ratepayers. The whole of the inhabitants are directly interested in rapid transit, therefore it is to the town's advantage to own the tramways; also it is much better to raise revenue by indirect taxation than by rates, therefore all towns should get as much control of such means of obtaining revenue as possible. We all feel some compunction in the paying of rates, but none of us object to pay a price for an article, or a service done for us, a part of which goes towards paying rates or reducing the existing rates.

When to Purchase.—Given that a local authority has decided to take over the street system and to equip it with an electric system of traction, I believe it would pay any corporation to obtain control of the system at the earliest possible date after having once made up their minds to do so, and this time, I believe, might with advantage be about three years before the license lapses for one very strong reason—it would prevent the tramway company from laying rails during that period which would not be serviceable for electric cars; and it would also prevent the liability of the corporation being placed in the position of having to find the cost that a company could, if they so desired, make a corporation pay by relaying during the last year or two the whole system of rails, and those rails not suitable for the purpose of power traction, and thereby making the purchase as expensive as possible with a view of choking them off. If this course—viz., the purchase—was made at the earliest date possible, the corporation, of course, would have to pay as part of the purchase the dividends that might or would be paid during the number of years that still remained before the license expired, also the directors' fees, and should the manager, etc., or other officials be dismissed in consequence, it would only be fair to compensate them also; but with all this it would be much cheaper in the end to purchase upon these terms than necessarily leave the purchase until the last minute.

The figures given in Table A are taken from three small works and three large ones. The small works generate the increased number of units generated at the average cost of 1·043d. per unit. Adding a proportion of the charges for interest and sinking fund brings the cost up to 1·243d. per unit. Therefore, it is shown that these works could afford to sell that number of units at 1·74d. per unit, and make a handsome profit of ½d. per unit on the transaction. And the larger works show as to what the costs are likely to fall to with the

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TABLE A.

Works.	1895			1896.			Increase. Units sold during the year.	Cost of generating the added units.	Cost of added load per unit.	Cost per unit for interest and sinking fund.	Total costs, interest, and sinking fund per added unit generated.	Charge per unit, tramway section.
	Units sold	Total costs	Per unit	Units sold.	Total costs.	Per unit						
Edinburgh ..	888,335	£6,181·33	1·67	1,721,557	£8,105·66	1·13	833 238	£1.924 33	·55	·2	—	—
Manchester .	1,748,244	£13,111·83	1·80	2,508 588	£15,156·05	1·45	760,344	£2,044·22	·64	·2	—	—
Westminster	2,830 396	£27,242·55	2·31	3,503,054	£30,505·76	2·09	672,658	£3,263·21	1·16	·2	—	—
								Average	·783	·2	·983	1·983d.
Nottingham.	171,654	£1,995	—	297,185	£2,687	—	115,531	£692	1 43	·2	—	—
Huddersfield	227,753	£2.723	—	304,163	£3,003	—	76,410	£280	·88	·2	—	—
Portsmouth .	406,118	£3,486	—	839,392	£5,980	—	433,174	£1,494	·82	—	—	—
									3·13	·2	1·243	2·243
									1·043		—	—

growth of electricity supply works. The total works costs for the increased number of units generated is shown to average ·783d. per unit, and with the added allowance for interest and sinking fund on the capital outlay of ·932d. per unit, showing that these works could afford to supply electricity at 1·483d. per unit at a profit of ½d. per unit as before. The interest on the capital is calculated at 3 per cent. and the sinking fund at 3 per cent. also, therefore above the ½d. per unit profit shown, an allowance of 6 per cent. is paid already on the capital outlay.

Electric Traction.

BY R. C. QUIN, A.I.E.E., BOROUGH ELECTRICAL ENGINEER, BLACKPOOL.

It goes without saying that the subject of electric traction is so important and extensive that it is impossible to deal with it comprehensively in a paper of this description. The author proposes, therefore, to set forth as briefly as possible the salient points of the subject, and to invite discussion upon them rather than to detail at length any particular system or systems of electric traction.

Road.—In the author's opinion, the road, or permanent way, is one of the chief factors which determine the success or failure of any electric traction undertaking, inasmuch as its condition will have a much greater effect upon the maintenance costs, and, consequently, the financial result, than would probably be the case with any other system of traction. Considerable difference of opinion seems to exist as to how this track should be constructed—whether the rails should be 43lb. per yard as upon the Giant's Causeway line, or 92lb. per yard as upon the Blackpool line—whether the gauge would be 3ft. or standard gauge. The weight of the rail must of course be proportioned to the weight of the cars running thereon, and to the soil upon which the rails are laid, but it would appear to the author that the present practice errs too much on the side of lightness. It will be admitted on all hands that smooth running is essential to the longevity of the rolling-stock, and that this cannot be attained without rigidity of construction, smoothness of running surface, and accuracy of gauge. In order to ensure these desirable ends it is essential, in the first place, that the track should be well laid on a good, solid foundation, accurately gauged, and substantially cross-tied. The usual cross-tie for tramways purposes is 1½in. by ½in., strap hammered round at each end, and threaded and bolted through the web of the rails, but at Hamburg—at which place it has been the author's privilege to investigate the permanent-way construction—things are done on a decidedly better plan. Here the rails, which weigh 106lb. per yard, are cross-tied by an I-shaped girder 4in. deep, which passes under the bottom flanges of both rails, and is secured at each end by two substantial and adjustable chairs. These ties are placed about 6ft. apart. The rails also are not butt jointed, but have a half and half lap joint, with a longitudinal cut through the web about 10in. in length. The fishplates securing these are 2ft. 10in. long fastened by six ⅞in. bolts. The fishplate on the tread side of the rail passes under the bottom flange as far as the web. This class of rail joint is one which, in the author's opinion, very nearly approaches the ideal. It has unbroken running surface, is rigidly constructed, and has a large rail-to-rail contact. The cross-over roads at Hamburg are also of unique construction. At these points the groove of the rail is gradually shallowed until at the actual crossing point it is ⅜in. as against 1½in. at other parts of the rail. The flange of the wheel projects 1in.; hence at these points continuity of running surface is attained by riding on the flange of the wheel.

Generator.—Shall it be high speed, slow speed, direct coupled, belt, or rope driven, if with the latter shall the flywheel be placed upon the engine or the dynamo—are questions which have been ably dealt with in the technical Press by Mr. J. S. Raworth. On the question of flywheels, the author begs to state his opinion that the flywheel should be left at the factory, as there is quite sufficient flywheel effect in a tramcar. The author further ventures to suggest that what is required is not so much uniform speed of the engine, or uniform E.M.F. of the line, as uniform motion of the tramcars; and in his experience neither of the former are absolutely essential to the attainment of the latter. Slow-speed engines, direct-coupled and belt-driven alike, are doing good service in traction work both in this country and on the Continent. But of these, so far as regards modern plant, he cannot speak from personal experience. He has within his charge for lighting purposes, however, engines varying in speed from 80 to 5,000 revolutions per minute. The traction plant is of the latter order—*i.e.*, direct-coupled Parsons steam-turbines, electrically governed. These turbines have been working since June, 1897, to the present time, and seem well adapted for the purpose. Their efficiency is extremely good, the attention and cost of up-keep at present extremely small, while the automatic regulation is everything that could be desired. The extent to which this range of regulation is called upon depends, of course, in a very large measure upon the weight of the cars, the number of starts per hour, the gradients, and, finally, the starting gear.

Motors.—The motors for traction purposes should certainly be of the enclosed type, as far as possible watertight, and their capacity such as to enable them on an emergency to develop for short periods at least three times their normal power. The truck carrying the motor or motors should be rigid in construction, flexibility being given solely to the supports of the car body and of the motor. The efficiency of a traction motor, though, of course, an important point, is not of such great moment as with stationary motors. The question of weight, as well as efficiency, has to be considered, and the question after all amounts solely to how much power it will require to move the total weight of car, equipment, and passengers a given distance at a given speed on a given length of track. The efficiency, again, should be greatest at certainly not more than three-quarters of the maximum power of the motor, or preferably at its usual working load. The arrangements for oiling should be such that, while giving efficient lubrication, oil should not be able to obtain access to the inner portion of the case. Certain makers of traction motors now cover the bottom coil of the field magnet with sheet lead. This is a good preventative of failure due to the access of moisture, dirt, or oil, but it would be better if these could be entirely excluded. In the author's experience, the weakest point in a traction armature is at the junction of the winding and the commutator. Great flexibility should be allowed at that point, and the armature coils and laminations cannot be too rigidly fixed. The sudden starting with heavy loads on heavy gradients is very apt to spring the windings and snap their connection with the commutator. There seems at present to be no settled practice as to the number of motors to be fixed upon a car. The author considers, however, that two motors should always be installed, either of which should be sufficiently powerful to take the car home in case the other breaks down. Further, that the starting arrangements should be such that the two motors are placed in series with a resistance and with one another at starting, and that under normal working conditions they should be in parallel, series-wound motors, of course, being used.

Gearing.—The question of gear now appears to be reaching finality, but it has passed through many phases. In the early days chain-gear was generally adopted, with doubtful success. Worm-gear followed, but seems now to be gradually giving way before spur gearing. The tramcars in the author's charge are at present all driven by worm-gear. The worms are steel, 4¼ pitch, having three parallel threads. The worm-wheels are

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gunmetal. The whole is contained in an oil-case. The worm is fitted with end-thrust ball bearings. Worm-gearing, if well fitted, is efficient, but the wear and tear are great, so that it does not long remain in an efficient condition. The worm-gear is now being replaced by single-reduction gear. The nature of the controlling gear has an important bearing upon the economic working of a traction system. It has not only an immediate effect upon the revenue account, but affects also the life of the motors and of the generators, not to speak of the comfort of the passengers. Moreover, with good controlling starting gear the maximum current taken momentarily by the car is considerably reduced, and with many cars working, and therefore many cars starting simultaneously, the amount of generating plant is most appreciably affected. Within the author's experience, cases have arisen under working conditions of the maximum current being eight times greater than the normal; this, of course, being with crude starting gear. If this maximum were not to exceed the normal by, say, 50 per cent.—and it certainly need not—the necessary amount of generating plant would be very considerably reduced. As bearing upon the question of the effect of controlling gear upon the life of motors, an incident which happened not very long ago may perhaps point a moral. A certain car, fitted with a series resistance and multiple-contact switch as starting gear, stood upon a heavy gradient. The engineer in charge ventured to start the car, the immediate effect of which was to burn out a motor armature. On a second occasion under similar circumstances he again attempted to start, but this time burnt out the armature of one of the generators. But not to be beaten, he repeated the operation under somewhat different conditions. The car was now equipped with a series-parallel controller, the motors being the same. On this occasion he was successful, as on all subsequent occasions when this experiment was tried.

Cars.—Double-deck cars are almost invariably used in England for urban tramway purposes. The practice, however, on the Continent is just the reverse. With the exception of Paris, single-deck cars seem to be the rule. The correct size of a car and the number of passengers it should carry, are questions which cannot be settled until the conditions of traffic are known. If the line is double throughout, a large number of cars can be conveniently worked. If it is a single line and loops, the workable number of cars becomes limited, and their capacity, therefore, must be proportioned to the requirements of the traffic. If the amount of traffic varies within wide limits during certain portions of the day, or at certain seasons of the year, it would appear to the author advisable to attach trailers to the motorcars at those times, rather than to carry a heavy dead load of car weight the whole time. While on this point, the author would suggest that some better unit of efficient working might be established than the cost per "car mile." What is a car mile? Is it a trailer car carrying 15 passengers and weighing three to four tons; a motorcar carrying 30 passengers and weighing seven to eight tons; or a motorcar carrying 80 to 90 passengers and weighing anything up to 23 tons? He would suggest "ton-mile" as a better unit.

System of Feed.—The preceding remarks apply with equal force to all methods of electric traction, but the most debatable feature in the question is the means to be adopted of conveying the energy from the generator to the motor. The trend of technical as also of public opinion in this country appears to be in favour of overhead. It is, the author believes, admitted by all that it is the cheapest method; but some have qualms as to its sightliness and safety. These points it is obvious with a little skill and forethought can be easily provided for. Strong posts of ornamental construction are now obtainable, and when used for the joint purpose of lighting the street and supporting the overhead conductor, cannot be objected to by the most critical. The overhead line must always be in evidence, but it is remarkable how accustomed one can become to it, so much so as not even to notice its presence. The best means of ensuring safety is good work—first-class materials and sound construction. The gauge of the trolley line should not be less than 000 S.W.G., although 0 B. & S. appears to be the general thing on the Continent. Two overhead conductors should be provided even for single line and loops, being, the author considers, cheaper in the end than spring frogs and other expedients. Section blocks should not under any circumstances be placed in curves, also they should be provided (when trolleys are used) with guard cheeks to prevent the trolley wheel jumping the line when passing. The span-wire system of support appears best suited to high rates of speed, and is convenient in narrow streets, where supports can be attached to the houses, but it necessitates a great number of straining wires at curves which are not sightly. The life of the overhead line is greatly affected by the class of contact-making apparatus which is employed. Certainly, the life appears longer with the rolling wheel than with the sliding bar. Whether the advantage which the bar has at curves and junctions sufficiently compensates for this the author cannot say. With a trolley line well erected and fitted with guard cheeks at cross-overs and junction frogs, there should be little risk of the trolley wheel jumping the line, but, nevertheless, such a contingency must be provided for. In the first place, the trolley head when free from the line should not be able to rise to any great extent from its working position. In the second place, should it happen that the trolley jumps the line when the car is proceeding at high speed and the head of the trolley locks against one of the supports (either bracket arm or span wire), something must give way. What will prove to be the weakest link cannot, of course, be given for certainty, but should it happen to be the trolley standard accidents are likely to occur. The author suggests that it would be best to provide the weakest link in the shape of a loose trolley-head, and that this trolley head should be anchored by an insulated cord to the trolley arm—say, 3ft. from the top end. The only result, then, of the locking of the trolley head would be its dropping free from the arm. It is necessary, where telephone or telegraph wires crossing, the overhead conductor, to provide some means for preventing these wires, in the event of their falling, from making contact with the overhead conductor. There are two ways of doing this. The first is to fix an insulator, such as a wood or other moulding, on the top of the conductor at those points; the second, to suspend above the trolley line one or more guard wires. These latter seem to be preferable, as in practice the wood moulding works loose and makes considerable noise by vibration when the cars are passing. The guard wires should be stranded and capable of withstanding as great a stress as the trolley line itself. They should, the author also considers, be efficiently connected to earth. If this is so, a telephone wire coming in contact with the overhead line and the guard wire causes a short-circuit and a cut-out at the generating station. With the overhead system a rail return is almost invariably used, and therefore the question of bonding and of the earth circuit should be considered at this point. For all practical purposes the conduction from rail to rail by fishplates and bolts must be neglected, and it becomes necessary to provide electrical bonds across these rail joints of the same equivalent area as the rail. The rails the author is now using have an area equivalent to a square inch of copper. The bonds consequently should have this section. Under these circumstances it is preferable to use two bonds, as one of a square inch section would be inconvenient. The heads of the bonds should have a contact area of at least 2½ square inches, and should be of such construction as not to render them liable to work slack. It is a good thing in calculating the fall of potential upon a given line to allow 20 per cent. for increased resistance due to the slackening of the bonds. Even with this bonding, unless the disposition of the gas and water mains has been carefully considered, the Board of Trade limit of stray earth current is likely to be exceeded. If a gas or water main crosses the track or approaches the vicinity thereof, and from that point takes a shorter route to the neighbourhood of the station earth than do the tramway rails, or has along that line of route a less resistance than the corresponding tramway return, it will take a greater proportion of the current than is allowable; then, parallel to that gas or water main, an insulated conductor should be laid from the point of the tramway rails above mentioned to the negative terminal of the dynamo.

Conduit.—The local conditions necessary for the successful working of a conduit system are, the author considers, freedom from sand and mud on the roads, good drainage, and a wide slot. The conductor should not be visible from the surface of the street, and should be frequently supported on insulators. It is necessary to have a wide groove in order to obtain an efficient form of collector or plough, as not only has it to contain the insulated conductors, but it must also be mechanically strong. The groove of the conduit should in all cases be parallel to the lines, and the conductor should not be continued across the points or cross-overs, as in these cases it would necessarily be exposed. Generally, conduits contain two insulated conductors, and this to the author seems preferable. It cannot be said that conduit systems have up to the present been successful enough to warrant their general adoption. Recently the author inspected four different conduit systems, but only two of these were then working. The initial cost of a conduit system varies from 30 to 200 per cent. in excess of the cost of an overhead system, and the upkeep, even where the conditions are favourable, is about 10 per cent. greater than with the overhead.

Accumulators.—The accumulator system of traction certainly possesses very great advantages, the principal of which is that the service of cars is not dependent on the maintenance of one system of feed, each car being entirely independent; but we have carefully to consider at what cost this independence is obtained. The crux of the whole question is the cost of carrying a useful load of passengers a certain distance, and for this purpose it is as well to see how the question is affected by the adoption of storage cells. There are three heads under which the additional expenditure is entailed: (1) the interest upon the additional capital required for the installation of the cells and also their depreciation; (2) the cost of propelling the additional dead load; (3) the inefficiency of the cells. With cars running all day with one charge, the weight and cost of

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cells are both very great, as a comparison of the cars used in Dresden for overhead line only, and of the cars at Charlottenburg for accumulators, will testify—Dresden cars carrying 40 passengers weigh eight tons; Charlottenburg cars carrying 42 passengers weigh 23 tons. In both cases the useful load of passengers is approximately three tons. The cost of the accumulators used on the latter cars is about £750 per car. The cost of traction accumulators varies from £75 to £125 per ton, the former figure being for rapid charging and discharging short-distance cells. The author was much interested in the statements made by Mr. Epstein in his Institution paper (on the authority, he believes, of the Hanover Tramway Company) that the cost of the accumulator system of working there was only ·2d. per car mile greater than the overhead system; and he must confess when making his recent visit to Hanover, he did so with the intention of ascertaining how that ·2d. was arrived at. To a certain extent he was unsuccessful, the cost of the up-keep of the cells not being obtainable; but he believes that the figures which he has obtained are sufficient to effectually disprove that statement. There is in Hanover one line of rather less than 10 miles worked entirely by accumulators—the cars working that line being also equipped for the overhead, so that they are interchangeable with cars working on the combined system. They weigh 11½ tons and carry 36 passengers. The time occupied in running this journey exclusive of charging and stoppages is 45 minutes. The cells are charged at two stations *en route*, at one of which eight minutes' charge is given at constant potential, and at the other 25 minutes. The accumulators are placed under the seats, each car being fitted with 208 cells of Tudor type, and there are three plates in each cell. The weight of these cells is approximately two tons, and the installation cost of each car £200. The energy taken per car mile on this track was 1·5 units. Although the up-keep cost of the cells was not obtainable, the average life of the cells was given at about 18 months, and, moreover, additional cars have to be provided on the accumulator line, as several cars are always occupied charging. There is also another line at Hanover worked on the overhead system. Here the cars carry 32 passengers and weigh six tons. The energy taken per car mile of these latter cars was ·68 unit. On the combined overhead and accumulator system, with cars similar to those in use on the accumulator line, the energy taken per car mile was 1·37 units. Leaving the initial cost of the accumulators out of the question, there is the effect on the revenue account to be considered. With rapid-charging low-capacity cells (which are really the only ones worth considering) the weight of cells for a five-mile journey with one charge is about one ton for every 3½ tons of car and passengers. Therefore, with a car and passenger load of 13 tons we must have four tons of accumulators. As every ton-mile on a given road requires the same expenditure of energy, it follows that the energy given to the motors to propel this car will have to be increased approximately 30 per cent. Opinions differ as to the efficiency of these cells, but generally the users of them consider that the watt-hour efficiency is about 60 per cent., and the author does not think the figure is far wrong. Therefore the energy of charging these car-carried cells has to be increased 117 per cent. owing to their inefficiency and weight. Further, the wear and tear of the road and cars is increased by the additional weight. The life of the plates of the cells is variously given by the users as from one to two years, by the representatives of the makers as from two to three years; but the majority of the users do not find much difference between the life of positive and negative plates. The cost of the up-keep of cells is given by the various tramway companies using them at from ¾d. to 3½d. per car mile, and the authors thinks a fair average may be taken at 1½d. Assuming the cost of current to be ·75d. per unit, and ·7 of a unit to be taken without cells—figures the author does not think advocates of accumulators will cavil at—the cost of energy with the overhead system would amount to ·325d., and with accumulators to 1·14d., or an additional cost of ·62d. This added to 1½d. for the up-keep of the cells per car mile, gives us the additional cost of 2·12d., neglecting the extra wear and tear of the cars and road.

Now consider the capital cost. The overhead system per mile of double track costs complete, including bonding of the rails, steel posts (on span wire or bracket system), about £1,600. If these posts are used for street-lighting purposes, the cost of the posts should be divided equally under the two heads, reducing the overhead cost to £1,000 per mile of double track; with a 2½ minutes' service and cars travelling eight miles per hour there will be six cars on the mile section, and, with the weight of the accumulators given, each car would cost £300 to equip, or £1,800 per mile of double track. Again, if charging stations were adopted with, say, 15 minutes' charge, six additional cars would be required at an additional cost per mile of £560, making altogether a sum of £2,360 per mile. With a slow service of cars the initial cost of the accumulators would probably be less than the overhead, but the additional cost of 2·12d. per car mile (with only 20,000 miles per car per annum) capitalised is equivalent to the sum of £3,530, bearing 5 per cent. interest for each car running.

Combined Systems.—Various combinations of the three systems before enumerated have been adopted. More generally it is a combination of the overhead line and accumulator system, but in all cases of which the author has cognisance the adoption of accumulator systems has been not a matter of choice, but of necessity. When the necessity arises the author would desire to point out most strongly that the dead load of the cars in proportion to its useful load should be as small as is compatible with stability of structure; that arrangements should be made that the additional dead load of the accumulators is carried only so far as is absolutely necessary. It is therefore advisable to so arrange the battery that it can be detached as a whole from the car at the junction from the overhead line. A great deal has been said from time to time as to the effect of the acid upon the cars and trucks, and of the odour of sulphuric acid which pervades the cars when the cells are placed under the seats. From what the author has seen of modern systems constructed on these lines, he can give his assurance that these complaints are not well founded; and, if it were not for the inconvenience of detaching the battery as a whole from the car under these circumstances, he would certainly recommend the cells being placed beneath the seats. Where the conditions are such as would permit of the working of a conduit system, and in the absence of permission to use the overhead, the author considers the combination of overhead and conduit much more preferable than the use of accumulators. The additional weight carried is negligible, and the working cost decidedly lower than with accumulators. There have been many attempts to devise improved methods of electric traction, to obviate the disadvantages of the systems above enumerated, but they one and all have drawbacks peculiarly their own, which have hitherto prevented their general adoption. The names of these systems are legion.

The conclusions arrived at by the author all tend to the opinion that in the present state of electric traction engineering there is but one good and reliable and cheap system, and that is, the overhead. Where a combination is necessary, and conditions are favourable, overhead and conduit combined comes next in order of merit; that, as at present constructed, accumulators are not, from a commercial point of view, a satisfactory solution of the traction problem.

Discussion.

Mr. J. H. Rider (Plymouth) said that the association ought to be congratulated that such papers should be brought before the members. Mr. Quin had mentioned Mr. Raworth's opinion as to flywheels. In his (the speaker's) opinion the accumulators were the best flywheels. Mr. Quin said that uniform speed of the engine was not so much required as uniform motion of the tramcar. Mr. Quin had also raised an important point as to whether car-miles or ton-miles was the right way to measure. He should say neither. The right way, he thought, was to reckon per passenger mile. With regard to guard wires, the author said they should be earthed. In this he agreed. With regard to Mr. Stewart's paper, he agreed with him in his opening remarks. The author also made some statements which he could not reconcile. The tramways should be in the hands of a committee, and the committee should be charged as ordinary consumers. The generating committee should have charge of the lighting department of the borough. He did not quite see where the charges for supplying mains for tramways came in. The committee should be treated as an ordinary consumer, and they should wire as if they were going to wire for houses. It was not the generating department's place to put up wires. It was also said that large rails were needed when trams were self-propelled. He did not see what the depth of groove had to do with the self-propelled traffic. It was impossible to use all their posts for arc lighting. The distance between them was only 40 yards, and that was too near for arc lamps. In his town they had themselves once thought of using their tram-posts for lighting purposes.

Alderman Higginbottom said this was a question for the chairmen of committees. Members might be interested to know that in Manchester they got parliamentary sanction for an electric tramway installation. They had adopted overhead traction, and in this he agreed with the author. It was pointed out that the conduit system would not do there. The accumulator system was the ideal system of electric traction, but the cells were not economical. He did not see the difficulty in charging the cells. In Mr. Stewart's paper the author mentioned that the accumulators had to be taken out on the road and replaced by another set of cells. It was quite possible to charge them without taking them out. The maintenance was the main point in working accumulator cars. In Manchester it was decided that the current should be supplied by the electricity committee. There should be a separate committee to work the tramways. The electricity committee should treat them as an ordinary consumer, but the electricity committee should lay all mains and services. The charge should be made according to meter. They intended to use alternate tramway columns for lighting purposes. As to the author's remarks about purchasing, he agreed with him that the corporation should obtain control as soon as possible. When a company knew that the corporation intended to purchase, they relaid all the track with new lines for horse traction, so that the corporation had to pay a very high price and then entirely relay the lines again for electric

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traction. Three years was the very shortest time in which to give notice.

Mr. Wilkinson (Harrogate) said that although the two papers were on the same subject, they did not cover the same ground. He was glad to learn that storage power had been reduced by 50 per cent. by using accumulators, and would be pleased to know where these results were obtained. The units should be divided into two parts—viz, the wheels, gearing, and motor, and the car itself.

Baillie Maclay said that the papers were of special interest to himself, as being connected with the Glasgow system. A few years ago they started there with horse traction. That had been a success, and they had for two or three years been debating as to which was the best system, and had decided for the trolley, which they had started on one of their longest and best routes. They had had a hard fight to retain a separate committee, but they had at last succeeded. On the route they were now fitting up they would use the tramway posts all along the road for lighting.

Mr. A. H. Gibbings asked what arrangement were made for the cost of lighting the streets?

Baillie Maclay said the Watching and Lighting Committee had charge of that.

Mr. E. Kilburn Scott said that in Paris the overhead system was not allowed inside the fortifications because of spoiling the appearance of the streets. There was in the suburbs, however, a trolley system, and the cars running into the city from them carried accumulators for use inside the walls. These cells were charged from the trolley outside. The cars were not like those of Birmingham, in that the cells were easily charged without being taken out on the road. A conduit system was also being laid down in Paris. The conduit system was a grand thing and though there was a lot of money spent over it, it was going to last a life-time. The Madras conduit trams were a failure because there was not enough concrete used for the bed.

Mr. A. S. Giles (Blackburn) said there were so many types of rail that it was difficult to know which was the best. Could there not be a standard rail? He agreed with Mr. Rider in using the passenger mile as the proper unit of efficient working.

Mr. T. P. Wilmshurst (Halifax) said he had just had the privilege of helping to open the new line at Halifax. Mr. Quin advocated using 000 trolley wire instead of 0. He hoped reasons would be given for that. A trolley line should be as thin and of as little weight as possible. If more copper was wanted, put it in the feeder. With regard to guard wires, he did not think that they were any good. Instead of them, telephone and telegraph wires should be doubly insulated where they crossed trolley lines. He quite agreed with Mr. Rider that the best flywheel was the accumulators.

Mr. A. S. Barnard (Hull) said that Mr. Quin mentioned an ideal rail. In Hull they had a 60ft. rail with a centre groove. This seemed to fulfil the requirements of the ideal rail. A uniform E.M.F. on the rail was to be desired. Regarding the bed of the tramway, in Hull the rails did not rest on the concrete itself, but on wooden sleepers on 8in. of concrete. As for street lighting the position of the posts was the great point in this. As to the depth of flange, in horse trams it was not noticeable if the cars ran on the flange, but it would not do in self-propelled system.

Alderman Butterworth (Derby) said he should not have spoken in that discussion, as in Derby there were no electric tramways. However, there were some horse trams, which in time to come he hoped would be worked by electricity. He supposed it was Derby which had been taken by the author when he said that three years was the most notice of intention to purchase which should be given before the license lapsed, as it was just that time now before the tramway company's lease would run out. He was glad to hear electric traction had been successful in Manchester and Glasgow.

Mr. Tremlett Carter said that the cast weld was not reliable. It had been used extensively in America, but had not given satisfaction. The conduit system took too long to put down, but once laid, it was undoubtedly the best system. As regarded variation of current, that was caused by the fact that all the cars did not stop and start at the same time. In order to keep the pressure constant, it was necessary to use compound generators and plenty of copper.

Mr. A. Haigh (Huddersfield) said the steam system in Huddersfield was working very satisfactorily, and if it was wished to change to electric traction, great opposition would be met with from the ratepayers.

Mr. W. A. Chamen then said that the statement in Mr. Stewart's paper that the Glasgow Corporation had raised the engineer's salary by £250 was not quite correct. Unfortunately for him, it was the tramway manager who had had the rise.

Mr. J. S. Raworth said he did not believe in the municipalisation of tramways. He hoped they would not throw him out of the window because of that. It was unfortunate that the word "tramway" represented two different things—viz., the old horse trams and the latest style of electric trams. All Lancashire round about the Oldham district would soon be covered by electric tramways, and it was only likely that all the towns through which they passed would each fight for its own interests. The difficulties of electric traction could not all be solved by means of municipalisation. The corporation should supply the current. He should be sorry for them to go away with the idea that powers were going to do everything. It was also a question if it was legal for the corporation to maintain tramways outside the borough.

Councillor Brodie (Blackpool) said that some time ago in Blackpool the trams on the conduit system were taken over, and in a short time the Council had to horse them all. When the conduit system was started they had the support of the 'bus people, who made a good harvest by the trams breaking down. He thought there was no doubt they would soon adopt the overhead system.

Mr E. Sayer said that there seemed to be some weakness at the junction of the winding of the commutator. His first experience of that was 12 or 13 years ago. In his point of view the breaking arose from connecting them with the shaft. They should be connected, not with the shaft, but with the core of the armature. In Budapest, where overhead wires in the town were not allowed, a change was made from overhead wires to the conduit system on coming within the town. That change was effected in a wonderfully short time.

Mr. J. H. Rider said that Mr. Raworth was the only gentleman who had touched on the question as to whether it was legal for corporations to maintain tramways outside the borough. Mention was made in Mr. Quin's paper of the lap joint. It was advisable to double the length of the rail rather than have so many joints. He also spoke of the car running on the flange. That, in his opinion, would not work well. He (the speaker) thought that the accumulators would act very well instead of flywheels. The commutator connections difficulty might be got over by using two-phase motors.

Mr. J. E. Edgcome (Kingston) said the question of the legality of supplying power outside the borough was interesting to him, as a company had just been formed for running electric cars from Kew to Hampton Court through Kingston. He wished to know if they would be able to supply the power from Kew to Kingston and the other way to Hampton Court?

Mr. Eck said that in Chicago the accumulators on the cars were charged in a few seconds without being taken out. If the parts were well designed, these cars seemed to have a favourable prospect before them, if one could believe what was said. Surface contact had only been adopted in one place at present. It should, he thought, be given a fair trial. With regard to the overhead line being a nuisance, in Chicago it had been adopted, and there had been built telescopic fire-escapes, so that in case of fire the wires did not impede the movements of the firemen. The flywheel question, he noticed, was coming up again. As to maintenance of line voltage, it should be kept as constant as possible. In the matter of electric traction, he thought that even now Englishmen would be "there" before the Americans.

Mr. R. C. Quin, in replying, said the general opinion was in favour of the flywheel, but he was dead against it. In running tramway plant, uniform motion of the car was required. In his station the voltage could be shut down momentarily, and the passengers would not notice any difference. Reference had been made to the similarity of street-lighting to tramway supply. If the two were used together, there should only be one engineer over all. He thought that the difficulties in Blackpool were not electric at all, but merely mechanical. Mr. Scott mentioned the Auvergne-Villiers line. That had only been opened three months or so, and had not had time to prove whether it worked well or otherwise.

Mr. J. E. Stewart said that with regard to running accumulator cars, he did not form the opinion that they were economical. He did not necessarily mean that arc lamps should be put on the posts. Why not incandescent lamps? With regard to the groove in the rails, he thought it wise to have it a good depth. He acknowledged he was wrong with regard to the city engineer of Glasgow getting a rise, and was glad that he had been corrected by Mr. Chamen.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

QUESTIONS.

76. How would you calculate the size of steam-pipe for supplying any one engine or set of engines? Give an example.—P. AULEY.

77. Which do you consider the best means of circulating the water in the boiler when getting up steam?—R. O. G.

ANSWERS.

Question No. 71.—What range of speed would you expect between no load and full load from 1-h.p. and 5-h.p. shunt motors respectively? Give actual figures if possible.

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Best Answer to No. 71 (*awarded* 10*s.*).—The speed of a dynamo-electric machine depends upon (1) the load, (2) the resistance of armature and series field coils, (3) excitation of the field magnets. Let us take, for example, the variations of a shunt-wound motor whose output is to be 5 h.p., and is to be run off a 200-volt circuit, the required speed being 1,400 revolutions, the number of armature circuits in parallel being two, and the number of armature conductors = 400.

Let E = volts at the brushes;
F = total useful flux;
N = number of armature conductors;
T = torque;
x = number of pairs of armature circuits in parallel;
r = resistance of armature;
r^1 = resistance of series field coils;
i = current;
n_2 = speed;

then power absorbed in armature $= \frac{746 \times 5}{\text{Efficiency}}$.

Assuming efficiency = ·86, then $\frac{746 \times 5}{\cdot 86} = 4,330$ watts (approximate). Taking the percentage drop of volts due to internal resistance to be 8 per cent., then drop in volts = 16.

The E.M.F. developed in armature as a generator = 200 − 16 = 184; by a current $(i) = \frac{4,330}{184} = 23{\cdot}2$ amperes.

$\therefore$ resistance of armature $= \frac{16}{23{\cdot}2} = {\cdot}69$ ohm.

$$F = \frac{E \times 60 \times 10^8 \times x}{N\, n_2} = \frac{184 \times 60 \times 10^8 \times 2}{400 \times 1,400} = 3,940,000.$$

$$T = \frac{11{\cdot}74}{10^{10}} \times \frac{i\,N\,F}{x} = \frac{11{\cdot}74}{10^{10}} \times \frac{23{\cdot}2 \times 400 \times 3{\cdot}94 \times 10^6}{2} = 21{\cdot}4.$$

Therefore speed light

$$= \frac{60 \times 10^8\, x}{F\,N} \cdot E. \quad = \frac{60 \times 10^8 \times 2 \times 200}{3{\cdot}94 \times 10^6 \times 400} = 1,526.$$

Speed at full load (n_2)

$$= 1,526 - {\cdot}142 \left(\frac{60 \times 10^8 \times x}{F\,N}\right)^2 \times T \quad (r + r^1)$$

$$= 1,526 - {\cdot}142 \left(\frac{60 \times 10^8 \times 2}{3{\cdot}94 \times 10^6 \times 400}\right)^2 \times 21{\cdot}4 \times {\cdot}69$$

$$= 1,526 - 126 = 1,400.$$

This shows a speed variation from no load to full load of about 9 per cent.

The following list gives the approximate speeds of 1-h.p. and 5-h.p. motors when fully loaded according to the design:

Motor.	High speed.	Medium.	Slow speed.
1 h.p.	1,600	1,300	900
5 h.p.	1,400	1,000	800

It is, however, sometimes necessary to have the speed practically constant under varying loads. This can be obtained (within certain limits) by compounding motors. This is done by winding some series coils in opposition to the shunt coils, and making the number of series turns bear to the number of shunt turns the same ratio as the resistance of armature and series coils bear to the resistance of the shunt coils—viz.:

$$\frac{\text{Turns in series coils}}{\text{Turns in shunt coils}} = -\frac{\text{resistances of arm.} + \text{series coils}}{\text{resistance of shunt coils}}.$$

The negative sign shows that the series coils are to oppose the shunt coils. Armature reaction neglected.—J. F. M.

Question No. 72.—A building is electrically lighted from accumulators, which are charged during the daytime. The tenant decides to take current from the alternating-current mains of the local supply company. The building is wired throughout on the ordinary two-wire plan, with single lead-covered cables, which at places are drawn into iron pipes. Will any alterations have to be made supposing that the insulation and other tests are in accordance with the supply company's rules? The wires are mostly run in wood casing in the usual way, and are not buried in the plaster.

Best Answer to No. 72 (*awarded* 10*s.*).—Some alterations to the wiring would be necessary before taking current from the alternating-current mains. For instance, where lead-covered cables are used for carrying alternating currents, they must be concentric or twin, preferably concentric if single conductors. The lead covering will absorb a certain amount of electrical energy, by virtue of the eddy currents set up in the lead covering, thus reducing the volts at the far end of the conductor. Of course the same rule applies if the conductors are in an iron pipe or other metallic covering. The iron pipes could be replaced by earthenware pipes, and then the conductors need not necessarily be concentric or lead covered.—T. J. A.

BECKENHAM.

(*Concluded from page 760, Vol. XXI.*)

[In resuming the publication of Mr. Angell's interesting report, we have been compelled to delete those clauses of a general character, and not dealing with Beckenham in particular.—Ed. *E. E.*]

ESTIMATES.

35. In considering the financial as distinct from the technical aspect of municipalising electric light, three considerations present themselves—viz.: (1) capital cost; (2) working expenses, including repayment of loan; (3) revenue. (1) Capital cost can be determined with a fair degree of accuracy. Even if somewhat underestimated, the comparatively small increased repayments do not materially affect the prosperity of the scheme. (2) Working expenses, (3) revenue—Estimates of both are merely conjectural, especially so in respect to revenue, based as it is on a supposititious number of customers increasing at an equally supposititious rate. Nevertheless, as on revenue depends the success of the undertaking, some effort should be made to determine possibilities.

36. In Appendix I. I submit proposals under which the scheme may be divided into three stages, each stage working progressively outwards from the generating station in Arthur-road, and including on its way (where deemed advisable) all minor streets. The operations in any one stage need not of course necessarily await completion of a previous stage or stages. Indeed, the principal cables once laid in stage No. 1, as indicated, subsequent stages and minor streets can be dealt with wholly or partially as riper experience might determine.

37. The following estimates of the cost of the three stages of the combined installation were given in my previous report—viz.:

District.	Total number of houses.	Total houses connected (viz., 1 in 3).	Total number of lights connected.	Miles of roads.	Estimated cost.
1	796	266	7,874	6½	£21,000
2	232	100	4,306	5½	9,000
3	376	126	2,464	2¾	6,000
Total	1,404	492	14,644	14¾	£36,000

Since that date the figures of the electrical engineer appointed by the Council have been submitted, and are as follows: District No. 1, £20,475; District No. 2, £11,596; District No. 3, £4.236—total, £36,307. The slight difference in the two estimates is accounted for by the different distribution of plant as between the two schemes. Both estimates include a dust destructor and a sufficiently large generating station to preclude the necessity for extension for a considerable period. Neither, however, include supply to secondary streets. These must be dealt with gradually as the success of the scheme warrants.

38. In Appendix II. an attempt is made to forecast the approximate financial development of the undertaking, the conclusions being practically the same as those of my previous report. No endeavour has been made to specify the time limit during which deficits would prevail, the estimates being based rather on the proportion of consumers to non-consumers at any period. The time interval between the proportions (1 in 8·7·6, etc.) is indeed purely conjectural, being dependant primarily on public support. From returns, however, from practically the whole of the municipal undertakings in the country, it would appear that the average period of deficits is about three years. It is anticipated, however, that the introduction of the free wiring system will in future shorten the period.

STREET-LIGHTING.

39. In my opinion the substitution of electricity for gas in public lighting should evidence a distinct improvement. Residents are apt to judge of the probable brilliancy of the light in their own dwellings by that of the street-lighting, and disappointment with the latter may considerably modify private demand. Street-lighting also, if effectively done, presents a very attractive feature, serving not only to advertise the light but tending to attract residents to the district, and, when here, to induce them to stay, inasmuch as but few persons will, by choice, quit a brilliantly

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lighted and consequently cheerful district for one in which comparatively depressing feeble yellow gaslight prevails. If no greater illuminating power be provided than that of the present gas-burners (very inadvisable, however), the cost would be much the same—viz., about £3 per 16-c.p. lamp. If, however, a greater illuminating power is required, say, equal to that of the present incandescent gas lighting (30 c.p. to 60 c.p.), the cost would be increased considerably. Arc lights (from 1,500 c.p. to 2,000 c.p.) in main thoroughfares (each costing about £25 annually) would entail still further expense, but when spaced at not greater intervals than 80 yards would give a most brilliant and inspiriting effect. I would suggest, therefore, that at the outset arc lamps of from 1,500 c.p. to 2,000 c.p., as at Tunbridge Wells, Ealing, etc., should be placed at intervals of 80 yards in the High-street and Southend-road (from Croydon-road to Copers Cope-road), in Rectory-road, and in Bromley-road to its junction with Manor-road; these lights to be automatically changed at, say, 11 p.m., to 16-c.p. incandescent lamps, one or two to each column. For this purpose the estimates (Appendix II.) include a sum of £400 (to be increased subsequently when the profit-earning stage arrives or as may be found desirable) for improved street-lighting. Ultimately as cables are laid down the various roads, one or two incandescent lights of 16 c.p. each, with double lens, might be fixed to each existing lamp column. With reference to this matter, however—viz., incandescent lights *v.* arc—it will be remembered that in my report of January last on incandescent gas lighting I stated that: "Even though electric lighting be adopted I believe that incandescent gas lighting may yet be advisable for lamps in minor streets. Electric arc lighting is, of course, advisable for principal street-lighting, but incandescent electric lighting for minor streets would probably not be justified, if incandescent gas, with its powerful illumination, can be obtained at anything like the price of ordinary gas lighting. In other words, I think the combination of electric arc and incandescent gas lighting may play an important future part in respect to street-lighting."

40. Comparisons between the cost and illuminating power of ordinary gas and electric light hardly hold good in respect to incandescent gas (Welsbach), which latter may, indeed, prove a strong competitor with electric light. Whilst, however, the features of the latest burners (about to be placed on the market)—viz., intensified light and elimination of chimneys—are distinct improvements, incandescent gas lacks the hygienic and economic advantages of electric light. It has also a somewhat ghastly effect, and it is stated to be injurious to the eyesight. Although, also, a great advance in street-lighting, it does not as yet present any monetary advantage (if renewal of mantles be considered), at any rate, at Beckenham, where the cost of incandescent exceeds that of ordinary lighting by about 6s. per lamp per annum. Whilst the growth of incandescent lighting has doubtless checked the development of electric lighting generally, Beckenham has neither more nor less to fear in this respect than other districts. Hitherto, also but few gas companies have shown much enterprise in the substitution of incandescent for ordinary street-lighting.

Charge to Consumers and Revenue.

41. Returns from the whole of the provincial installations (local authorities and companies) indicate that the maximum charge per unit is 9d., the minimum 4½d., and the average 6d., the maximum charge (9d.) occurring once only—viz., at Hastings. The Crystal Palace District Electric Supply Company charge from 6½d. to 7d. per unit. Usually, also, a material reduction in price is made after a given number of hours' consumption per term, determined by Wright's maximum indicator. Day current for heating, lighting, etc., purposes, which could be supplied at a low charge of from 2d. or 3d. per unit, would probably be appreciated by householders, and would prove a source of profit to the undertaking. As a high charge per unit would seriously discourage possible consumers, and so prolong the years of loss, the lowest possible price should be fixed, say, at the outset, not exceeding 7d. per unit for the first hour, reduced, say, to 3d. for subsequent hours. In this connection the economic effect of a combined scheme of electric lighting and dust destruction has an important bearing. The equivalent cost of current at 7d. for the first hour and 3d. subsequent (averaging about 6d. per unit) is about 3s. 7d. per 1,000 cubic feet of gas. It must be remembered, moreover, that the greater facility for turning off current affords opportunity (more especially in the lighting of bedrooms and cellars) for a considerable reduction in consumption.

42. The following table indicates the average charge per unit and revenue per lamp in 79 towns:

	Average charge per unit.	Average revenue per lamp.
Local authorities:	d.	s. d.
3 metropolitan	6½	11 4
42 provincial	5¾	6 5¾
Private companies:		
24 metropolitan	6½	8 6
10 provincial	6¾	7 7

The highest revenue per 8-c.p. lamp is 17s. 3d. (Islington), and the low 3s. 7d. (Kelvinside). In the estimates (Appendix II.) the revenue per 8-c.p. lamp has been taken at 7s. 6d.

Wiring of Houses.

49. In most towns until quite recently consumers were left to make their own arrangements for the wiring of their houses, with the result that progress was slow and demand for current inactive. In a few towns some system of "free wiring" now prevails, and to this system I wish to direct the Council's special attention. By this system householders are enabled to get their houses wired by the local authority or a free wiring syndicate free of initial cost, the local authority or wiring agency recouping themselves by a slightly increased charge per unit of current, or by quarterly repayments of their outlay. To many persons the initial cost is a fatal objection, placing electricity indeed outside practical consideration; to others, short leases, agreements, and tenancies are equally fatal objections. Apart from mere inertia also, in view of their inexperience of electrical matters generally, a tendency exists on the part of private householders to shirk the responsibility, trouble, risk, and enterprise involved in arranging with contractors for the execution of the work. Though probably objections can be urged against the principle involved in free wiring, nevertheless it appears to be a reasonable expedient for meeting the initial difficulties of lighting existing houses—difficulties which but increase the longer the undertaking be deferred. Once supply is available, however, most new houses of any pretensions would without doubt be wired at the outset, if only to facilitate letting.

50. The following five methods by which wiring may be effected are in vogue—viz.: by private householders employing—(1) a wiring contractor (acting as agent for or independently of the local authority), the consumer paying the actual cost of the work; (2) a "free" wiring firm (acting as agent for or independently of the local authority), such firm bearing the cost, but recouping themselves by an extra charge per unit of currrent (¾d. to 1d.) to the consumer. In the next three methods the work can be effected by any local or reputable contractor acting as agent for the local authority, the latter bearing the initial cost in such cases: (3) the local authority charging the consumer or landlord a certain percentage of such cost for a term of years, the wires to belong to such consumer or landlord at the expiration of the agreed term; (4) the local authority charging the consumer 1s. per light per annum, equal approximately to 5 per cent. on the outlay, the wiring remaining the property of the local authority; (5) the local authority making no charge whatever to the consumer for use of the wires. This latter method (5), which it is proposed to adopt at West Ham, and I believe at Taunton, lends itself to the penny-in-the-slot system, better known in connection with gas supply. It indicates quite a new departure, and must, indeed, be considered at present as *ultra vires*, inasmuch as the West Ham Corporation find it necessary to apply to Parliament for special enabling powers; full details of this system are not as yet, however, available. As method No. 2 appears to bear somewhat unfavourably on large consumers (unless a sliding scale be adopted), it would seem to be fairer that each consumer should repay the actual cost of wiring by instalments, with or without interest (method 3), covering an agreed period.

Financial Position of Beckenham.

61. In view of the proposed large expenditure, the following facts as to the financial position of Beckenham are of interest: population, 24,200; ratable value (approximate), £200,000; maximum borrowing powers, £400,000; present debt, £66,912; previous maximum debt—viz., 1892—£92,328. It will therefore be seen that the present indebtedness is but one-sixth of the limit imposed by Section 234 of the Public Health Act, 1875.

62. In the following statement is given the average rates and ratable value of Beckenham and of other towns:

Towns.	General district rate.	Total rate.	Ratable value per head of population.
	s. d.	s. d.	£ s. d.
Beckenham	2 1	4 8* / 5 6†	7 18 7
Average of 60 provincial towns	2 8¾	5 11½	5 0 10
Average of 76 metropolitan districts	2 5¾	6 2½	7 18 4‡

* Beckenham sewerage area. † West Kent area. ‡ Inclusive of the City and West-end. Note.—The above figures are for the year 1896.

63. The following statistics given by C. E. Baker, Esq., on his recent election to the chairmanship of the Council are also pertinent—viz.: number of urban districts in England, including large towns, such as London, Manchester, Liverpool, Leeds, etc., Beckenham ranking seventieth in ratable value, 1,070; average county borough rate, 2s. 11d.; average non county borough rate, 2s. 8d.; average urban district rate, 2s. 9d; Beckenham district rate, 2s. 1d. It will be seen, therefore, that the general district rate at Beckenham, whilst considerably below the average rate of the country, is also 8d. below that of urban districts generally, and further, that in comparative rating, ratable value, and indebtedness, this district occupies a most enviable position. Whilst the favourable financial position, of course, affords no excuse for extravagant expenditure, it nevertheless enables the district to avail itself of any favourable opportunity for legitimate municipal enterprise.

64. After interviews with many leading borough electrical engineers and after endeavour to diagnose, so to speak, the causes of comparative success or failure in various districts, both in respect to general local conditions and to means adopted for creating a demand. I am of opinion that conditions of success are not absent in the case of Beckenham, and that, whilst partial and insufficient measures may prove stale and unprofitable for many years, a well-conceived scheme, pushed forward with the energy and intelligence generally associated with large commercial and industrial undertakings, must within a few years become not only a self-supporting but a profit-earning institution, tending to lessen local rates and to give to the district during winter time an attractiveness similar in degree, though different in kind, to that which so abundantly characterises it during the summer season.

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APPENDIX II.—SHOWING PROFIT AND LOSS AT VARIOUS STAGES OF SUPPLY (INCLUSIVE OF EXTRA ANNUAL EXPENDITURE OF £300 ON PUBLIC LIGHTING).

STAGE I.	1 in 18. Houses connected, 100. Lamps connected, 2,953.	1 in 14. Houses, 133. Lamps, 3,906.	1 in 9. Houses, 200. Lamps, 5,906.	1 in 7. Houses, 266. Lamps, 7,874.	Total number of houses, District 1 } 1,815
	£	£	£	£	
Working expenses, including repayment.	1,912	2,077	2,408	2,738	
Revenue	1,107	1,476	2,215	2,952	
Profit	—	—	—	£214	Beckenham district.
Loss	£805	£601	£193	—	

STAGE II.	1 in 9. Houses connected, 38. Lamps connected, 1,615.	1 in 7. Houses, 50. Lamps, 2,153.	1 in 4½. Houses, 76. Lamps, 3,230.	1 in 3½. Houses, 100. Lamps, 4,306.	Total number of houses, District 2 } 357
Working expenses	990	1,056	1,190	1,322	
Revenue	605	807	1,211	1,614	
Profit	—	—	£21	£292	Shortlands district.
Loss	£385	£249	—	—	

STAGE III.	1 in 28. Houses connected, 47. Lamps connected, 924.	1 in 21. Houses, 63. Lamps, 1,232.	1 in 14. Houses, 94 Lamps, 1,848.	1 in 10½. Houses, 126. Lamps, 2,464.	Total number of houses, District 3 } 1,337
Working expenses	512	559	652	746	
Revenue	347	463	694	926	
Profit	—	—	£42	£180	Alexandra district.
Loss	£165	£96	—	—	

NOTES.—(*a*) As will be seen, the proportion of houses taking current in each district is dissimilar, inasmuch as the number of houses in the "principal," as compared with those in the "secondary," streets vary considerably in each district. If the comparison, however, be confined to houses in the principal streets only, the proportions would be similar in each district—viz., 1 in 8, 1 in 6, 1 in 4, 1 in 3. (*b*) The time interval between any of the stages in the vertical columns is a matter of speculation, and may be one or more years, according to public demand for supply. During this interval the annual profit or loss would gradually increase or decrease, as the case may be, till the amount (whether profit or loss) shown in the next column is reached. (*c*) Extensions to Stages II. and III. can, of course, be taken in hand at any period, and in any sequence, either before or after a profit accrues in Stage No. 1. (*d*) Profits can be carried to (1) relief of rates, (2) reduction in price of current, (3) reserve fund.

BLACKPOOL CORPORATION ELECTRICITY WORKS.

The following is an abstract of the accounts of the Blackpool Corporation electricity works for the year ended March 31, 1898. The total capital expended up to date amounts to £83,155, exclusive of the tramway plant installed in the electricity works:

EXPENDITURE.

Dr.		
Generation.		
Coal, including unloading, shunting, etc.	£2,586	
Oil, waste, and stores, £398; water, £390	788	
Wages of electricians, stokers, drivers, etc.	1,497	
Repairs to buildings and plant, £500; tools, works lighting, and medical attendance, £153	653	
		£5,521
Distribution.		
Repairs to cables, meters, transformers, etc.		468
Management.		
Rents, rates, taxes, etc.	255	
Salaries of engineers, clerks, etc.	640	
Printing, stationery, stamps, and travelling expenses, etc.	268	
		1,163
Total expenditure		7,152
Balance, being gross profit carried down		5,675
		£12,827

Cr. INCOME.	
By sales of current (private lighting)	£9,010
Ditto (public lighting)	2,056
Ditto (tramways)	1,286
	12,352
Meter rentals, £278; sundry receipts, £197	475
	£12,827

DISPOSAL OF PROFIT.

Interest	£2,071
Sinking fund	1,785
	3,856
Net profit on year's working carried to rates	1,819
	5,675
By balance down (gross profit on year)	5,675
	£5,675

WOLVERHAMPTON ELECTRICITY WORKS.

The following is the report of the Lighting Committee to the Council under date of May 24, 1898:

Your committee are pleased to report that the operations of the year have again been successful. From the accounts it will be seen that a profit of £589. 14s. 4d. has been made after payment of interest and sinking fund. This has been applied to the deficiency on the working of the previous years, reducing the same to £588. 0s. 6d.

Appended to this report the committee present the electric lighting accounts for the year ended March 31, 1898, from which we extract the following:

REVENUE ACCOUNT.

Expenditure.				£ s. d.
Generation of Electricity.				
Coal	£614	18	11	
Oil, waste, water, and engine-room stores	221	11	2	
Wages at generating station	829	15	2	
Repairs and maintenance as follows:				
Buildings	28	3	2	
Engines, boilers, transformers, other machinery, and plant	516	11	10	
				2,211 0 3
Distribution of Electricity.				
Repairs and maintenance of mains	2	19	11	
Ditto of meters, switches, etc.	1	6	10	
Ditto of apparatus at distributing stations	10	6	0	
				14 12 9
Attending and repairs to public lamps				247 14 8
Rents, Rates, and Taxes.				
Rents	0	5	0	
Rates and taxes	115	2	11	
				115 7 11
Management Expenses.				
Salaries—engineer's department and collector	526	11	11	
Ditto accountant's staff (proportion)	20	0	0	
Stationery, printing, and advertising	71	3	5	
Cost of management of proportion of Corporation 3 per cent. stock	43	8	7	
General establishment charges	42	7	7	
				703 11 6

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Special Charges.			
Insurances, etc.		98 14 0	
Bad debts		32 1 8	
		3,423 2 9	
Balance carried to net revenue account		2,833 18 9	
		£6,257 1 6	
Income.			
Sale of current per meter at 6d. per Board of Trade unit		4,687 6 0	
Ditto at 3d. ditto		302 16 9	
Ditto under contract		0 9 0	
		4,990 11 9	
Less estimated allowance to be made under the maximum demand system in respect of March, 1898, quarter		126 0 0	
		4,864 11 9	
Public lighting (street lamps)		1,275 0 0	
		6,139 11 9	
Rental of meters, etc.		102 9 7	
Work executed on account of customers		15 0 2	
		£6,257 1 6	

Balance-Sheet.

Liabilities.—Capital Account.	£ s. d.
Redeemable stock—Wolverhampton Corporation 3 per cent. stock, £32,314. 16s. 11d. ; less amount appropriated for extinction of stock, £3,560. 12s. 2d.	28,754 4 9
Sundry creditors at March 31, 1898	1,017 18 6
Cash due to treasurer, March 31, 1898	8,121 16 8
	37,893 19 11
Loans repaid out of revenue, £345. 12s. 7d. ; and loans fund contributions from revenue, with accumulations, to March 31, 1898, £3,560. 12s. 2d.	3,906 4 9
	41,800 4 8
Revenue Account.	
Sundry creditors at March 31, 1898	255 17 0
Interest accrued, but not paid at March 31, 1898	111 11 0
Cash due to treasurer, March 31, 1898	3,084 14 2
	£45,252 6 10
Assets—Capital Account.	
Capital expenditure, as per capital account	41,377 16 11
Costs of issue of stock, ditto	403 18 9
	41,781 15 8
Sundry debtors at March 31, 1898	18 9 0
	£41,800 4 8
Revenue Account.	
Stores on hand March 31, 1898 : coal, £85 ; oils, waste, etc., £63. 6s. 7d.; general, £108. 6s. 8d.	256 13 3
Sundry debtors for current to March 31, 1898, £2,554. 10s. 1d.; and other debtors, £52. 18s. 4d.	2,607 8 5
Net revenue account — Balance, deficiency to March 31, 1897, £1,177. 14s. 10d. ; less profit for year ended March 31, 1898, £589. 14s. 4d.	588 0 6
	£45,252 6 10

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			370,089
Quantity sold	Public lamps	79,438	291,233
	By contract	18	
	Private consumers by meter	211,777	
Quantity used on works			3,931
Total quantity accounted for			295,164
Quantity not accounted for			74,925
Number of public lamps			51
Total maximum supply demanded—32-watt lamps			14,151

BELFAST ELECTRICITY WORKS.

We have received the accounts of the Belfast Corporation electricity works for the year ended Dec. 31, 1897, from which it appears that the total expenditure on capital account amounts to £52,065. 16s. 1d. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., during the past year.

Revenue Account.

Dr. Generation of Electricity.		£ s. d.
Gas	£1,094 8 9	
Oil, waste, water, and engine-room stores	126 12 11	
Salaries and wages	656 11 5	
Repairs and maintenance	155 18 0	
		2,033 11 1
Distribution of Electricity.		
Repairs and renewals of mains	178 5 2	
Repairs at consumers' premises	2 1 4	
Repairs at distributing station	1 10 3	
		181 16 9
Rents, Rates, and Taxes.		
Rents	123 12 4	
Rates and taxes	159 8 4	
		283 0 8
Management Expenses.		
Salaries—engineer's department	339 7 8	
Stationery and printing	40 7 8	
General establishment charges	83 15 9	
		463 11 0
Special charges—insurance		12 1 0
		2,974 0 7
Amount carried to net revenue account		2,292 5 4
		£5,266 5 11

Cr.	£ s. d.
Sale of current, £5,657. 19s. 11d. ; less discount and bad debt, £582. 2s. 9d.	5,075 17 2
Meter rents, £140. 2s. 5d.; less bad debt, 4s. 2d.	139 18 3
Testing fees	0 10 6
Improver's fee	50 0 0
	£5,266 5 11

General Balance-Sheet.

Liabilities.	£ s. d.
Capital account—amount received	52,899 9 0
Sundry creditors	1,856 5 7
Interest	2,354 6 3
Dividends	112 6 5
Sinking fund	254 8 8
Balance at credit of net revenue account	1,279 13 5
	£58,756 9 4
Assets.	
Capital account—amount expended	52,065 16 1
Stores on hand—oils, waste, etc.	10 10 0
Ditto repairs and maintenance—spare parts of engines	82 10 10
Sundry debtors for current supplied to Dec. 31, 1897	2,289 14 3
Ditto for meter rents to Dec. 31, 1897	39 1 2
Treasurer—balance in his hands	4,268 17 0
	£58,756 9 4

Statement of Electricity Generated, Sold, etc.

Units generated			235,972
Quantity sold	By meter at 2¾d.	7,663	201,832
	By meter at 4d.	7,427	
	By meter at 7d.	186,686	
	Charging batteries at 6d.	56	
Quantity used on works			8,819
Quantity lost in battery			12,626
Total quantity accounted for			223,227
Quantity not accounted for			12,695
Total maximum supply demanded in watts			360,000

COMPANIES' MEETINGS AND REPORTS.

CAMBRIDGE STREET TRAMWAYS COMPANY.

An extraordinary general meeting of the shareholders of this Company was held at the Lion Hotel last week for the purpose of considering, and, if thought advisable, of approving and authorising the seal of the Company to be fixed to an agreement between the Tramways Company on the one part, and the British Electric Traction Company on the other part, for the sale of the undertaking and assets of the Tramways Company to the British Electric Traction Company, Limited, upon the terms and under the conditions set forth in the said agreement. In a circular sent to the shareholders convening the meeting, the directors stated "that the British Electric Traction Company, Limited, will give the holders of the 2,000 fully-paid shares of £10 each the sum of £8 per share, or an allotment of 5 per cent. preference shares of the new tramways company—*i.e.*, a holder of 10 shares will have £80 in cash or eight preference shares of £10 each ; a holder of three shares could have £4 in cash and two preference shares of £10 each, or he might pay £6 and have three preference shares. The British Electric Traction Company will also pay all liabilities and mortgage bonds. The agreement is conditional on getting the consent of the local authorities, the Board of Trade, and Act of Parliament."

Mr. Barnabas Gibson, chairman of the board of directors, who presided, pointed out that the British Electric Traction Company would repay the Tramways Company all costs and expenses which the Tramways Company might pay or incur in respect to the preparation and execution of the agreement.

On the motion being put to the meeting 17 shareholders voted for the proposal and one remained neutral.

The **Chairman,** who had received proxies representing nearly £10,000, declared the motion carried.

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ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

The ninth ordinary general meeting was held on the 28th ult. at Winchester House.

Mr. George Herring, who presided, moved the adoption of the report (already published by us). The directors recommended a dividend on the ordinary shares at the rate of 30 per cent. per annum for the six months ended May 31, and a bonus of 10 per cent. for the year, making the distribution 35 per cent. for the past year on the ordinary shares. They also recommended a dividend of £30 per share and a bonus of £20 per share on the founders' shares for the year, and the payment to the trustees of the ordinary shares reserve fund of £7,859, as well as a payment of a similar amount to the trustees of the founders' shares reserve fund. As the trustees of the latter fund had sold certain securities, they proposed to divide a further £20 a share out of the proceeds, making the total distribution on each founders' share £70 for the past year.

Mr. J. B. Braithwaite, jun., seconded the motion, which was carried unanimously, as well as a resolution approving the payment of the dividends recommended and the payments mentioned to the trustees of the ordinary shares and founders' shares reserve funds.

THOMAS PARKER, LIMITED.

The report of the directors for the year ended April 30, 1898, states that, after writing off various depreciations, the balance standing to the credit of profit and loss account is £9,004. 3s. 10d. Out of this the directors propose to pay a dividend at the rate of 8 per cent. per annum, less income tax, amounting to £5,709. 16s. 11d., to place £2,000 to a reserve fund, and to carry forward to next year the balance of £1,294. 6s. 11d. During the past year the works have been well supplied with orders, but it has been impossible to make full use of the increase in the fitting shop owing to the non-delivery of machine tools, occasioned by the engineers' strike. Some of these are still undelivered, but are promised for an early date. Orders in hand are very satisfactory, and everything points to a successful trade for the coming year. The directors have very carefully considered the advisability of borrowing on debentures sufficient money to enable them to pay off their present indebtedness to the bankers and give them sufficient cash in hand for their trade purposes and for any extension of the works or machinery which may hereafter be considered necessary, and have determined to create debentures to the extent of £75,000, of which they propose at once to issue £50,000 worth and the remainder as circumstances render necessary. The debentures will carry interest at £4 per cent. per annum, and will rank *pari passu* as a first charge on the whole of the property of the Company, and will be repaid on July 15, 1908, or on such earlier date as the Company may by six months' notice in writing appoint. Interest will be paid half-yearly, on Jan 15 and July 15 in each year, and a proportionate part of the first half-year's interest, calculated from the date of payment of the instalments. will be paid on Jan. 15, 1899; £20 per cent. will be payable on application and £80 per cent. on allotment. The directors will in the first instance offer these debentures to the shareholders and their friends, and believe, looking at the present position of the Company and the satisfactory security which is offered, there will be no difficulty in raising the money required The director who retires by rotation is Mr. W. Thomas, who is eligible for and offers himself for re-election. The auditors, Messrs. Allen Edwards and Smith, also retire, but are eligible for and offer themselves for re-election.

UNITED RIVER PLATE TELEPHONE COMPANY, LIMITED.

The report for the year ended March 31 states that the gross receipts in sterling in the River Plate were £67,208, as against £60,325 for the year before, and the working expenses in the River Plate £33,780, leaving a profit after the deduction of debenture interest and all London charges, less transfer fees and interest on investments, of £23,539, to which must be added £7,576 brought forward and the amount of paid taxes refunded by the municipality of Buenos Ayres, estimated to produce £6,240, leaving an available balance of £37,356. The directors propose to transfer £3,000 to depreciation fund and £10,000 to reserve fund, and recommend a dividend of 6 per cent., free of tax (as compared with 5 per cent. last year), on the ordinary share capital, leaving £6,956 to be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hammersmith.—The Vestry invite tenders for the supply of eight 25-kw. transformers. Further particulars appear in our advertising columns. Tenders by July 4.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns. Tenders by Aug. 10.

St. Pancras.—The Vestry invite tenders for condensing plant, steam-pipes, etc., for the Regent's Park Generating Station, 47, Stanhope-street, N.W. Further particulars appear in our advertising columns. Tenders by July 12.

Belfast.—Tenders are invited by the Belfast Harbour Commissioners for the extension of their electric lighting station, Abercorn Basin. Specification, etc., at the office of the harbour engineer, Mr. G. F. L. Giles. Tenders by July 4.

Brussels.—The Belgian Government will shortly invite tenders for the introduction of electric traction on their line from Mons to Boussu. The estimate is £26,000, £9,600 of which is for rolling-stock. The line has a length of six miles, exclusive of branches.

Stavelot (Belgium).—The Municipal Authorities invite tenders for the installation and working of an electric plant for light and power for 30 years. Conditions, etc., may be obtained for 2s. 8d. from the Town Clerk, at Stavelot. The deposit is £120 Open until Aug. 2.

West Hartlepool.—The Town Council of West Hartlepool invite competitive plans, designs, and tenders for the erection of refuse destructor, boilers, etc., adjoining the electric light station, Burn-road. Conditions, etc., can be obtained upon application to Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on July 27.

Glasgow.—Tenders are invited by the Corporation for providing and erecting the following plant required for their new generating station at Port Dundas—viz.: (1) cast-iron and mild-steel tanks; and (2) cast-iron hoppers, chutes, bolts, etc. Particulars, etc., may be obtained on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by July 28.

Exeter.—The Corporation invite tenders for the supply, delivery, and fixing of a steam alternator of from 100 to 150 kilowatt capacity. It is essential that the alternator should be fixed ready for working by Michaelmas next. Tenders, accompanied by drawings and all particulars, endorsed "Steam Alternator," must be sent to the Town Clerk, Exeter, by 12 noon on July 5.

London, E.—Tenders are invited by the Shoreditch Vestry for the supply and erection of dry-back marine-type boilers, steam and feed pipes, and sundry ironwork at the Vestry's electric generating station, Coronet street, Shoreditch. Specifications, etc., can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders by 4 p.m. on 12th inst.

Northwich.—Tenders are invited by the Guardians of Northwich Union for the electric lighting of their workhouse. The premises may be viewed on an appointment being made with the Master of the Workhouse, who will supply each person proposing to tender with a copy of the specification and schedule of lights. Forms of contract may also be inspected at the Workhouse. Tenders, endorsed "Electric Lighting," must be delivered to Mr. Algernon Fletcher, union clerk, Northwich, by 14th inst.

Brighton. — The Council invite tenders for the supply of unarmoured and armoured lead-covered cables at the Corporation electricity works for one year from July 31. Specifications and forms of tender may be obtained at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, addressed to the Clerk, and endorsed "Tender for Cable," must be sent in by 10 a.m. on July 11.

Middlesbrough.—Tenders are invited by the Tees Union Shipping Company for the construction and erection of an electrical coal-hoist upon their wharf at Middlesbrough. Plans may be seen at the office of Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W., and a copy of general plan and specification to be obtained upon payment of £2. 2s., which will not be returned. Tenders to be delivered to the Secretary, Tees Union Shipping Company, Middlesbrough, marked "Tender for Coal Hoist," by July 15.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of one 150-kw. high-speed engine and alternator coupled direct, and sundry additional steam and exhaust pipes. Copies of the specification, with general conditions and forms of tender, may be obtained at the office of Mr. A. H. Miller, town clerk, Town Hall, Yarmouth, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Copies of drawings and any further information may be obtained at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster, S.W. Sealed tenders, endorsed "Electric Light Plant," must be delivered at the Town Hall by 10 a.m. on 19th inst.

RESULTS OF TENDERS.

Ayr.—The Town Council have accepted the tender of Messrs. Johnston and Phillips for 40 new electric lamps at £7. 8s. 6d. each.

Belfast.—Tenders have been received by the Belfast Harbour Commissioners for the supply of three belt-driven, continuous-current, series-wound dynamos, capable of giving 15 amperes, 2,850 volts, at a speed of not exceeding 800 revolutions per minute for 18 hours' continuous running, without undue heating. The tender sent in by C. A. Müller, Bradford (for Schuckert and Co., Nuremberg), has been accepted.

London, W.—The following tenders have been received by the Vestry of Hammersmith for the supply and erection of the following additional plant: (Section A) Ledward evaporative condenser and tanks; (B) air pump; (C) circulating pumps; (D) pipework:

Section A.			
Ledward and Co. (accepted)	£1,345	0	0
Section B.			
Blake and Knowles	426	0	0
Cole and Co.	670	0	0
Sections B and C.			
Allen and Co (accepted)	785	0	0
Sections B and D.			
Spence and Co.	3,893	10	0
Penn and Co.	2,070	0	0

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BUSINESS NOTES.

Removal.—The Synchronome Syndicate, Limited, has removed to 32 and 34, Clerkenwell-road, E.C.

Western and Brazilian Telegraph Company, Limited.—The receipts of the Company for the past week were £2,815.

Tunbridge Wells.—The second year's working of the electric lighting undertaking shows a net profit of £1,632. 2s. 10d.

York.—We understand that Messrs. Crompton have got a good share of the contract work for the electric lighting of York.

Glossop.—The Town Council is about to apply to the Board of Trade for a provisional order for electric lighting of Glossop.

Yarmouth.—The Town Council passed a resolution at last week's meeting in favour of a municipal telephone exchange.

Norwich.—The installation of the Norwich tramway system has been begun. A start has been made with the Earlham-road and Thorpe sections.

Leamington.—The Board of Trade decline to proceed this year with the electric lighting order which the Corporation had been endeavouring to obtain.

Projects.—Schemes for an electric tramway between London and Oxford and between London and Brighton are to be submitted shortly to the Light Railway Commissioners.

Dover.—The Dover electric tramway success has enabled the Town Council to reduce the rates by 2d. in the pound. The *Courier* advises Tunbridge Wells to follow Dover's example.

West Bromwich.—The British Electric Traction Company have proposed to instal the overhead system of electric traction in such a manner as to embody all the latest improvements.

Electric Lighting in the City.—The motion made by Mr. Thomas H. Brooke Hitching, referred to in our last issue, is before a committee of the Court of Common Council for consideration and report.

Shrewsbury.—The Town Council have applied to the Local Government Board for permission to borrow £35,000 to complete the purchase of the undertaking of the Shropshire Electric Light and Power Company, Limited.

Battersea.—The Vestry have unanimously resolved to refuse the application of the National Telephone Company for permission to lay underground telephone tubes in Lavender-hill, from St. John's-road to the parish boundary.

Newmarket.—The National Telephone Company have been refused permission to erect poles in a public street, and a strong feeling is expressed that the Council should not permit the erection of poles in any streets in the town.

Morecambe.—The promenade is now electrically lighted by 55 lamps. The lighting will be extended from the West-end Pier to the Battery Inn this week. The lamps are of 1,000 c.p., and are 22ft. from the ground and 43 yards apart.

Exeter.—An enquiry has been held into the application of the Council for leave to borrow £7,000 for the purposes of electric lighting. It has been resolved that the main streets be lighted by electricity as from midsummer day.

Tipton.—The Urban District Council have consented to the application by the Midland Electric Corporation for Power Distribution, Limited, to the Board of Trade for a provisional order to supply electricity within the district of Tipton.

Leeds.—The Leeds Corporation have received tenders for supply of two additional engines and dynamos of 1,000 h.p. and for 50 additional electric cars. The new extension of electric car service will likely be in operation in about six months.

Canterbury.—In consequence of the number of orders thus far received the Town Council have fixed the scale of charges at 6d. per unit for private lighting purposes, and at half that amount for power and heat (less a series of liberal discounts to large consumers).

West Bromwich.—A scheme for placing the whole of the tramway lines in the district, when the leases shortly expire, under municipal management, is under consideration. This will of course involve combined action between the various boroughs and district councils.

Opera by Telephone.—An opera performed in Paris was recently listened to in Gerrard-street, Soho, by a small audience by means of telephone instruments. The music was heard with distinctness and purity, both solos and choruses. The performance was evidently enjoyed.

Batley.—At a meeting of the Batley Tradesmen's Association on Friday the making of a circular electric tram service was suggested. A resolution asking the General Purposes Committee to urge on the communication of the Mount Pleasant district with the centre of the town was carried.

Brompton and Piccadilly Electric Railway Company.—The capital of the Brompton and Piccadilly-circus Electric Railway will be offered to the public in a few days. The capital is £600,000 in £10 shares. The tunnels will be 11½ft. diameter. The generating station will be on the Thames at Chelsea.

Chester.—The Town Council are about to have arc mains and distributing mains laid for the supply of public and private lighting in various streets, at an estimated cost (including street lamps, etc.) of £1,260. A retaining wall will be built round the yard of the electric light works at an estimated cost of £150.

Edmundsons' Electricity Corporation, Limited.—We are informed that the directors of this Company have decided to recommend payment of a dividend of 5 per cent. upon the ordinary shares of this Company for the year ended March 31 last, carrying forward a balance of £1,012. 14s. 2d. to the next account.

Edison-Bell Phonograph Company.—At the first meeting of the shareholders of the Edison-Bell Consolidated Phonograph Company, held at Edison House on the 22nd inst., the Right Hon. the Earl of Denbigh occupied the chair. There were no resolutions before the meeting, the usual vote of thanks to the directors excepted.

Newport.—Now that the extension of the tramway system will be undertaken forthwith, the local firm which contracted having been successful in overcoming the difficulties in the matter of hardwood blocks and granite setts, an extension of the tramway system with electric traction to Bassaleg and Risca roads is being talked of.

Klondyke.—It appears, says the *Financial News*, that a Bill authorising the erection of a complete electric lighting plant in Dawson City has been passed, and it is stated that the necessary work is to be actively undertaken almost immediately. A street railway is also under contemplation and has been authorised by Parliament.

Accident.—Mr. J. T. Halker, a mining student, residing at Winstanley, who had accompanied two firemen into the pit of the Park Collieries, Ashton, near Wigan, was killed by an electric shock on the 24th ult. It appeared he had gripped the brasswork connected with the electric fittings. When his hand was released he fell down dead.

Fire.—A fire, said to have originated on the switchboard, occurred at the Metropolitan Electric Supply Company's station, off South-street, Marylebone, on the 28th ult. The inability of the firemen to get at the boilers caused some alarm, but this difficulty was overcome, and about two hours after the outbreak the fire appeared to be nearly out.

Barnsley.—A largely attended meeting was held on the 23rd inst. to protest against the decision of the Town Council to hand over the proposed tramways to a private company. The meeting was called at the instance of the Trades Council and the Socialistic Federation. A resolution demanding that the tramways should be established by the Corporation was carried.

Edinburgh.—On a statutory notice by the Postmaster-General requiring the Corporation to give consent to the placing and maintaining of a line or lines of underground telegraphs in or under certain streets or within the city, the Lord Provost's Committee have resolved to recommend the Council to grant consent provided the wires are to be used for Post Office purposes.

Catalogue.—We have received a new edition of Messrs. Crompton and Co.'s catalogue of enclosed long-burning arc lamps and of electric heating and cooking apparatus. The prices of many of the latter have been very considerably reduced, and increased discounts are offered to the trade. We notice that the prices include the necessary detachable connectors ready for use, usually charged as extras.

Derby.—Colonel W. R. Slacke, R.E., held a public enquiry last week into the application of the Corporation to borrow the sums of £20,000 for purposes of electric lighting, £5,500 for the provision of a depôt on the Nottingham-road, £1,000 for the construction of a six-cell refuse destructor at Little Chester, and £346 for the installation of the electric light at the borough asylum and Ford-street depôt respectively.

Presentation.—On Friday evening last the employés of the Scottish House-to-House Electricity Company, Limited, met along with a few friends at the works in Coatbridge and presented Mr. G. C. Laird the resident engineer, with a set of mathematical instruments in a russian leather case, suitably inscribed, on the occasion of his leaving Coatbridge to take up the position of chief assistant to the burgh electrical engineer, Paisley.

St. Pancras.—The Electricity Committee of the Vestry reported at the last meeting that they had instructed the chief electrical engineer to make tests as to the possibility of using the waste steam from the destructor works for generating electricity. A series of tests were conducted, but in consequence of the irregularity in the supply of steam it was found impossible to rely upon it for generating purposes, and therefore had to be abandoned.

Bo'ness.—At the last monthly meeting of the Bo'ness Dock and Harbour Commissioners, electrical matters were reported to be making good progress, the engines and boilers being erected, the steam-pipes and connections fitted up, the engine and boiler house completed, and the lamp-posts had nearly all been erected. It was agreed that a star-light be supplied to the clock tower, the Burgh Commissioners paying their moiety of the cost of lighting.

Tramway Patent.—Messrs. R. Bostock and F. A. Cheetham, of Brighouse, showed last week at the electricity works of the Brighouse Corporation the working of their patented invention for the purpose of preventing accident to life or limb by the breaking of guard wires or trolley wires on overhead electric tramways. The apparatus automatically cuts off the electric current between the poles immediately there is a breakage. We hear that the model is to be exhibited to the members of the Leeds Tramways Committee.

London Electric Supply Corporation.—An extraordinary meeting of the London Electric Supply Corporation was held on 24th ult. at the Cannon-street Hotel, Lord Wantage presiding. Resolutions to the effect that the capital of the Company should be reduced from £1,250,000 to £850,000 (as already reported by us) were confirmed. Mr. Roger de Quincé Quincy and Mr. R. Stewart Bain have been elected directors of the Corporation, the latter as managing director, and Mr. H. C. Carter has been appointed secretary.

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Obituary.—A famous British engineer has passed away in the person of Sir James Nicholas Douglass, late engineer-in-chief to Trinity House, who died at Stella, his residence at Bonchurch, in the Isle of Wight, last week, at the age of 71. He was the son of Nicholas Douglass, C.E., of Stella-on-Tyne, Durham. Sir James received a knighthood in 1882, was a F.R.S., and a member of the Institute of Mechanical Engineers and of the Institute of Electrical Engineers.

Limerick Electric Tramways Company.—The plans and documents in relation to this Company, which proposes to apply for a provisional order to construct an electric tramway service in the city, have now been lodged with the town clerk, the secretary of the Harbour Commissioners, and the clerk of the union by Mr. F. M. Fitt, solicitor, Limerick, who is acting for the Company. The schedules are signed by Mr. H. J. Fuller, who is engineer to the Company, and who is also engineer to the Shannon Electrical Power Syndicate.

Exhibition.—A permanent exhibition of manufactures and machinery is now open in Lima, in the machinery hall of the Exhibition Palace, under the auspices of the Government of Peru, and under the management of the National Society of Industry. No charge is made for space, no duties on exhibits, and many privileges are accorded to exhibitors. Peru offers a splendid field for the extension of British trade. Particulars may be obtained from E. Lembcke, Esq., Consul-General, 237, Winchester House, Old Broad-street, E.C.

Tourist Guide.—We have received an advance Press copy of the Great Eastern Railway Company's illustrated "Tourist Guide to the Continent," edited by Percy Lindley—a remarkably good sixpennyworth. Among its fresh features are particulars of the new express service to Norway, Denmark, and Sweden, *vid* the Royal Mail Harwich-Hook of Holland route; a series of Continental maps, a chapter upon cycling routes in Holland, Belgium, and Germany, and a chapter, "Dull useful information," giving particulars as to the cost of Continental travel.

Blackpool.—At a ratepayers' meeting, at which there was a small attendance, a resolution was passed to the effect that the meeting thought no further money should be spent on electrical extension until there had been a thorough enquiry by the Local Government Board, and also that a more equitable system of charges for electricity should be adopted; and also another condemning the proposal to adopt the overhead trolley system for the tramways in Blackpool, such system being dangerous, unsightly, and unsuited to a health and pleasure resort.

Hampstead.—The Vestry have asked the member for the borough to support the second reading of the Bermondsey and Marylebone Electricity Bill. The Lighting Committee have been requested to consider and report as to which other of the roads of the parish should be lighted by electricity, and also to report on the present charges and methods of charging for electric current for public and private lighting. The Works Committee is to report upon the advisability of placing in the Board-room an electrical indicator for automatically recording the votes of members.

Lewisham.—At the last meeting of the District Board of Works the Works Committee reported that they had considered a communication from the Board of Trade enclosing a letter from the Blackheath and Greenwich Electric Light Company asking for permission to supply energy on the alternating-current system in portions of the area prescribed by their order. The committee had received and considered a report from the surveyor upon this subject, and on their recommendation it was decided to inform the Board of Trade that in their opinion the direct-current system would be preferable.

Stockport.—The Gas and Electric Lighting Committee have appointed Mr. A. J. H. Carter, late clerk of works and chief assistant engineer for the Brighton Corporation, electrical clerk of works for the borough of Stockport. There were 54 applications for the position. The General Purposes Committee have passed the following resolution: "That the borough members be requested to support any motion brought before Parliament for granting competition in the telephone service, and thus allowing for the future the free and unrestricted development of the telephony of this country."

Camberley.—A proposal to establish an electric light company to supply the district embraced by the Frimley Urban District Council was before the Urban District Council last week. After considerable discussion the Chairman said that the Council were not at the present time disposed to oppose their application for a provisional order, having regard to the fact that, in the event of such provisional order being granted the Council would not be stopped from itself obtaining an order, but that the Council, in the interests of the ratepayers, would require such precautions taken as would be for the welfare of the district.

City of London Electric Lighting Company, Limited.—The directors have declared the following interim dividends for the six months ending June 30, 1898: on the preference shares at the usual rate of 6 per cent. per annum; on the fully-paid ordinary shares, Nos. 40,001 to 90,000, at the rate of 5 per cent. per annum, and at the same rate on the partly-paid ordinary shares, Nos. 90,001 to 100,000, calculated on the capital paid up thereon in accordance with the terms of issue. These dividends will be subject to the deduction of income tax, and will be payable on July 22, 1898, to those shareholders registered in the books of the Company on July 5, 1898.

Shoreditch.—The Vestry have decided to reduce the charge for current to private consumers to 5d. per unit for the first two hours, and 2d. per unit after, consumers to have the option of being charged at a fixed rate of 4½d. per unit, and to abolish the meter rents. The charge for current for motive power will be reduced to 2d. per unit for all hours; day users of current for light will be charged on separate meters at 3½d. per unit. Users of 50,000 units of current for motive power will be charged at the rate of 4d. per unit for current for lighting purposes; users of 75,000 units for power 3½d. for lighting; and users of 100,000 units for power 3d. per unit for lighting purposes.

Rotherhithe.—The Vestry at the last meeting agreed to extensions of mains by the London Electric Supply Corporation. A motion to the effect that the surveyor prepare a report "on the manipulation of heat from the dust destructor," with a view to lighting the town hall and other municipal buildings with the electric light, was deferred for six months. A report having been read with reference to the proposed installation of the electric light in the town hall, it was asked if it was seriously intended to disestablish the gas installation in the hall. The Chairman stated that, under the rules of the County Council, electricity and gas must not be confined in the same fittings. Mr. Stuart stated that the fittings were adapted either for electricity or gas.

Monte Video Telephone Company, Limited.—A meeting of this Company is called for the 6th inst. in order to alter the articles of association so as to allow a rearrangement of the Company's capital. The directors propose (1) to give to the present preferred shareholders, for every share which they now hold, three £1 cumulative 5 per cent. preference shares, non-preferential as to capital, and two £1 ordinary shares; (2) to give to the present ordinary shareholders, for every share they now hold, one £1 ordinary share; (3) to give to the holders of the promissory notes issued in lieu of dividend in 1892, three preference shares of £1 each and two ordinary shares of £1 each for every £5 so held.

Hackney.—The Vestry have passed the following resolution: "The electric lighting order being the property of the ratepayers, this Vestry decides to use the same for the benefit of the ratepayers, and refuses to sell, lease, or in any way part with the same, either to a syndicate, public company, or any person or persons. The Vestry therefore resolves that whatever action is taken in relation to putting the electric lighting order into operation shall be done by the Vestry under its direct control." The Vestry have also asked the Board of Trade to refrain from exercising their powers of revocation for a further period of 12 months, and have decided to ask three electrical engineers for the terms upon which they will advise the committee dealing with the question.

Hull.—At a meeting of the Electric Lighting Committee of the City Council, held on the 24th ult., Mr. Skinner presiding, the engineer reported that he had inspected at Messrs. Siemens's works the cables to be used in the East Hull extension and found them satisfactory. He also reported that that firm had done the 100 private service connections included in the contract. The engineer recommended that connections from now be made by the Corporation, and asked authority to engage a labourer and purchase a hand-cart. After some discussion it was determined to defer the further consideration of the report, Messrs. Siemens to do the work in the meantime. The new station in Sculcoates-lane will probably not be opened before about two months. It was resolved to have a report prepared on the subject of this delay, and to call a special meeting at the earliest opportunity to consider it.

South Staffordshire Tramways.—A conference of local authorities was held on Friday last for the purpose of discussing the future method of traction on the South Staffordshire steam tramways. Representatives from West Bromwich, Handsworth, Wednesbury, Tipton, Dudley, and Darlaston attended. The Mayor of West Bromwich (Councillor S. Pitt), who presided, presented a report concerning investigations recently instituted by a deputation on the subject, and also explained that they had resolved to recommend the West Bromwich Corporation to take over the tramways at the end of the present lease four years hence, or if the local authorities agreed they could take them over jointly. After discussion, the meeting was adjourned until July 20 in order to enable the various local authorities to consider the question of municipalisation before discussing the proposals of the British Electric Traction Company.

Appointment Vacant.—A thoroughly experienced engineer is required at the Grove Fever Hospital, Lower Tooting, S.W., under the Metropolitan Asylums Board. Wages, 60s. per week, with board, lodging, washing, and uniform, subject to statutory deduction under the provisions of the Poor-Law Officers' Superannuation Act, 1896. Candidates must be between 25 and 40 years of age, must produce either a Board of Trade certificate or a certificate of proficiency from the Royal Navy, or other satisfactory evidence of competency, and must be able to take charge of the boilers, engines, electric light apparatus, and the lamps and connections thereof. The person appointed will be required to reside on the premises. Forms of application can be obtained at the Chief Office of the Metropolitan Asylums Board, Norfolk House, Norfolk-street, Strand, W.C., where such forms, duly filled up and accompanied by copies (not originals) of three testimonials and certificates of recent date, must be delivered by 10 a.m. on July 14.

Shannon Electrical Syndicate.—The following letter of Mr. Harnett J. Fuller, engineer to the Shannon Electric Power Company, Limited, 179, Great Brunswick-street, Dublin, dated 21st ult., has appeared in the *Times*: "Referring to the allusion made yesterday in the House of Lords to the above undertaking, and to the fact of the subject having been introduced in connection with the discussion upon the Irish Industries Bill, I beg to be permitted to state through your columns that there is no connection whatever between the two subjects named. The proposed

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Bill, in which we are in no way interested, was not applicable to the case of the Shannon Power Company. That company has already acquired, by friendly arrangement with the owners, the lands required for its works; and it would be entirely inconsistent with the views of its directors and shareholders to interfere in any way with the rights of property without the fullest enquiry and consideration. Arrangements have been made to safeguard every such interest, and to avoid detriment to any."—Sir Henry Grattan-Bellew has been added to the directorate of the Syndicate.

Glasgow.—A conference took place last week with regard to the proposed construction of electric tramways on Paisley and Beith roads between a Glasgow sub-committee and representatives of Paisley. The Convener having stated the object of the conference, Councillor Goudie explained the position of the Paisley Town Council regarding the proposals of the British Electric Traction Company to construct electric tramways in that burgh, and also on Beith-road between Paisley and Johnstone; and Mr. Mann having similarly explained the position of the District Committee, a general discussion ensued and interchange of views. Representatives of the British Electric Traction Company were in attendance, and stated that in the meantime they proposed to lay only a single line of rails, with passing places, and that the company would not undertake to lay a double line of rails, even on the road between Glasgow and Paisley, until the company were satisfied that their traffic could not be accommodated by a single line. The Glasgow committee afterwards considered the matter, and in view of the above unanimously agreed to report that in their opinion the granting of the order to the Traction Company should be strenuously opposed.

Bromley.—At the last meeting of the Urban District Council, the Surveyor reported that, having regard to the regulations made by the Board of Trade securing safety to the public, he was of opinion that the proposed system of supply of electrical energy would be satisfactory to the Council. The clerk was directed to reply to the Board of Trade to the effect that the Council had no observations to make in the matter. The Light Railways Committee reported that they had given their consideration to the question of opposing the proposed London Southern Light (Electric) Railway, and submitted for the approval of the Council a draft petition to the Light Railway Commissioners against the proposed order, which they recommended be engrossed and that the seal of the Council be affixed thereto. The committee further recommended that the clerk be authorised to circularise the owners and occupiers of property on the proposed line of route to ascertain whether they are in favour of or against the proposal. This was agreed to with the proviso that the opposition to the light railway scheme be taken solely to put the Council in a position to make such restrictions and suggestions to the promoters that they might think desirable.

Kensington.—At the meeting of the Vestry on the 29th ult. a report of the Law and Parliamentary Committee on the Electric Lighting Act, 1898 (provisional order), was submitted, stating that the committee had further considered the communication received from the Vestry of St. Marylebone, in which attention was called to the opposition which was threatened to the Bill for the confirmation of the provisional orders granted to that Vestry and to the Vestry of Bermondsey for the supply of electricity in their districts, and the request made that the Kensington Vestry would ask the members of Parliament for the borough to support the Bill in question. Looking to the majority by which the Bill passed its second reading in the House of Commons on the 14th ult., it seems hardly likely that further opposition will be offered to the same; but the committee felt that the Vestry should accede to the request of the Vestry of St. Marylebone, and should communicate with the borough members urging them to give their support to the Bill in the event of any further opposition being made in regard to the passing of the same. The committee recommended that this course be followed, and that the Vestry of St. Marylebone be informed of the action taken.

Islington.—At an ordinary meeting of the Vestry to-day a report will be submitted from the Electric Lighting Committee stating that, in consequence of the colliery strike in South Wales, it has found great difficulty in obtaining smokeless coal for the furnaces at the electric lighting station; that it has in consequence been unable to conform strictly to the requirements of the Public Health Act in this respect, and as it is desirous of doing so as far as it is possible it recommends that the furnaces be fitted with smoke-consuming devices at a total estimated cost of £192. Also, that it having received a statutory requisition from three residents in Highbury-crescent for a supply of electrical energy, it will be necessary to lay a distributing main from the corner of Highbury-place for this purpose, and recommending that such main be laid at an estimated cost of £250. The financial statement for two weeks ending June 18, 1898, shows as follows: balance as per last statement—electricity revenue at debit £721. 6s. 10d., electricity capital at credit £9,444. 5s. 7d.; receipts and payments since last ordinary meeting—electricity revenue receipts £14. 1s. 8d., payments £159. 18s. 4d., electricity capital payments £158. 17s. 5d.; balances at this date—electricity revenue at debit £867. 3s. 7d., electricity capital at credit £9,285. 8s. 2d.

Eades Electric Car.—Upon the invitation of the Manchester Carriage and Tramways Company, representatives of the Moss Side District Council witnessed the trial on Saturday last of the "sample car" which has been specially fitted for electric running on the overhead trolley system. As no portion of the tramway system is at present prepared for electric traction, the car used was fitted up with accumulators, in addition to two 15-h.p. motors. Mr. Eades and his son were in charge. The car is lighted by six incandescent electric lamps, two coloured at each end, and two plain near the centre. There is accommodation for 18 passengers inside, and 23 outside the car. The trip, the *Manchester Guardian* says, was very successful, the vibration being slight, while the brake worked without jolting, and brought the car, when running at a moderate speed, to a stand in half its length. The accumulators store sufficient power for the car to run 12 miles, and at the end of the journey fresh accumulators, ready charged, can be substituted in a few minutes, the others being left to be recharged, an operation which takes about three hours. At the conclusion of the trip Mr. Unsworth, chairman of the Council, on behalf of the members present, expressed great satisfaction with the arrangements and comfort of the car. It is understood that negotiations are pending for a number of these experimental cars to be placed on various routes of the existing tramway system.

Southampton.—A warm discussion took place at the Town Council meeting last week when the adoption of the accounts of the Electric Lighting Committee was proposed. Alderman Bone, in moving the adoption of the accounts, said they showed that during 1897-8 their revenue had been £900. 11s. 3d. more than during 1896-7, that the increased revenue had been earned on exactly the same plant and the same management expenses, but there had been a reduction in the charge from 7d. to 6d. and 6d. to 4½d. The sum of £21,000 was given for the purchase of the works, and £5,000 was paid for property. They had paid £726 for interest, and the amount transferred to sinking fund was £1,200. 11s. 5d. That was a large amount to transfer, and for the £21,000 they were only able to borrow for 21 years. There was a gross total profit of £1,912, which was sufficient to enable them to pay interest and repayment of capital on the £26,000, which was all the capital that had been remunerative; but at the present time, that was during the past year, they had acquired property of the value of £1,207, and having paid off that sum they had practically acquired it for the ratepayers. The Alderman said he felt sure that the whole of the suspense account would be swept off, and that in three years they would have a profit for the benefit of the ratepayers, who would then have a splendid property. The accounts were ultimately adopted.

London County Council.—The London County Council have approved of the plans submitted with the application of Messrs. Kincaid, Waller, and Manville on behalf of the South London Electric Supply Corporation for the construction of a generating station and works on a site adjoining Bengeworth-road, Loughborough Junction, and authorised the erection of such generating station and works as shown upon the said plans, such approval and authorisation being, however, subject to certain conditions. The Building Act Committee have reported that of the 11 provisional orders applied for this session, the Board of Trade had granted only four—namely, those applied for by the Vestries of Bermondsey and St. Marylebone in respect of their respective parishes, and an order each to the Charing Cross and Strand Electricity Supply Corporation and the County of London and Brush Provincial Electric Lighting Company in respect of portions of the Holborn and St. Giles's districts. The Board had adopted many of the amendments suggested on behalf of the Council, but had declined to insert the suggested clause for the protection of the Council's tramways. The limit of price in the companies' orders had been reduced to 7d. per unit, but in that of the vestries the price was as in previous orders, 8d.; in the companies' orders the provision as to continuous current had been omitted, but it had been inserted in the vestry orders, from which, moreover, the clause enabling the undertaking to be transferred to a company had been struck out.

Manchester.—The report of the Special Tramways Committee of the Manchester City Council, as to the proposed arrangements with local authorities for the leasing of lines outside the city boundary, states: "In entering into the negotiations with the various urban district councils, the committee divided them into two classes—namely, those who are at the present time the owners of the lines in their districts, and those in whose districts the existing lines are the property of the Manchester Carriage and Tramways Company, but which lines the various authorities have the power to purchase under the Tramways Act, 1870. Your committee, in the first instance, endeavoured to arrive at a scheme of dividing the profits earned in the out-districts in such a manner as to recoup the Manchester Corporation for its working expenses, and to afford the outside districts a return for their capital outlay. The result was that, at a large meeting of local authorities held on May 10 last, the various authorities preferred to make individual arrangements with Manchester on the basis of a lease to be taken by the Manchester Corporation. Provisional arrangements on this basis have accordingly been entered into with several of the local authorities who are not at present the owners of the lines in their districts, the rent payable by Manchester to be sufficient to clear the local authority from any payment whatever, not, however, affording them any profit or return during the term of the lease—namely, 21 years—but at the end of that period the lines will become vested in the authority. These terms are embodied in a form of agreement, which has been forwarded to the undermentioned local authorities—viz., the District Council of Failsworth, the District Council of Gorton, the District Council of Denton, the District Council of Levenshulme, the District Council of Heaton Norris, and the District Council of Stretford.—The Manchester Carriage and Tramways Company's Bill was before Lord Northbrook's (House of Lords) Committee on Wednesday. The preamble was found not proved. The Bill was opposed by the Manchester City Council, as it intended to acquire the lines on the expiration of the leases. The Bill sought extensive powers for the construction and maintenance of lines working by overhead electricity,

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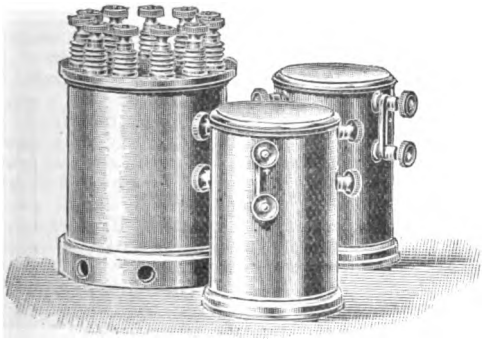
Waterloo and City Railway.—The Duke of Cambridge will formally open the Waterloo and City Railway on Monday, July 11. His Royal Highness will be received about noon at Waterloo by Mr. Wyndham Portal, the chairman of the Waterloo and City Railway Company, accompanied by the rest of the directors of that company, and the directors of the London and South-Western Railway Company, as also by Mr. Charles J. Owens, the general manager, engineers, and other officials of the two lines. The Duke will be conducted down one of the inclines which lead from the terminus of the South-Western Railway to the platforms of the Waterloo and City line, where one of the new electric trains will be in readiness to convey the party to the City station, which is situated underground immediately opposite the Mansion House. His Royal Highness will alight to inspect the station arrangements, and, having declared the line open, will return to Waterloo, where he will lunch with the directors of the two companies. Sir Francis Marindin has already made an unofficial inspection of the permanent way, and at his suggestion the treads of the two staircases giving access to the City station—one at the angle of the premises of Messrs. Mappin and Webb in the Poultry, the other in Walbrook fronting the Mansion House—have been increased in width so as to comply with the Board of Trade requirements. These staircases will afford ingress and egress to the City station pending the approaching completion of the public subway below the crowded crossing at the Mansion House, the Bank of England, and the Royal Exchange, and as soon as the subway is ready for use a third means of approach to the new railway will be provided. It is hoped that the line will be available for traffic on the day following the opening ceremony.—*The Times.*

Hibbert One-Volt Standards.—After a thorough test extending over a considerable period of time, Messrs. Crompton and Co., Limited, have now finally decided to place upon the market the Hibbert one-volt standard. From results which have been



previously published, this standard differs from a Clark cell in having a temperature error which is practically imperceptible—being approximately less than one part in 10,000 per degree Centigrade—and is equal to the Clark in respect to rapid recovery after accidental charge and discharge. The value given by the cell is exceedingly constant, and a point of some importance is that it can be manufactured to give exactly one volt at any specified temperature. The cells are fitted up in brass cases containing two, three, or ten cells each, the 10-cell set forming an exceedingly handy and accurate ratio of 1 to 10.

Parliament.—The House of Lords Committee have passed the preamble of the General Power Distributing Company's Bill, which is for the supply of electrical energy for lighting, traction, manufacturing, and other purposes over an area of about 2,000 square miles, including many large towns. The committee stated that they were prepared to consider any clause which corporations within the company's proposed area of supply might suggest, for the purpose of giving to such corporations greater power than they now possessed in respect of the laying of the company's mains through their thoroughfares. The committee also decided that a clause must be inserted to enable corporations to take from the company electrical energy in bulk for the supply of their respective districts. With regard to the construction of the company's central generating station at Warsop, the committee held that some limit of time must be inserted in the Bill. On hearing the announcement of the committee, the counsel representing the Corporations of Nottingham, Sheffield, Doncaster, Chesterfield, Lincoln, Ilkeston, and Rotherham intimated that they would take no further part in the proceedings before the committee. The committee have also passed the preamble of the Bridgwater Electric Bill and the Metropolitan Railway Bill.—The House of Commons Committee on electric trams for London have rejected the clause providing to do away with the consent of the London County Council to the use of mechanical power upon tramways in the county of London. They, however, state in their report that they are strongly of opinion that the congested state of London makes the speedy adoption of electric traction on tramways necessary, and they earnestly trust that arrangements may be made by the London County Council (with the London United Tramways Company) whereby the benefits of one system or another of electric traction may be secured to the public at the earliest possible date.—Sir John William Maclure the other evening asked the Secretary to the Treasury with reference to communications from the Levenshulme Urban District Council, the Heaton Norris Council, and the Corporation of the city of Manchester, letters which had not been definitely replied to, "as to whether he will consent to the removal of telegraph poles by the substitution of underground wires through this district, which is most rapidly increasing in population and house building, and already is practically a continuous line of houses along the road from Heaton Norris to Manchester?" Mr. Hanbury said "The Postmaster-General very much regrets that, amidst the pressure of other business, some of the communications addressed to him on this subject have been overlooked, and that the definite replies which ought to have been sent to them were not given at the proper time. He wishes, however, to add that the original application from Levenshulme in August, 1896, was definitely answered, that the only application which would appear to have been received from Heaton Norris—namely, in January, 1897—was also duly answered, and that it is only the later application from Manchester and the renewed applications from Levenshulme which have been overlooked. Though some of the applications were not duly answered, careful enquiries have been made in the district as to the possibility of complying with them. In the cases of Levenshulme and Heaton Norris it is regretted that the expense of putting the wires underground in those districts would not be justified. In the case of Manchester, it is proposed to substitute underground wires as soon as the existing line of telegraph poles need renewal, probably in two or three years' time.

PROVISIONAL PATENTS, 1898.

JUNE 20.

13666. Improvements relating to electrical fuses. William Clark, Ashbrooke Tower, Sunderland.

13680. Improvements in secondary electric batteries and accumulators. Samuel Walter Hart and Edward James Clark, 73, St. Stephen's-road, Upton Park, London.

13682. Improvements in electric incandescent lamps. Victor Saglier and Edgard de Marçay, 64, Mark-lane, London. (Complete specification.)

13687. Improvements in electric arc furnaces. Percy Crundall Day and the Acetylene Illuminating Company, Limited, 55, Chancery-lane, London.

13702. Improvements in dynamo-electric machines and electric motors. Henry Francis Joel, jun., 55, Northbrook-road, Ilford, Essex.

13707. Improved electro-acoustic telegraph with Morse transmitter. Nicolas Flechtenmacher, 322, High Holborn, London. (Complete specification.)

13709. Improvements in or relating to the electric propulsion of railway trains. Otto Herrmann Emil Kaselowsky, 322, High Holborn, London. (Complete specification.)

13721. Improvements in suspended electroliers. Joseph Grace Smith Cunnington, 47 Lincoln's-inn-fields, London. (Complete specification.)

JUNE 21.

13759. Improvements in the manufacture of electric cables. Gerald Carlyle Allingham and William Fennell, Harrowgreen, Leytonstone-road, London.

13765. Improvements in quadruplex and multiplex telegraphy, and to apparatus for use in connection therewith. Sidney George Brown, 9, Queen's-road, Bournemouth.

13769. Employment and useful application of the electric force to aerostats and balloons of all kinds. Manuel Vassaur, 47, New Broad-street, London.

13781. Improvements in automatic elect ic block-signal systems for railways. Louis Charles Werner, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13793. Improvements in electric generators. Edmund Edwards, 65, Chancery-lane, London. (Philip Albert Emanuel, United States.) (Complete specification.)

13818. Improvements in or relating to coin-operated signal apparatus for pay-station telephones. William Phillips Thompson, 6, Lord-street, Liverpool. (Heber R. Mason and Emery D. Weimer, United States.)

13827. Improvements in speed-varying devices and electric motors for use therein. Reginald Belfield, 322, High Holborn, London. (Robert H. Hassler, United States.)

JUNE 22.

13861. Improvements in and connected with the electro-deposition of copper and other metals on rotary cathodes. William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.) (Complete specification.)

13882. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi, 24, Southampton-buildings, Chancery-lane, London.

13895. Method of reducing the energy of magnetisation of electrical transformers when the output is small. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

JUNE 23.

13942. Combined standard and portable electric light. Frederick Thomson, 18, Westbank-terrace, Hillhead, Glasgow.

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13943. Improvements in the filaments of electric incandescent lamps. William Arthur Coates and Robert Ley Wood, 2, Ormond-place, Cheltenham.

13946. A new and improved electric connection and coupling. William Henry Hunt, 13, Aldersgate-street, London.

13951. Improvements in metallic tubular conductors for protecting electric wires and cables. George Miller Stewart, 7, Staple-inn, London.

13960. Electrode for accumulators. Hermann Dämm, 5, Hatton-garden, London. (Complete specification.)

13969. Improvements in trembler interruptors for electric currents. Alfred Wydts and Octave Rochefort, 45, Southampton-buildings, Chancery-lane, London.

JUNE 24.

13999. Improvements in and appertaining to electric stop motions employed in machinery or apparatus for elongating or drawing strands of cotton and other fibres. Wilmot Tunstall and John Crabtree, Market-place, Huddersfield.

14007. Improvements in apparatus for working wireless telegraphy. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

14012. Improvements in electric light fittings. Henry Clark Brown, 43, Southampton-buildings, Chancery-lane, London.

14021. Portable electrical tool-holders and tools. Alfred Benham, 88, Cornwall-road, Bayswater, London.

14045. Improvements in receivers for use in hydro-electric operations and other purposes. Leopold Lambotte, 171, Queen Victoria-street, London.

JUNE 25.

14058. Improved means for operating electric railways by a combination of alternating and continuous currents. Charles Pollak, 47, Lincoln's-inn-fields, London.

14059. Improvements in apparatus for producing radiation by electricity. Charles Henry Stearn and Charles Fred Topham, 4, Branstone-road, Kew Gardens, Surrey.

14077. Improved dynamo brush. Casper Friedrich Kirchhoff, 102, Burdett-road, Bow, London.

14101. Improvements in surface-contact railway systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

14107. Improvements in prepayment electricity meters. Francis Maddison Long and Ernest Schattner, 55, Chancery-lane, London. (Complete specification.)

14112. Improvements in or connected with primary batteries. Axel Peters, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

14113. Improvements in or connected with the distribution of electricity by alternating currents. Herbert Appleton Wagner, Norfolk House, Norfolk-street, Strand, London.

14114. Improvements in electrical apparatus for use in propelling vehicles and for other purposes. Courtenay William Thompson, 47, Lincoln's-inn-fields, London.

14124. Improvements in the construction of drums or reels for electric and other cables. Walter Badger Brown, 22, Southampton-buildings, Chancery-lane, London.

14132. Improvements in and relating to electrical furnaces more particularly applicable for the production of calcium carbide. William Lang Durban and John Gore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

13594. Electrical meters, applicable to prepayment electrical meters. Bastian.

15396. Carbons for electric welding, brazing, and the like purposes. De Tunzelmann.

15903. Electric batteries. Seton and Dobell.

16718. Electrical recording instruments. Callendar.

16797. Controlling apparatus for accumulator batteries. Erlacher and Besso.

17733. Incandescent electric lamps. Farrall.

17820. Manufacture of electric cables and apparatus therefor. Smith.

18119. Incandescence electric lampholders. Marsh and Vandam.

18354. Apparatus for measuring and recording electric currents. Aron.

18416. Electric traction. Thompson and Walker.

18719. Supports for the current collectors of electric railways and tramways with overhead conductors. Siemens Bros. and Co., Limited. (Siemens and Halske.)

1898.

2106. Electric arc lamps. Girdlestone and Thorkelin.

3316. Self-restoring annunciator, more particularly suitable for employment in connection with telephone switchboards. Kingsbury. (The Western Electric Company.)

4176. Distribution of electricity over electric railways on the series system. Cattori.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended June 26 were £1,474, as compared with £1,716 in same week of 1897, being a decrease of £242.

Birmingham Tramways.—The traffic receipts for the week ending June 25 were £4,001. 15s. 4d., as compared with £4,178. 16s. 2d. for same week in 1897, being a decrease of £177. 0s. 10d.

Dover Tramways.—The traffic receipts for the week ending June 25 were £169. 13s. 2d. The total receipts for the year 1898 are £3,020. 15s. 8d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending June 24 were £2,828. 19s. 8d., compared with £4,027. 13s. 6d. for same period of last year, being a decrease of £1,198. 13s. 10d.

South Staffordshire Tramways.—The traffic returns for the week ending June 24 were £620. 1s. 10d., as compared with £767. 0s. 0d. in same week of 1897. The aggregate receipts for the year are £15,101. 2s. 9d., as against £15,452. 19s. 7d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended June 26 were £986, compared with £1,337 for same week of 1897, being a decrease of £351. The total receipts for the half-year amount to £26,518, compared with £26,645 for the same period last year, being a decrease of £127.

Dublin S.D. Tramways.—The traffic receipts for the week ending June 24 were £738. 15s. 11d., as compared with £837. 14s. 7d. in the corresponding week in the previous year, being a decrease of £98. 18s. 8d. The number of passengers carried was 109,671 in 1898 and 117,681 in 1897. The aggregate returns up to date are £12,450. 8s. 5d., as compared with £13,200. 0s. 11d. last year, being a decrease of £749. 12s. 6d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	10-10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16-16½
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10½-11½
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
—— Pref. Half-Shares	1	1¼-1¾
—— " "	5	4½-4¾
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	7½-8½
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	25-26
—— Prov. Cert. 90,001-100,000	5	17½-18½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	68-71
—— Ordinary	2	1¾-2¼
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15-16
—— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	12-13
—— " " "	4	6-7
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	88-93
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	3	2¼-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red	100	103-105
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	3¾-4¼
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3¼-3¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-108
Elmore's Copper Depositing	1	¼-½
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	8-9
—— 7 per cent. Preference	5	9½-10½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-15
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	101-106
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¼-1¾
—— £5 Shares	5	7½-8
—— £4½ shares	4	6½-7
Oriental Telephone and Electric Company	1½	⅝-⅞
Royal Electrical Company of Montreal	—	143-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	2	2-2½
St. James's and Pall Mall, Limited, Ordinary	5	15-16
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	100	116-119
Westminster Electric Supply, Ordinary	5	14½-15
Yorkshire House-to-House	5	8⅛-8⅝

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NOTES.

Balmoral.—We are glad to see that good work is being done in this installation.

New Book.—"Les Compteurs d' Electricité," by E. Coustet. Published by Bernard Tignol, Paris.

Electric Launch.—The trial trip of a sea-going electric launch, built to the order of the Russian Government, is arranged for Monday next at Portsmouth.

Lighthouses.—In reply to a question in the House of Commons the other day, Mr. Ritchie stated that three additional lighthouses are in course of being connected with the shore by electric cables.

Sir R. Rawlinson's Will.—The late Sir Robert Rawlinson has left a legacy of £1,000 to the Institution of Civil Engineers, and to the trustees of St. Thomas's Hospital an interest worth about £35,000.

Smoke.—It is hard lines upon central-station managers to be hauled before magistrates because they cannot get steam coal. Of course we recognise that provision should be made in the initial scheme for troubles of this sort, but few care to expend a lot of money to provide with what only happens once in a hundred years.

Village-Lighting.—At the recent meeting of the Gas Institute at Belfast, Mr. Shadbolt read a paper on "Village-Lighting"—a comparison in which he compared the various methods of lighting of a village with the estimated cost. Although such estimates are of little practical service, they show the ideas which are floating through the minds of those interested in the gas industry, and, as may be expected, the lighting by gas is made to compare very favourably with the other methods discussed.

Lifting by Magnets.—According to the *Scientific American*, an Illinois steel company uses electromagnets capable of picking up a load not exceeding five tons, and by this means to transfer steel beams or plates from one part of the shop to another. We suppose that we ought to look upon this as a great advance in shop work, but we should prefer the electric crane if the load to be carried had to pass over our heads, and we do not see what the gain is to have electromagnets for the purpose described.

Electrical Engineers (R.E.) Volunteers.—It has been decided to enrol no more men for this year. As many men as can be dealt with at the first training, which takes place at the western defences, Isle of Wight, in July and August, have now joined the corps. Further applications will, however, be received, and eligible men engaging to enrol may attend a certain number of military drills during September and October, though they cannot be formally enrolled before Nov. 1, the beginning of the next volunteer year.

Motor Traction.—We are glad to see that there is a likelihood of the members of the Propelled Traffic Association amalgamating with the Automobile Club. It seems to us that much better work can be done combined than separate. When there exists several organisations, opponents always play off the one against the other, and there is no doubt, if self-propelled vehicles are to come into operation, a good deal of prejudice must be overcome, and a good deal of hard work will have to be done before the public, to any great extent, take up the matter.

Sheffield and Belfast.—As is well known, Sheffield is one of those corporations which has municipalised its tramways, for a length, at any rate, of about 12 miles. The accounts just published show that during the past year a net profit has been made of between £13,000 and £14,000. The Corporation is preparing to extend the system, and to introduce electric traction. Although mentioning two places widely apart, we may also note here that Belfast is attempting to come to terms with the directors of the tramway company to establish electric traction over their system.

Overhead or Underground.—During a discussion on electric traction the other day, we heard a remark from a gentleman who had recently come from America, and who was greatly interested in municipal traction, that it was singular that while the fashion in America for the use of trolleys was decreasing, the large towns were generally insisting upon underground work, the fashion in England was increasing, and the gentleman suggested that we were following or tending to follow an exploded piece of practice. It would be interesting to know a little more on the subject.

Melbourne.—The last big fire in Melbourne clearly demonstrated the necessity of having officials quickly at hand who were well acquainted with the position of the fire plugs. The Metropolitan Board of Works has now decided that the turncocks' residences shall be as near the fire stations as possible and connected by telephone. This is undoubtedly one of the uses to which telephony is specially adapted. We know cases in England where the captain of the fire brigade has suggested such use of the telephone, and the members of council have so strongly opposed what they termed a useless innovation that the captain resigned a position he had held honourably and successfully for many years.

The War.—After the first outburst upon the question of cables at the commencement of the Spanish and American war, little has been said. This probably arises from the fact that the position of the two countries is such that free cable communication with Spain will make little difference in the ultimate results, hence there has been no serious attempt to disconnect cables to the south of Cuba with that island. It is said by our American contemporaries that the electrical industry in the States has quite received a fillip from the war in that the factories have had to supply a large amount of material, so that we have again an illustration of the old saying that "It is an ill wind that blows nobody good."

A New Danger.—The war has developed a new source of danger, as shown by an accident which occurred at the mouth of the Potomac River last week. During a thunderstorm a flash of lightning struck the switchboard at Fort Washington which controls all the mines laid along the river. Three of the mines exploded with tremendous force, sending enormous spouts of water high into the air. It appears that there was no actual damage done, as no ship was near enough to be hurt, but many of the craft in the river had hairbreadth escapes from a disaster. The occurrence may be considered a fortunate one if it leads to more efficient arrangements being made for guarding highly sensitive electric appliances from being affected by meteorological causes.

Southampton.—This Corporation is now taking over the whole of the tram and 'bus system in the borough. Quite recently we made an excursion over the district, knowing that the Corporation were going to undertake this work, and we were glad at the same time to hear that it was their idea to use electric traction. Our own views with regard to corporations and tramways have been freely expressed on several occasions, but we cannot shut our eyes to the facts, and if corporations will insist upon undertaking tramway work, we trust that it may lead to a great extension of electric traction. We are quite sure that, so far as the maintenance of the streets is concerned, the task with electric traction will be easier than with horse traction, and much more satisfactory.

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British Electric Traction.—It must be presumed that directors of companies know their own business best, but we always feel that the directors of industrial concerns do not sufficiently take into their confidence the technical Press. Perhaps, on the whole, they are wise in their generation, but there are occasions—especially when the company is of a *bonâ fide* character—when the criticisms of technical papers might be valuable and do good. Our own readers may have noticed that during the week a prospectus has been issued of the British Electric Traction Company to issue £100,000 of debenture stock. Now, this company is and has been carrying on good work, and even if we only consider that it is still pioneering, it ought to have our good word and wishes for its success.

Ozone.—We have received an excellently illustrated and well-printed pamphlet from the Electric Ozone Syndicate upon Mr. Andreoli's methods of producing ozone. This pamphlet contains a long list of the commercial applications of ozone. We would ask Mr. Andreoli and all persons engaged in this branch of electrical work to consider how far they could adopt ozone generation for use in military hospitals. It seems to us that with the discovery of the value of X-ray apparatus a new period of surgical apparatus was inaugurated. It would be necessary in all warlike operations to have this apparatus at hand, and, if we may suggest, it will be found as necessary in the course of a few years to have ozone-generation apparatus amongst the warlike stores as it will be the Röntgen-ray apparatus. If ozone is, as we believe it to be, one of the most efficacious antiseptics that Nature has provided us with, its use in surgery should be assured.

Light Railways.—At a recent meeting of engineers, we were again asked to make the attempt to reconcile preaching with practice. Needless to say we respectfully declined. The text upon which we were asked to preach was that some months or years ago various parties asserted the necessity of light railways in order to help the agricultural industry. Where are those railways now? Or, where are the suggestions for such railways? The concrete work seems to be restricted to the suburbs of towns, and the poor agricultural resident is to go hang. We ask what was expected, and did people suppose that company promoters and investors were going to make a cobweb over the kingdom with light railways unless there is a good prospect of making money by the operation? Investors do not act as philanthropists, although at times to gain their own ends they may talk as philanthropists; and there is not much likelihood of the light railways being laid down unless there is a probability of their paying.

The Electric Telescope.—The latest apparatus for telegraphing images to a distance is the idea of M. Dussand, the inventor of the microphonograph. The image is received in a camera, passed through a rotating shutter pierced with small openings arranged in a spiral, and falls upon a selenium plate, through which is passed an electric current traversing the primary circuit of an induction coil. The apertures of the shutter bring the light of successive parts of the image to the selenium, setting up currents in the secondary circuit of the coil that vary in strength with the intensity of light, according to a well-known law. The varying currents pass to the receiving instrument, where a very sensitive telephone diaphragm is displaced more or less in front of a fixed plate, more or less weakening a beam of light that passes a shutter exactly like that of the transmitter, and moved in unison with it, and is thrown upon a screen by a system of lenses. The light reaching the screen has the same intensity as the corresponding part of the image. The result is, so the theorists say, that when both shutters are rotated over the entire image in a tenth of a second, the time visual impressions persist, and the entire image is seen on the screen.

Consular Reports.—Considerable developments in electrical industries appear to have taken place in Italy during the year 1897, says the *Financial Times*, and Vice-Consul Cassinis, in his report on the district of Turin, thinks it is desirable that English companies should pay attention to the future which is opening up for that country in the matter of electrical power. In Piedmont, special opportunities seem to be afforded owing so its being so rich in waterfalls. It is suggested by our Consul that the question should be studied, and he is of the opinion that practical proposals could not fail to lead to important business relations between Italy and England, more especially as the financial crisis may now be looked upon as being over. In a report upon the trade of Spezia, Vice-Consul Towsey mentions that the municipality has under consideration a project for lighting the principal streets of the town by electricity, and for laying down the requisite plant at the municipal gasworks, which fact it might be in the interests of electrical engineers in this country to take note of and follow up.

Turkey.—Although the edict forbidding the installation of electric lighting or telephones in the Sultan's realm—at least so far as European Turkey is concerned—the Commander of the Faithful himself seems vastly interested in electrical matters. He also indulges in what he denies, up to the present, to his more or less faithful subjects. The Sultan's palace is magnificently lit by electricity, and the electric boat on the artificial lake in the palace gardens is daily patronised by his Majesty. A paragraph in the *Electrotechnischer Anzeiger*, referring to a recent dinner at the Yildiz Kiosk, states that the Sultan asked the German Ambassador repeated questions referring to electric lighting, and that he appeared particularly interested in the mode of power transmission as applied in the Lauffen-Frankfort station. Perhaps we may soon hear of Turkey being thrown open to electric enterprise, a field which should pay, as lavish expenditure for anything that glitters, and especially for anything that is new and Western into the bargain, is the main characteristic of the Oriental.

Free Wiring.—Mr. O. Claude Robson, in his inaugural address to the Municipal Engineers at Edinburgh on this point, said: "One great difficulty encountered in the general adoption of electric light in a residential neighbourhood, and especially where the property is of a small class character, is the expense incidental to the wiring of premises. Endeavours have been made in several directions to remove the difficulty by instituting what is nominally called the free wiring of premises by companies formed for that purpose. This is a work, however, that would be better taken in hand by the municipal promoters themselves, and it does appear most desirable with this intent that borrowing powers should be accorded to local authorities similar to those now exercised for private improvement work, by which the payment of the cost of the work by the owner or occupier, as the case may be, could be spread over a term of years commensurate with the period of the loan. This would be but little felt by the owners of property, and would, I believe, conduce very largely to the extension of electric lighting in residential property tenanted by the middle and working classes."

Illuminating Gas from Sewage.—"At the annual conference of the Association of Municipal and County Engineers in Edinburgh last week, Mr. Duncan Cameron, city surveyor of Exeter, the inventor of the septic tank

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system of sewage treatment, read a paper on the subject, in which he said that one of the most notable points observed in the Exeter tank had been the hitherto unrecognised energy stored in sewage, as evidenced by the production of marsh gas. The works and public baths adjoining at Exeter had been lit with the gas and incandescent mantles. He had not had more than 10 such lights burning at one time, but it was apparent, even under the conditions of leakage existing, that more than twice this number could be kept constantly alight, and this estimate was made during the cold, wet weather of last winter. The gas was innocuous, and could only be detected ordinarily by applying a light." The above is the summary given by a contemporary, but the summary does not go on to say that in the discussion which followed the possibility of lighting by the means suggested was pooh-poohed. We heard the discussion, and think that before such statements are sown broadcast without qualification some investigation of the matter should be made. It would then be found that much qualification was necessary.

Wonderment.—How is it that financial and daily papers get early and so-called complete accounts of technical processes? Is it a case of "bribery" or "blackmail"? The *Pall Mall* is indignant at the Hooley exposure, but is such indignation warranted? If, says the immaculate, if you had only gone to the editor-in-chief or the proprietor and said this or that or the other, why somebody would have been instantly dismissed. This is all "bunkum." If a man gets a salary of a thousand a year and lives at the rate of five thousand without going into the bankruptcy court, he gets four thousand outside his salary, and everyone around him knows something of how it is done—and so does his editor-in-chief, if he wants to know. To continue about our first question. It is absolutely certain that the articles and paragraphs in these untechnical papers about wonderful discoveries and processes are inserted and paid for, and the purpose is for promoters to use sentences from such articles to ensnare a too gullible public. We don't sympathise much with the public, because they will speculate anyway, and deserve to be caught. Why don't we specify these things? Well, if anyone has not fought a libel suit, they might so ask; but anyone who has will say, Be discreet, write in the abstract, not in the concrete; tell the public they are being gulled, and let them decide upon the specific cases.

Wireless Telegraphy.—A tune is popular when we hear it from every street-organ, so a scientific application becomes popular when shown in every school conversazione. Thus we are glad that the Corporation Committee of the City of London Schools in their conversazione at the school, Victoria-embankment, last week provided the following attractions, amongst which wireless telegraphy finds a place: The professional students of the Guildhall School of Music went through an excellent programme in the great hall, where the boy pipers of the Royal Caledonian Asylum also played selections of music. In the gymnasium a number of boys gave gymnastic displays, showing great skill and much careful training. The City of London School has always taken a foremost place in science teaching, and the demonstrations given during the evening were attended by large numbers of guests. These included stereoscopic projection with the limelight and colour photography in the physical lecture theatre, by Mr. O. G. Jones, one of the masters; wireless telegraphy, in which one form of Lodge's coherer was used, in the physics laboratory; an exhibition of biological and other objects, together with demonstrations of the X-rays, in the chemical laboratory, under the direction of Messrs. Durham and Scarf, science masters; and exhibits in the science rooms, workshops, and classrooms. Another interesting feature was a fine collection of pictures kindly lent to the school by many eminent artists.

Ships' Cranes.—Electric cranes have now been used for some time on the Norddeutscher Lloyd's steamers. They are all built on the same model, with a lift of about 17ft., in two sizes, for loads of 3 and 1½ tons respectively. As many as 16 have been erected on one vessel, the power station of which is worked by four steam dynamos, which, working continuously, give 75 kw. for lighting and 90 kw. for power purposes. At 105 volts there are 210 turns. Only two of these dynamos are required for 16 cranes, one being reserved for the supply of current for lighting purposes and the other for a stand-by. The liftwork consists of a simple worm-and-wheel gear fixed to a 25-h.p. motor of 700 revolutions, which latter increase by decreasing load up to 2½ times, when the hook is empty. The turning motor has a double worm and wheel, and a cogwheel transmission without self-acting stop. For the latter purpose a hand-brake is fixed upon an elongation of the motor axle, a slight pressure upon the footplate of the brake being sufficient to stop at once a load descending at the maximum speed. Two marine controllers, behind which are fixed two resistances of 32 h.p. capacity, serve to start, regulate, and turn the motors. Both are directed by a single lever which is turned in the direction in which it is desired to move the crane. The arrangements of both sizes of cranes are identically the same, therefore the smaller ones work with about the same speed. The following figures are given in the *Zeitschrift für Elektrotechnik* for the large and small sizes respectively:

Load	3 tons.	1½ ton.
Lift	5½ yards.	5½ yards.
Speed when loaded	0·33 yard.	0·63 yard.
Speed when empty	0·6 – 0·75 yard.	1·1 – 1·3 yard.
Lift motor	25 h.p., 900 revs.	25 h.p., 900 revs.
Speed of turn at the hook	4 yards per sec.	4 yards per sec.
Turning motor	7 h.p., 700 revs.	7 h.p., 700 revs.

Useful effect of the total cranes inclusive of motor, 25%.

Municipal Trams.—A blow, says the parliamentary correspondent of a northern contemporary, has been struck at the municipalisation of tramways. Two Scottish Corporations, Dundee and Aberdeen, seeing the success which has attended the efforts of other corporations in carrying on a tramway system in the public interest, came to an arrangement with the existing tramway companies to purchase. This arrangement required the confirmation of Parliament, but the Bill to give effect to the purchase was opposed in the case of Dundee by the Caledonian and the North British Railway Companies, and in the case of Aberdeen by the Great North of Scotland Railway Company. The grounds of opposition were that the tramway system might become a burden upon the rates, and that it was unfair to allow corporations to use public funds to compete with private companies. To the surprise of the Corporation of Dundee, whose Bill was the first to be taken, a committee of the House of Commons, presided over by Mr. Tatton Egerton, decided to pass the Bill on condition that the Corporation maintained the fares at such a price as would enable the tramways to show a surplus on a balance-sheet to be annually prepared. If there should be a loss on the working in any year the amount was to be carried to a suspense debit balance, to be satisfied by an increase in the fares sufficient to meet such deficiency. The Corporation of Aberdeen, the consideration of whose Bill followed, asked the committee to allow them to consider whether they would go on or withdraw their Bill. What the corporations say is that with this proviso by the committee

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they will be unable to borrow money at the same low rate for tramway extension.

African Telegraphs.—The Congo loan has been completed. This means an expenditure of about £800,000, the major part of which will be expended on an extensive telegraph system which is to be laid in conjunction with the building of a large railway from the Upper Congo to Lake Tanganyika. The Congo State, which is, of course, really the King of the Belgians, will have to pay 4 per cent. on the loan. It is stated that altogether an expenditure of £4,000,000 is contemplated for the complete work. According to the London correspondent of the *Manchester Guardian*, King Leopold has given Mr. Mohun, who was formerly United States Consul and Commercial Agent in the Congo Free State, and has since occupied a similar position in Zanzibar, a commission to build a line of telegraphs from a point about the middle of the west coast of Lake Tanganyika to Nyangwe on the Upper Congo, a town which was formerly famous as the headquarters of the Arab slave-traders who had established themselves in the Upper Congo region. From Nyangwe, Mr. Mohun is to carry a line along the river as far as Stanley Falls, where it will join the line connecting Stanley Falls with Boma and the lower river. From Stanley Falls the line is further to be carried along the Aruwimi, the river of which so much was heard during the Stanley-Emin relief expedition, to Wadelai, in the valley of the Upper Nile. It will be seen that in this way two long arms will extend from Stanley Falls and join the great trunk line from south to north which Mr. Rhodes is pushing forward with so much energy. Mr. Mohun is allowed an entirely free hand in the selection of his staff, and English and American engineers will be employed. From Tanganyika to Nyangwe the forest trees are to be utilised, but along the banks of the Congo and the Aruwimi poles will be erected for carrying the wire.

Electricity at Earl's Court.—Electricity plays a large part in the entertainments provided at the International Universal Exhibition at Earl's Court. Not only is the attractiveness of the grounds and waterways mostly due to the lavish display of multi-coloured lights, but many of the shows themselves are indebted to electricity as their mainstay. There is the theatrophone or electrophone, at which performances of the London and suburban theatres are made audible to non-spectators; there is the kinetoscope, the vicograph, the grammophone, and other sound-producing appliances; the electric theatre, where a 20 minutes' performance of a "Day in the Alps" takes place—a very clever illusion, which is entirely worked by electricity by means of innumerable switches. At the rise of the curtain the auditorium is darkened, and on the stage dimly lighted appears beautiful Alpine scenery, the mountain gorges and peaks glow with red sunlight. Gradually the morning gives place to a bright midsummer day, the villagers are seen crossing the bridge, etc. Then dark clouds begin to gather, and a heavy storm with vivid lightning, thunder, wind, and rain passes over the mountain and hamlet. Gradually and very naturally the storm subsides, and as the sky clears up a rainbow spans the heavens. The sunset comes, twilight gradually creeps over the quiet scene, with it the beautiful Alpine glow, the shadows steal over the mountain crags, and twinkling stars appear; lights appear in the windows of the various buildings, and the moon rises, flooding the scene with its silver beauty. The principal attraction is the naval spectacle at the Empress Theatre, a miniature naval battle which is most cleverly worked out. There are 12 vessels, modelled to scale, varying in size from 11ft. to 21ft. in length. They are moved by a cable paid out on board, and after going through the various peace manœuvres they begin a battle, firing guns and torpedoes—the latter actually hitting their targets—explode mines, and do all the things we are told the American and Spanish fleets are doing to each other at Santiago. It is stated that Admirals Markham and FitzGeorge have supervised the various evolutions of the boats in order to ensure their compliance with Admiralty orders, and doubtless the display is most interesting to naval students.

The Searchlight in Torpedo Attacks.—As to the use of the searchlight in torpedo attacks, says Lieutenant Smith in *Cassier*, data from the United States torpedo station records will be of interest. In 26 different exercises that have taken place between the torpedo boats stationed there and searchlights ashore, or in ships of the navy afloat, the average distance of discovery by the aid of the light was 781 yards; the greatest distance 2,000 yards; and the least, practically zero, the boat having got alongside the ship without discovery. The weather during these exercises was generally good, never with any appreciable fog or mist, and occasionally with a full moon. Other sets of figures were obtained by causing the boats to run out under the searchlight to the limit of visibility. The distances under these circumstances varied from 1,000 to 2,750 yards. The difference is due to the great difficulty of picking up a small neutral-tinted object by a sweeping beam. Now, taking the average distance of discovery, as above stated, at 781 yards, in order to reach torpedo range of 500 yards, the boat must cross a zone of 281 yards, which at the moderate torpedo-boat speed of 20 knots would require 25 seconds. Is this sufficient to put the boat out of action? If not, the chances of a single boat against a single ship depending only on searchlights would be more than one-half. With several boats making a preconcerted attack, the chances of the ship would be correspondingly less. It may be stated that in all the exercises referred to no advantage was taken of cover, such as might have been afforded by vessels at anchor or outlying islands. In making an attack, the boats always kept in visible range of the searchlights within a radius of 2,000 yards. It is to be regretted that there are no definite data on which to base a conclusion as to the time that would be required to disable or destroy an attacking torpedo boat. European practice in the annual manœuvres has limited the time from three minutes to one minute, the tendency having been gradually to reduce it. The United States torpedo station rules have required an interval of two minutes outside of 400 yards, equivalent to one minute and forty-eight seconds outside of 500 yards at the speed ordinarily used. In Europe, the attacking boat has been required actually to make a hit with a dummy-head in order to score a success; but with regard to the time necessary to ensure the destruction of the boat, everything was surmise, an arbitrary rule governing. I am under the impression that in 25 seconds, the average time of reaching torpedo range from the probable distance of discovery, as determined by the United States torpedo station experiments, the torpedo boat would not be found to be *hors de combat*. If the working range of the torpedo is materially increased by any new automatic steering device, all the arguments as above acquire added weight in proportion. The rational defence of the ship, then, whether at anchor or under way, seems to be the scout, the torpedo-boat destroyer, the torpedo boat, the vedette launch, and the picket boat. Here, perhaps, is the field for the submarine boat.

A Chat with Marconi.—A *Dublin Mail* representative has interviewed Signor Marconi, with the following

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result. Signor Marconi said: "We have an installation that sends messages a distance of 14½ miles across salt water between Bournemouth and Alum Bay, Isle of Wight." This was done to prove that weather temperature and climate had no power to affect the working of my system. It proved incidentally that the invention can be worked by any capable telegraphist without any special training whatever. It was also proved that any vessel coming within 12 miles of either of the two stations, which had on board an instrument similar to the ones used at the stations, could communicate with the latter. A small tug of ours communicated with the shore at a distance of 18 miles, although the weather was extremely unfavourable. I found that it is easier to communicate between ship and ship or between ship and shore than it is to exchange messages between stations on land. When last year the Italian Government kindly placed at my disposal two ironclads for purposes of experiment, I established communication at a distance of 12 miles with the shore and between the ships themselves. The invention is now being used in the Italian Navy. The size of the vessel upon which the invention is used does not affect its working, the best results having been obtained on the small tug-boat referred to off the Isle of Wight. The sea was then very rough, and we had at times 2ft. of water in the cabin, all the instruments being drenched with it, but without impairing their usefulness. On that occasion communication was established with the island 18 miles away. Captain Kennedy, R.E., who was on board, stated these results in a public lecture delivered at Whitehall, and expressed his complete satisfaction at the success of the experiments. In war the invention is of the greatest use to torpedo boats or destroyers, which, with the apparatus on board, would be able to communicate at a considerable distance with the battleships of the squadron to which they were attached. This has been proved by experiments made in the navy by one of the Great Powers. In the mercantile marine the invention is of even more practical utility than on board a man-of-war. Provided lightships and lighthouses are fitted with my apparatus, ships in foggy weather can be warned of danger from the lighthouse or lightship when the flashlight or the sound of a bell could not reach the vessel. Ships could also communicate with each other and interchange a warning. The warning apparatus in a lighthouse can be so set as to sound the alarm to any ship coming within a radius of 10 miles, and the latter will know from the kind of signal received what particular lighthouse it is that has signalled. This is done by means of a reflector moved around the receiving instrument on the principle of a dark lantern, through which only the electric rays penetrate. I have been informed by an evening newspaper of the 20th inst. that when a party from the House of Commons visited the dockyard at Portsmouth they found officers and men of the Royal Navy being instructed in the working of wireless telegraphy, which I have frequently discussed with British officers of both the army and navy."

Johannesburg.—Perhaps we ought to relegate this note to another column, but we don't. We have before us the city engineer's report for last year, and, knowing the thoroughness with which Mr. Aburrow does his work, we naturally looked for his remarks upon gas and electric light. The latter is progressing favourably. The number of consumers is 370 as against those for gas 387. No additions were made to the gas-making plant during the year, but a good deal has been added to the electrical plant. However, it may be as well to give the paragraph verbatim relating to these matters in the report: "The following particulars of the lighting department have been compiled from the annual report of the general manager: Number of gas consumers, 387. About 5¼ miles of gas mains and branches were laid in various streets during the year, the total length of mains now being about 25 miles. The two gasholders have a capacity of 160,000 and 65,000 cubic feet, or a total of 225,000 cubic feet. No additions were made to the gas-making plant. The quantity of gas manufactured was 31,120,700 cubic feet, being an increase of 5,614,900 cubic feet over the previous year, and was disposed of as follows:

	Cubic feet.
Private consumers	18,626,200
Public lighting	5,217,150
Used on works	724,600
Lost in distribution	6,552,750
Total	31,120,700

The average price at which the gas was sold during 1897 was a fraction over 1s. 8¾d. per 1,000 cubic feet. A fitting shop and incandescent burner shop have been built both of wood and iron, so that the work of preparing and fixing the incandescent gas burners for street lighting is now done departmentally.—Number of electric consumers, 370. About 53 miles of overhead wires were fixed, out of which Messrs. Siemens and Halske erected 26 miles. The total length of streets containing electric mains is now about 25½ miles, representing about 87 miles of wires. There are approximately 21,000 8-c.p. lamps connected to the electric mains, and eight arc lamps for the use of private consumers, which do not include the lamps for street lighting. The number of units generated was 639,592, being an increase of 234,230 over the previous year. The current was distributed as follows:

	Units.
Private consumers	385,111
Public lighting	91,754
„ „ (Doomfontein)	4,767
Used on works	26,416
Unaccounted for, being difference between station meters and consumers' meters, by transformer losses and loss in mains, etc.	131,544
Total	639,592

The average price obtained per unit sold during 1897 was a fraction under 1s. 5d. The total number of public lamps under the jurisdiction is 42 arc lamps of 2,000 n.c.p., 130 incandescent lamps of 35 c.p. (connected to Siemens and Halske's mains), 131 incandescent lamps, mostly 16 c.p., 3 gas lamps (3 lights), 446 gas lamps (1 light)—total, 752 lamps. Eight incandescent lamps in Doomfontein are supplied with current from the town lighting works. The principal streets lighted during 1897 were Jeppe-street East, Kerk-street East, Plein-street, De Villiers-street, Noord-street, Avenue-road, Klein-street (Hospital Hill), Loveday and Rissik, Smit and De Korte streets (Braamfontein), nearly the whole of Jeppestown, and a portion of Belgravia. The following additional plant, etc., has been put down during the year: one 45-kw. alternator with switchboard; one overhead travelling crane in old engine-house; four 100-h.p. "Sterling" water-tube boilers and a Worthington feed pump; one wrought-iron chimney, 150ft. high and 6ft. 6in. diameter; two 200-h.p. Turner compound horizontal condensing engines; two 120-kw. three-phase generators, self-excited, with switchboards complete; one switchboard, 36ft. long, containing generator and circuit boards for the three-phase plant, with instruments and synchronising gear; one new wood and iron engine-house, 60ft. 6in. by 47ft.; extension to boiler house, 60ft. 6in. by 36ft.; and one small electrical testing room.

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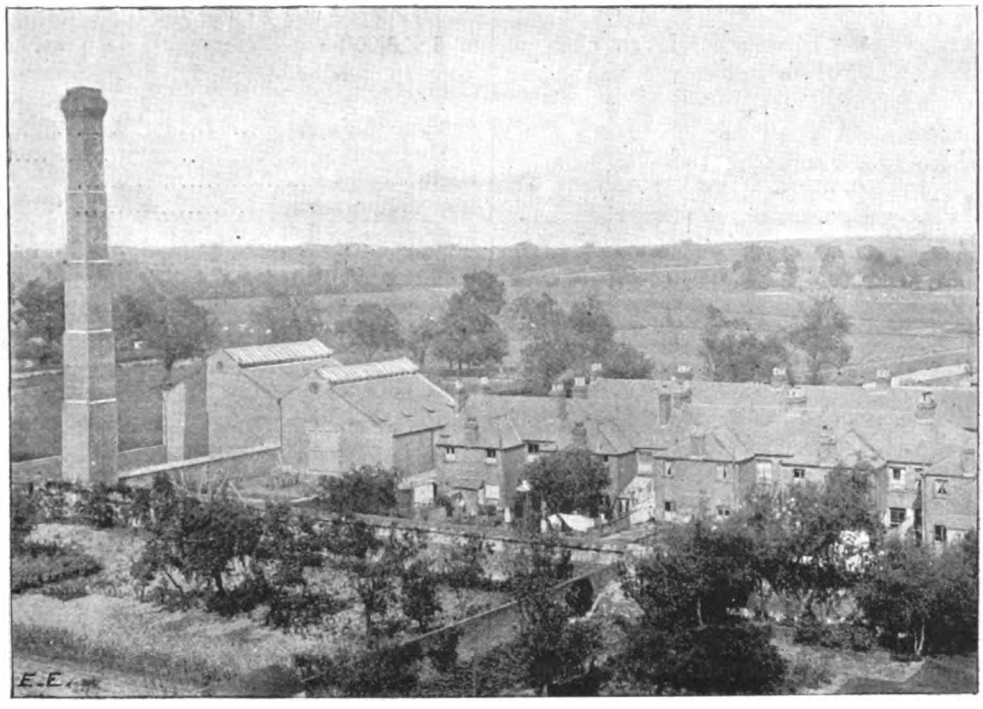
WINCHESTER ELECTRIC LIGHTING.

The city was lighted by oil previous to 1895, when the Council secured a provisional order, but obtaining a low tender from the gas company for public lighting, they decided not to proceed with the order.

In the autumn of 1896, Messrs. Edmundsons' Electricity Corporation made the Council an offer for a transfer of the order, giving them the option of purchasing the undertaking upon easy conditions. The necessary formal proceedings occupied a long time, and the work was not actually started till last autumn. The whole of the works have been designed and erected by Messrs. Edmundsons, Mr. H. N. Warburton acting as their resident engineer. The general scheme is based on the assumption that 6,000 8-c.p. lamps may be expected to be connected in the area in which the mains are laid within a year or so.

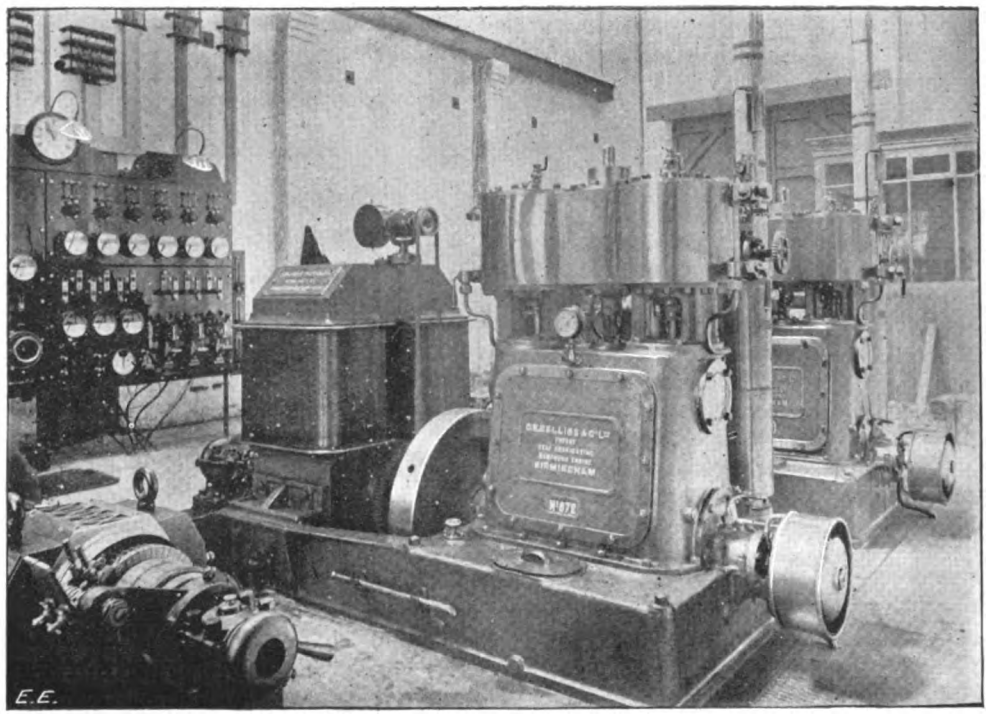
A site for the station was obtained on the north side of the town on a piece of ground formerly occupied by the buildings of the Abbey of Hyde, in the church of which were buried several of the Saxon kings—notably, Alfred the Great. The site is not far from the railway station, and there is a stream running through the premises, which is intended to be used for condensing purposes when the station grows larger.



Winchester Electric Light Station.

The buildings were erected under the supervision of Mr. Thomas Stopher, the architect, in Winchester, by Mr. J Thompson, of Peterborough, who, at the time the contract was settled, was engaged in the repair of the cathedral roof. The buildings are plain, but adapted for their purpose, and ample room is left for extensions.

A plan of the station given herewith shows the arrangement of the plant, which consists at present of two Babcock and Wilcox boilers, each with a grate area of 19·15 square feet, and made to evaporate 2,280lb. per hour. The two boilers are set as a pair, and room is left in the buildings



Bellias-Parker Combination Set at Winchester.

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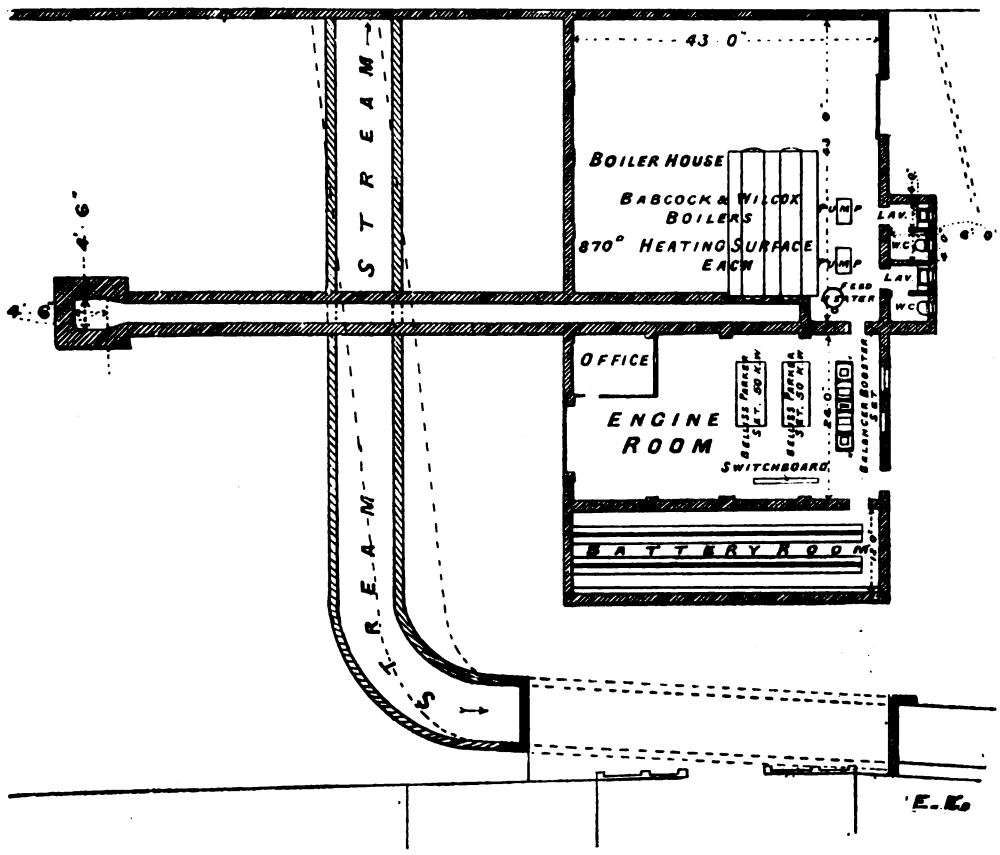
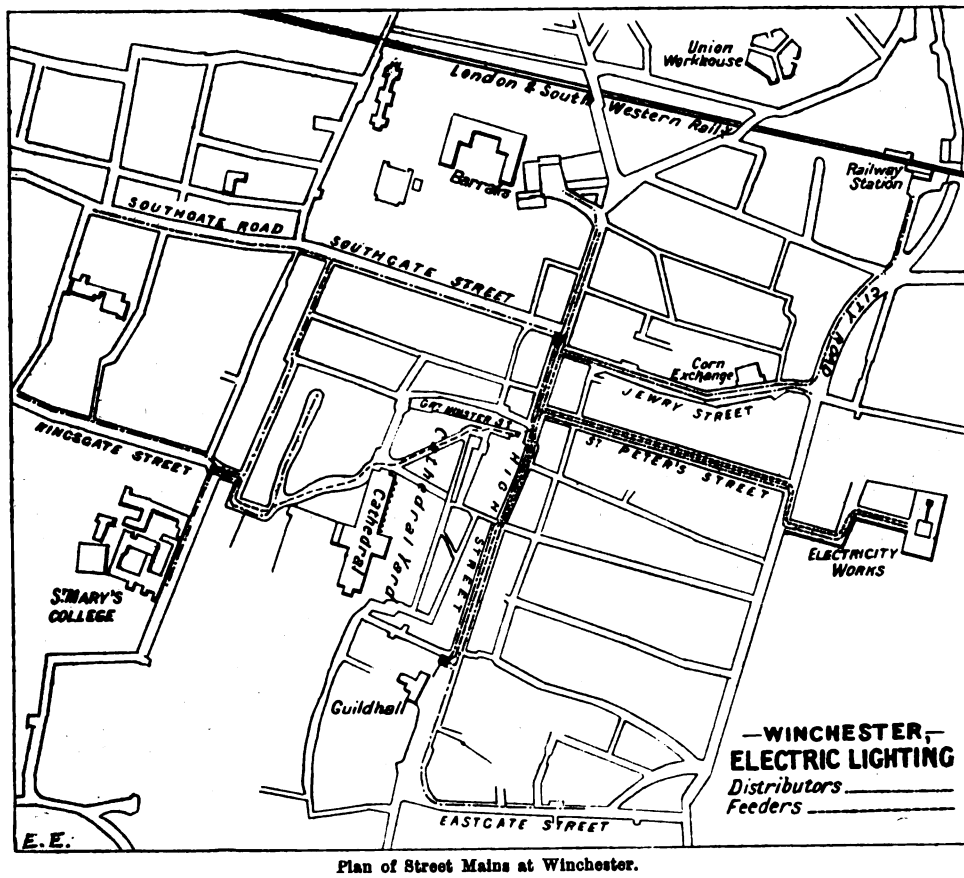
for another pair. The boilers are of the usual Babcock and Wilcox construction, and their working pressure is 150lb. per square inch. A Babcock and Wilcox water-tube heater, of sufficient capacity to raise the temperature of 7,000lb. of water per hour from 32deg. to about 200deg. F., using exhaust steam, is also installed, and contains 98 square feet heating surface. There are also two Worthington duplex direct-acting feed pumps of the 3¼ by 5½ by 5 size, having a capacity of 1,800 gallons per hour.



Plan of the Winchester Electric Light Station.

Two Belliss compound self-lubricating single-valve quick-revolution engines of the E.C.C. 5 type are erected, and are capable of giving 75 b.h.p. at 450 revolutions with 120lb. steam. Each engine is fitted with a separator, the drain from which is connected to a Geipel steam-trap. Two Parker shunt-wound dynamos are coupled direct to the Belliss engines, the output being 115 amperes at from 420 to 460 volts.

The steam-piping is not at present arranged in duplicate



Plan of Street Mains at Winchester.

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but is so designed that the second portion of the ring can be added with the first extensions. The pipes and bends are of wrought steel with welded seams and heavy forged flanges screwed on hot and brazed. The T-pieces and pocket pipes are made of a special mixture of cold-blast hematite and steel. The pipes are carefully drained to Geipel traps. The exhaust pipe is of cast iron and passes under the engine-room floor, which is covered by wrought-iron chequer plates. A by-pass is provided for the feed heater. The feed pipes are arranged in complete duplicate, with valves to cut off any section that may fail. The connections provided allow of the feed pumps either drawing from the river or supplying from the tank and delivering to either boilers or supply tank. Steam for the pumps is taken from the boilers independent of the main steam-ring. All steam-pipes are covered with magnesia covering, supplied by the Washing Chemical Company. A galvanised iron feed tank holding about 2,500 gallons is fitted over the lavatories.

The accumulators consist of 230 cells of the D.P. type, F size 19 plate, with a normal discharge of 65 amperes in nine hours, or 98 amperes in four hours, and are contained in glass boxes. The accumulators are charged through boosters, the potential at the switchboard not being altered, extra pressure being given by the boosters. Two boosters are used, each capable of giving 60 amperes at 70 volts. These machines are driven by the motors for maintaining the balance of the three-wire system, the armatures being wound on sleeves and slipped on to the end of the balancer spindles.

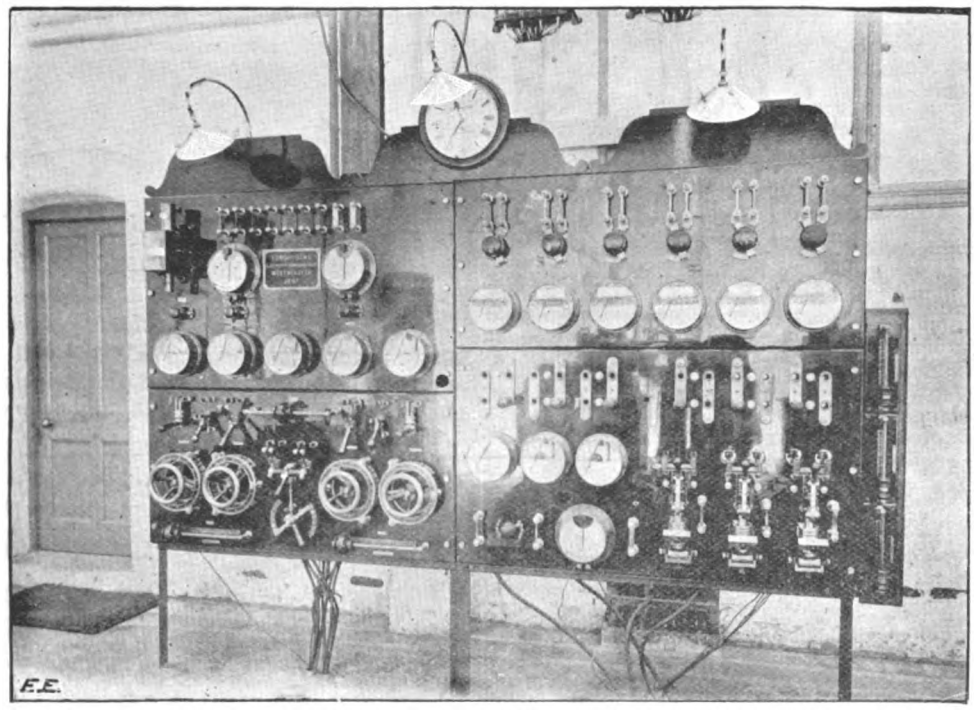
The balance of the three-wire system is maintained by a balancer transformer, which consists of two dynamos coupled together, each capable of dealing with 50 amperes at 210 to 230 volts, allowing of the system being 100 amperes out of balance. Either of these machines is capable of driving two boosters at full load.

The switchboard was designed by Messrs. Edmundsons, and made for them by Messrs. Parker. It is composed of four panels—the right-hand pair being the feeder and dynamo panels, containing the usual duplex cut-outs for feeders, double 'bus bars, automatic cut-outs for dynamos and ammeters; the left-hand pair containing switches and regulators for controlling accumulators and starting and regulating the balancer. Ammeters are provided for measuring the charge and discharge of the current in the neutral wire. The feature of the board is the use of polarised voltmeters for putting the dynamos and accumulators in parallel. All the instruments are of the Kelvin make.

The pressure at the consumers' lamps is 210 volts. While the load is small, the accumulators, which are of very large capacity for the size of the station, will supply all the lamps, so that only one shift is expected to be required for some time to come. The supply is on the three-wire system at 420 volts on the outers, the balance when the engines are running being, as previously explained, maintained by the balancing transformer.

The mains are all of the Callender's Cable Construction Company's make. The feeders are triple-concentric, lead coated and armoured, and the distributors are three-core of the same type. The use of three-core makes the fitting of services a much simpler matter. All the mains are laid direct in the ground. The feeder and network boxes are of Callender's standard type. The ends of the cables are sealed with bitumen compound, through which the connections project for the purpose of disconnecting and testing. There are at present about 3,113 yards of feeders—·15 square inch, ·15 square inch, and ·075 square inch triple-concentric; 3,359 yards of distributors—·075 square inch, ·075 square inch, and ·050 square inch three core; 1,771 yards of distributors—·050 square inch, ·050 square inch, and ·035 square inch three-core.

The system of charging is that known as the maximum demand—viz., 7d. per hour for the first hour, 4d. for the second, and 2d. for all following. There are not very many customers connected at present—only about 12 or 15—but orders are coming in very quickly now that current is being supplied. There is an excellent field for lighting, and there are many excellent shops and good residential houses, which would make a good field in themselves, and there are also the celebrated public schools, which, with the houses connected, are sure to become good customers. The military barracks (burnt down a few years ago, and about to be rebuilt on an extensive scale), the county infirmary, the diocesan training college, a number of breweries (one of which is already lighted), and the various municipal and county public buildings are expected in the ordinary course of things to become customers.



View of the Switchboard at Winchester.

The Opening.

The formal opening of the works took place on the 30th ult. Those present included the Mayor (Mr. Alfred Bowker), the Mayoress (Miss Bowker), Miss Edith Bowker, the Bishop of Guildford, Canon Warburton, Aldermen T. F. Kirby, W. Shenton, W. T. Warren, T. Stopher, Councillors G. Wright, W. H. Jacob, C. H. Goodbody, J. Marks, W. D. Gibb, B. D. Cancellor, A. Tebbutt, A. R. Dyer, F. S. Morgan, C S. Wooldridge, R. J. Harris, P. W.

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Snelling, and H. Easther, General Oldfield, General Montgomery, Colonel Hamilton, Mr. J. Hansford (Ryde), H. A. Warburton (secretary and engineer), F. G. Poulton (assistant engineer), W. T. Pressland, A.I.E.E. (consulting engineer), W. Gibb, and many others.

Alderman J. F. Kirby, the chairman of directors of the Winchester Electric Light and Power Company, introduced Mr. J. C. Wigham, engineer for Edmundsons' Electricity Corporation, who proved himself an adept at delivering a concise and popular lecture on the intricacies of windings, gearings, and accumulators, taking the party through the various boiler, engine, and accumulator rooms. Everything was spick and span and extremely clean and bright. This fact, as well as the total absence of noise in the engine-room, was greatly commented upon by the visitors. The Mayoress then turned on the engines, and was somewhat startled by a slight escape of steam, after which she proceeded to switch on the first light. This "first light" is, of course, a mere figure of speech, as a number of houses had already been supplied with current during the preceding week. Mr. Kirby then presented the Mayoress with the switch used for the occasion, which is a suitably inscribed gilt replica of the one made for her Majesty's waiting-room at Windsor Station.

The MAYOR having suitably replied, the party adjourned for luncheon provided by the directors of the company at the Royal Hotel.

By this time the rain had set in and the tables, which had been laid in the beautiful garden of the former convent, had to be removed inside. But soon the party—numbering about 70—were peacefully at work under a pleasant verandah discussing country pies and '92 Heldsick to the strains of the band of the 1st V.B. Hants Regiment.

After the toast of "The Queen" had been honoured,

Mr. KIRBY, who occupied the chair, proposed "The Mayor and Corporation of Winchester."

The MAYOR, in responding, said he believed they had already applications for about 3,000 lamps. They had been very fairly treated by the company from beginning to the end. He thought that when the motor traffic would develop, it would be an advantage to Winchester that they had a station where these vehicles could be recharged on their run down to the coast. He begged to propose "Success to the Winchester Company."

Mr. F. E. GRIPPER, managing director, replied, giving a history of the works since their commencement. He acknowledged the help they had received from the Corporation and the directors of the Winchester Company, who had been most energetic in pushing the matter through. He said that he had never known a case where electric lighting had been found to damage a gas company, and he believed that though shareholders in gas companies did look at electric light companies with suspicion at first, in the end they came to look upon them as fairly decent sort of rivals.—Mr. WIGHAM also replied.

Alderman SHENTON proposed the health of "The Visitors," to which Colonel HAMILTON, of Ryde, responded, expressing a hope that the municipal authorities of that town would soon follow suit by introducing the electric light in a manner similar to that adopted by this Corporation.

The MAYOR proposed a vote of thanks to the chairman, and the latter's reply terminated the proceedings.

THE ELECTRIC LIGHTING OF EDINBURGH.*

BY FRANK A. NEWINGTON, RESIDENT ELECTRICAL ENGINEER.

The Corporation of Edinburgh obtained, in 1891, a provisional order from the Board of Trade for the electric lighting of the city. The building of the station and the work of laying the mains in the streets was commenced in May, 1894, and the supply of electric energy was first commenced on April 11, 1895. Prof. Kennedy is the consulting engineer to the Corporation.

Generating Station.—The building is situated in Dewar-place and Torphichen-street. It consists of the boiler-house and engine-room on the ground floor, the coal store over the boiler-house, and the battery-room, meter-testing room and store over the engine-room, the offices being at the south corner of the building.

Boiler-House.—The boiler-house is 152ft. long by 46ft. wide. This at present contains 13 boilers; four others will be erected within the next three months. The boilers are of the dry-back type, 10ft. 3in. diameter by 12ft. long, with two Purves flues, 3ft. 3in. diameter, and 166 tubes of 2¾in. internal diameter. They are designed to evaporate 10,000lb. of water per hour, the working pressure being 160lb. per square inch. The boilers are fitted with mechanical stokers of the coking type. Directly above the shells of the boilers superheaters are fixed, each of these consisting of two nests of zigzag tubes or coils 1½in. diameter; there are 26 of these coils to each superheater. The coils are connected at both the back and front of the boiler to a cast-iron pipe; the steam from the boiler enters at the back pipe, then passes through the coils and leaves by the front pipe. The gases, after leaving the furnace flues, enter a brick combustion chamber, pass through the tubes to the front of the boiler, over the top of the boiler around the superheater tubes, and then down each side of the boiler to the main flue. By these means the steam is superheated 40deg. to 60deg. F.

Feed Pumps.—There are two duplex steam-pumps, having a maximum capacity of about 6,000 gallons per hour each, and three three-throw pumps driven through gearing by electric motors, each with a capacity of 4,500 gallons per hour. There are two ranges of feed-water pipes, and each boiler is fitted with two check valves. The feed water is measured by Kennedy water-meters, and is heated by exhaust steam feed heaters. There are three electric motors in the pump-room for driving the shafting for the mechanical stokers The coal is delivered in railway trucks by a siding from the Caledonian Railway. At the east entrance to the boiler-house there is a hoist driven by an electric motor, which lifts the truck to the coal-store level; railway lines are fixed the whole length of the coal store, 8ft. 6in. above the floor level, and the trucks are drawn along these by means of an endless rope also driven by an electric motor. The coal is unloaded on to the coal-store floor, and runs into hoppers fixed to the ceiling of the boiler-house, there being one hopper to each pair of boilers. Immediately below the hopper there is a measuring box holding 4cwt. of coal, having slides at the top and bottom; below this box are the shoots for leading the coal into the hoppers of the mechanical stokers. The slides in the measuring box are arranged so that on opening the top one the measuring box is filled with coal; this is then shut and the bottom one opened, a measured quantity of coal being delivered to the boiler each time—ordinary counters are connected to the sides to indicate the number of times the slides are opened. This arrangement works admirably, saving a large amount of labour.

Engine-Room.—The engine-room consists of a building 102ft. long by 98ft. wide, divided down the centre by a row of columns; these carry the roof, which is in two spans. The machinery at present erected consists of—two 100-i.h.p. engines, coupled to two 60-kw. dynamos; two 250-i.h.p. engines, coupled to two 155-kw. dynamos; ten 360-i.h.p. engines, coupled to ten 225-kw. dynamos; two 150-i.h.p. engines, coupled to two 84-kw. alternators; and two 240-i.h.p. engines, coupled to two 150-kw. alternators. The engines are Willans central-valve type, running from 350 to 450 revolutions per minute, and are direct-coupled to the dynamos and alternators. Both high and low tension systems of distribution are in use, the high-tension mains supplying the outlying parts of the city, and the low-tension mains the more central part. The dynamos are two-pole shunt-wound machines; the 10 large machines are wound for a pressure of 460 volts, the four smaller machines for 230 volts. The four alternators are designed for 2,100 volts. The engines and dynamos are bolted down to a solid block of concrete about 7ft. thick. This is not in contact with the walls of the building, there being a space of about 3ft. between them. The steam-pipes form complete rings both in the boiler-house and engine-room, and the stop-valves are so arranged that any section can be shut off without stopping more than one engine or boiler. The main steam-pipes are 8in. in diameter, the straight lengths are of steel, with the flanges screwed and brazed on, the bends are of copper with steel flanges. The pipes are carried by rods from brackets fixed to the walls,

* Paper read before the annual meeting of the Incorporated Association of Municipal and County Engineers at Edinburgh, July 1, 1898.

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thus allowing for expansion. The branch pipes to the engines are of copper. Four direct-coupled sets of 390-kw. capacity, two for the low-tension system and two for the high, will be erected in about three months' time. This new plant will fill up the station. The engines for these sets will be of the Belliss high-speed type.

Switchboards.—The switchboards are arranged on a raised platform at the west end of the engine-room. The low-tension switchboard is arranged for 18 dynamos and 19 feeders. The current from the dynamos is carried by cables laid in trenches under the engine-room floor to the switchboard, passing through fuses, automatic switches, and ampere-gauges to a common bar, to which the feeders are also connected. The feeders on leaving the switchboard are carried into a cellar below, and then run to various parts of the city. On starting an engine, it is run up to its proper speed, which is regulated by the governor, the stop-valve is opened out full, and all the regulation is done by the switchboard attendant, by means of a resistance in the shunt winding of the dynamo.

The high-tension switchboard is arranged for seven alternators and seven circuits. Each alternator and circuit has a fuse and ammeter and two single-pole switches. There are two omnibus bars, either of which can be connected to the inner conductor of the concentric mains by means of the circuit switches. The outer conductor is permanently connected to the machines, and is also connected to an earth-plate in the station. There are seven Ferranti rectifiers for changing alternating currents to rectified currents for arc lamps, with the necessary switchboard for six circuits of arc lamps. Each rectifier is capable of lighting 35 to 40 12-ampere arc lamps in series. The rectified circuits are used to supply the outlying street lamps.

Battery Room.—There are two batteries, one for the positive, the other for the negative side of the system; each consists of 128 cells, having a capacity of 850 ampere-hours, at a discharge rate of 180 amperes. The batteries are always connected to the omnibus bars on the switchboard, but as the pressure of the dynamos is not sufficient to charge all the cells at once, motor-generators or boosters are used; these are put in series with the dynamos, and are capable of increasing the pressure of the battery circuit 100 volts or so above the pressure of the dynamos. By this means the batteries are very conveniently worked, it being possible to charge them at any time. The cells are of the Crompton-Howell and Tudor types.

Distribution.—The low-tension system used is a three-wire network, with feeders at various points supplying it direct from the generation station. There are at present 16 pairs of conductors going out of the station. The points at which these feed into the distributing network are arranged according to the demand for energy in different parts of the city; the section of the conductors also varies for the same reason. From these feeding points pilot wires are brought back to the station and connected to voltmeters, which show the pressure of the supply at these points. The feeders chiefly consist of bare copper strip, carried on insulators in concrete culverts; where it has not been possible to use this on account of there not being sufficient room between the pavements and the cellars of the houses, Siemens armoured cable has been laid down. One of the chief advantages of using culvert and copper strip lies in the ease with which the section of the conductor of any feeder can be increased as the load on that feeder increases. All that it is necessary to do is to add one or more extra strips of copper. The usual section of the copper strip is 1in. wide by ¼in. thick, and any number of these up to about six (or 1½ square inch section) can be used. The distributing mains in use are insulated with indiarubber, bitumen, or paper. They are drawn into Doulton's stoneware casing when laid under the pavement, or into cast-iron pipes under the roadway. The pressure between the two outer mains is 460 volts, or between either outer main and the middle wire 230 volts—that is, the pressure at the consumers' lamps is 230 volts. The distributing network of one district is connected to that of another district as much as possible, in order to ensure an even pressure throughout the system.

The high-tension system is used for the outlying and scattered parts of the city. The conductors in all cases are concentric cables, insulated with paper impregnated with oil, and lead sheathed. These are laid in Doulton stoneware casing or in iron pipes. Armoured cable laid directly in the ground is also in use. The pressure of the high-tension mains is 2,100 volts; this is reduced to either 230 or 115 volts before entering the consumers' premises. The transformers for this purpose are contained in cast-iron watertight boxes, which are sunk under the pathway. The size of the transformers varies according to the number of consumers supplied by them. An extension of the high-tension mains is now being made to Portobello, about five miles distant from the generating station. Transformer sub-stations with a low-tension distributing network will be used.

Public Lighting.—There are now 608 arc lamps in use in the city, 441 of which are lighted from the low-tension mains, and the remainder by the rectified circuits. The lamp-posts are placed 60 and 70 yards apart, except those in Prince's-street and Leith-walk, which are only about 45 yards apart. The lamps hang from a bracket projecting from the top of the posts, the centre of the lamps being 23ft. from the pavement. The circuits for the arc lamps have been arranged so that alternate lamps are on different circuits; this allows every other lamp to be switched out at midnight. The low-tension lamps are connected to the distributing mains, but the rectified lamps require separate conductors laid from the station for each circuit. These lamps are switched on and off at the station, but in the case of the low-tension lamps the lamp trimmers go round to switch them on and off. The public arc lighting is now being extended by the addition of 130 lamps. A site of about 3½ acres has recently been acquired by the Corporation at the north-east end of the city, on which another generating station will be erected. Only a part of the ground will be built on at present, the buildings being designed for about 10,000 h.p. of machinery. The station when completed, however, will contain machinery of 40,000 h.p. to 50,000 h.p.

Financial Results.—When the supply was commenced on April 11, 1895, there were about 20 consumers connected to the mains, having an equivalent of 2,500 8-c.p. lamps and 46 street arc lamps. At the completion of the first year's working, on May 15, 1896, there were 507 consumers connected, having 53,250 8-c.p. lamps and 245 street arc lamps. On May 15, 1897, there were 900 consumers connected with 91,980 8-c.p. lamps and 471 street arc lamps, and on May 15, 1898, there were 1,630 consumers with 149,480 8-c.p. lamps and 556 street arc lamps. During the last 12 months, therefore, an average of more than 1,100 8-c.p. lamps have been connected to the mains each week, and applications for a further 15,000 8-c.p. lamps have been received. The price per Board of Trade unit at first was 6d. for lighting, with discounts amounting to 25 per cent. according to the quantity used, and 3½d. for power and heating. This has been reduced each year as follows:

1895-6,	lighting 6d.	per unit,	power 3½d.	per unit.
1896-7	,, 5d.	,,	,, 3d.	,,
1897-8	,, 4d.	,,	,, 2d.	,,
1898-9	,, 3½d.	,,	,, 1½d.	,,

The public arc lamps, arc lamp-posts, and all cables, connections, etc., are supplied and erected by the electric lighting department, who also trim the lamps and keep them in repair, for which the following charges per lamp per annum have been made:

1895-6	£20	1897-8	£16
1896-7	18	1898-9	14

The following are the units sold during each year:

	1895-6.	1896-7.	1897-8.
Private lighting	556,744	1,052,570	1,973,315
Power	13,914	47,727	86,654
Public lighting	331,043	621,276	834,660
Total	901,701	1,721,573	2,894,629

The capital expended on the undertaking now amounts to about £282,000. A reserve fund has been commenced, £4,050 having been put aside for this purpose for the year ending May 15, 1897, and £4,000 for the year ending May 15, 1898. A considerable net profit has been made each year, after paying all charges, including interest and sinking fund on the capital expenditure and the contributions to the reserve fund, in spite of the reduction in the price of energy.

Year.	Net profit.
1895-6	£3,976
1896-7	£3,374
1897-8	£2,000 to £3,000 (estimated, as the figures are not yet completed).

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The following table gives the works costs and total costs per unit sold for the years 1895-6 and 1896-7. The figures for the year 1897-8 are not quite ready yet. Works costs include fuel, oil, water, stores, wages, and maintenance. Total costs include works costs, salaries, management, rent, taxes, and insurance:

Year.	Works costs.	Total costs.
1895-6	·92d.	1·67d.
1896-7	·63d.	1·13d.

The growth of the undertaking has been extremely rapid, and the results very satisfactory. This, I think, has been largely due to the policy which the Corporation has adopted—namely, of extending the supply mains wherever there has been a demand for electric energy, and in reducing the price per unit as quickly as possible.

MUNICIPAL ELECTRICAL ASSOCIATION.

THIRD ANNUAL MEETING.

THIRD DAY'S PROCEEDINGS.

(Concluded from page 22.)

The following paper was then read in abstract:

The Use of Accumulators in Connection with Lighting and Traction Systems.

BY J. H. RIDER, BOROUGH ELECTRIAL ENGINEER, PLYMOUTH.

Accumulators have always been an essential part of the equipment of a continuous-current lighting station, and their value is becoming more recognised every day in alternating-current and power stations. In order, therefore, that the opinions and experiences of members may be obtained this paper is presented, with the hope that it may give rise to an useful discussion. The efficiency of accumulators $\left(\frac{\text{watts output}}{\text{watts input}}\right)$ will seldom exceed 75 per cent. under ordinary working conditions, and since a steam plant must always be used to charge them, it follows that a given output can generally be obtained more cheaply directly from the steam plant if it can be run at an economical load than from accumulators.

But in deciding what is an economical load for any given set of steam plant, the whole of the plant—boilers and piping, as well as engines and dynamos—must be taken into account. By proper sub-division of the dynamo units, it will generally be found possible to keep the running sets at a fairly economical load. But with the boilers and piping it is different. Steam has practically to be kept up for the whole of the 24 hours in as many boilers as will be required at the maximum load, and the whole of the steam-piping kept connected ready for use. So that at, say, anything under three-quarters of the maximum load, the steam plant is generally working uneconomically, because of the large "stand-by" and radiating losses. Therefore it would pay to run one of the dynamos, if necessary, for the sole purpose of charging accumulators, when the load on plant as a whole had dropped to an uneconomical plant. Or if a dynamo have to be run in order to supply electricity for other purposes, and it can only be run under such conditions at a low load factor, then it would pay to use its surplus power for charging cells. The discharge from the cells can, in like manner, be economically used at any time when either a dynamo would otherwise have to run lightly loaded, as, for example, when the load on the station was more than x dynamos could do, but considerably under the output of $x+1$ dynamos. Or, when the gain in efficiency by using the steam plant direct, would be more than counterbalanced by the extra number of men required to work it. Or, when by taking a share of the load at the "peak," the total amount of the plant at the station may be reduced. It may be therefore stated, as a general rule, that it will pay to use accumulators in a station if they can be both charged and discharged at a time when the steam plant or part of the steam plant would otherwise be working at an uneconomical load.

It is practically impossible in any station so to arrange matters that all the plant working shall be kept at an economical load for any length of time. The demand is constantly varying, and oftentimes in a most unexpected manner, so that in almost every station a set of accumulators would be of service, the cells being used to level the load on the plant. We all want our "load curve" to be a horizontal straight line, and accumulators will help us to obtain this by filling up the hollows with a charge and by levelling the peaks with a discharge. Accumulators are of far more value in a station when used in this way, than when kept for the purpose of acting as a stand-by, in the event of a failure of any of the plant. Of course, when charged, they are always available for this up to the limit of their output, but primarily their use should be to supplement the plant, by helping it to work at an economical load. The prime cost of a battery for a given kilowatt output (for five hours), is roughly the same as for steam dynamos and boilers for the same output. The depreciation need not be more than 5 per cent. per annum if properly treated and looked after, and this is is about the same as for the steam plant.

We will briefly consider the use of accumulators in (1) the continuous-current lighting station, (2) the alternating-current lighting station, (3) the traction station, and (4) the combined lighting and traction station.

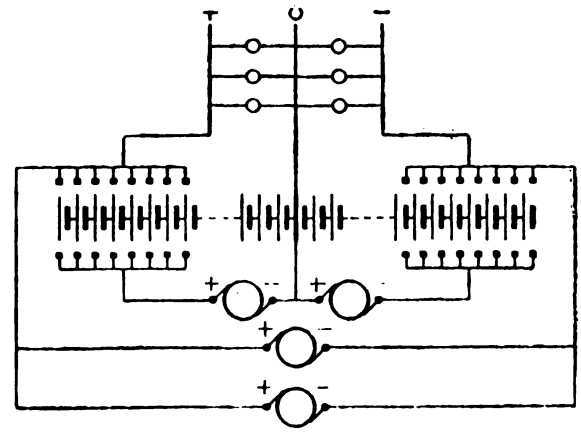

FIG. 1.

Continuous-Current Lighting Station. — Continuous-current lighting stations are now almost universally on the multiple-wire system, with either three or five distributors, and the battery is therefore divided into equal sections, the whole being, however, in one series. Fig. 1 shows an arrangement which is in use at a number of stations in this country. It will be noticed that only two of the dynamos are connected with the middle wire. The others (generally of a larger size) are connected directly across the outers. Even though the accumulators may be large enough to take the difference in load between the two sides of the system, when the larger dynamos are running, it is not possible, or, at any rate, advisable to connect all the machines directly to the outers because the two sides of the battery may be discharged unequally, and it is therefore necessary to be able to charge

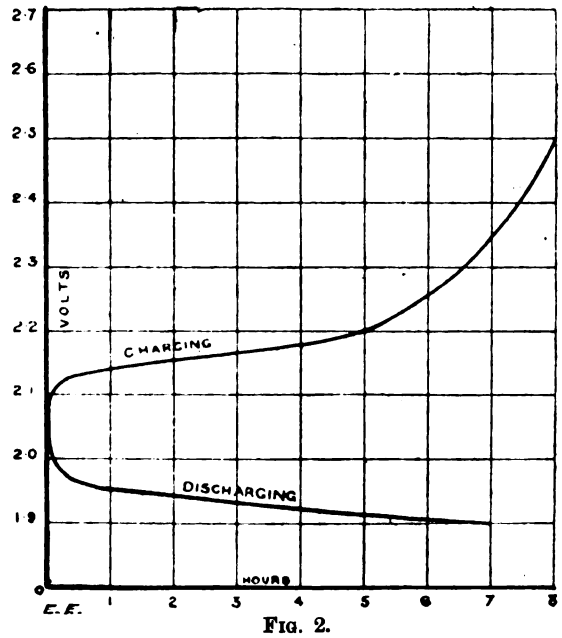

FIG. 2.

them at different rates. The larger machines need only give a voltage equal to that required on the feeders at the highest load. The two smaller ones must be able to give together a voltage at least 25 per cent. higher than this in order to properly charge the cells. As is well known, the voltage of a cell remains sensibly constant during discharge, but during charge the back E.M.F. gradually rises, owing to the chemical action and the formation of gases. This is shown in Fig. 2. One result of this rise of pressure at the terminals of the cells is that the battery must either be entirely cut off from the lighting circuit, during charging, or else regulating switches must be used, so that the number of cells connected to the mains may be varied, and the pressure on the lighting circuit

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kept constant. And as the number of cells connected to the lighting circuit must be altered, so also must regulating switches be provided to vary the number of cells connected to the charging dynamos, in order that the end cells may be equally charged with the rest. These regulating switches are indicated in Fig. 1. It is extremely important to watch that the charging switches are never connected to a less number of cells than the discharging switches, or else the intermediate cells will be liable to be charged in the reverse direction. It will be found practically impossible to prevent unequal charging and discharging of the end cells, particularly if there be any load on the mains while the charging is going on. Nothing is more liable to upset a battery as a whole than to have any cells unequally charged with the rest. Even at a little sacrifice of efficiency the battery should, as far as possible, be charged and

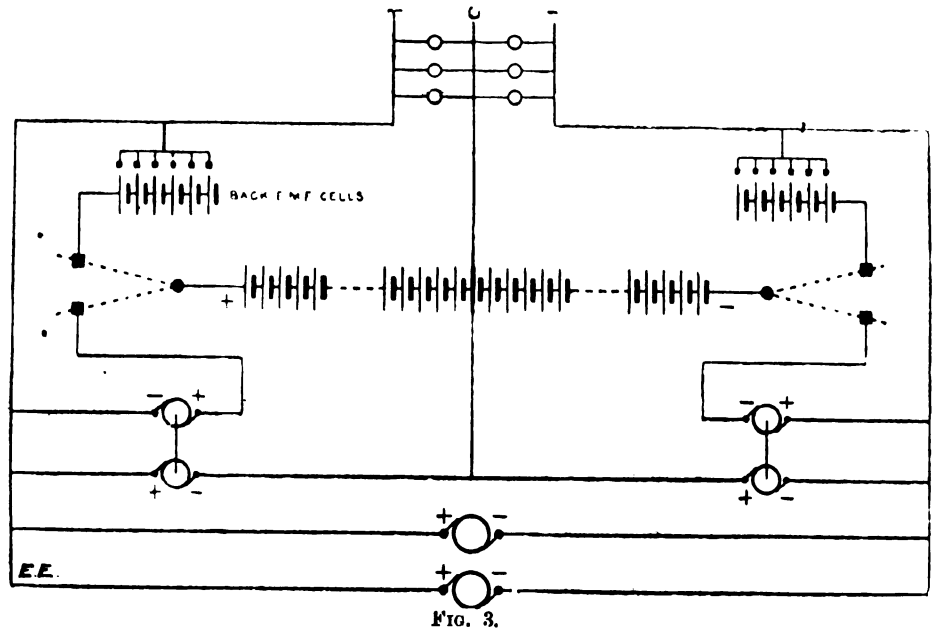

FIG. 3.

discharged as a whole in order that every cell may be equally treated. This is hardly possible by the arrangement shown in Fig. 1. Unequal use of the cells leads to unequal capacities, with the liability to reversals and all its consequent troubles. For these reasons the arrangement shown in Fig. 3 is much to be preferred. All the dynamos are connected directly across the outers, the two smaller ones having a middle wire connection as well. There are no regulating switches required at all, except when the battery is being discharged. The dynamos at all times give the voltage required on the 'bus bars, and there is no need whatever to vary their pressure on account of the charging of the cells. The extra voltage required for the charging is added to the voltage of the 'bus bars by means of a small "booster," in the cell-charging circuit, and the rate of charge can be varied to any extent simply by varying its excitation. The boosters can be carried on extensions of the shafts of the smaller units, as indicated in Fig. 3, or may be motor driven if desired. Each side of the battery may thus be charged and discharged as a whole, and when discharging its pressure is varied by means of back E.M.F. cells as indicated. A sign of the times is the tendency to favourably consider the use of accumulators in sub-stations. They should be charged directly from the mains during periods of light loads, the extra voltage being obtained by means of motor-driven boosters. Not only the station plant, but also some of the mains may by this means be kept economically loaded.

Alternating-Current Lighting Stations.—Contrary to the general practice of engineers who have to use alternating-current plant, the writer has for many years advocated the use of accumulators in such stations. Their uses are two-fold. They can be used as a stand-by for the exciting plant, and also, particularly in small stations, to keep up the supply during the hours of light load, through the medium of a motor alternator. The day-load plant could conveniently consist of an engine, alternator, and dynamo on the same shaft, with a clutch coupling between the engine and the machines, as in Fig. 4. The alternator and dynamo should each be of the same output, and the engine sufficient to drive either at full load, or both at half load. During the daytime the engine would drive both, the alternator for whatever lighting there may be on the mains, and the dynamo for charging the cells. As the lighting load increased, so the charging current would be decreased, keeping the load on the engine constant. When it was desired to use the discharge from the cells, the engine would be uncoupled, and the dynamo run as a motor, driving the alternator. This may be done either at the time of the "peak" of the load, thus reducing the demand upon the boilers, or at any time when there was only a small load on the station, such as after midnight, or on Sunday mornings, so that a number of the staff may be relieved. If the alternators be excited from 'bus bars, fed by a common exciter or exciters, the cells would be joined in parallel with them, and the charging dynamo would take the place of all or some of the exciters. If each alternator have a separate exciter, then change-over switches should be provided, so that the cells may be used on any machine when required instead of its own exciter.

Traction Stations.—Accumulators have earned for themselves a bad name in connection with traction systems because they have in most cases been carried upon the cars, each set having only its own car to propel. The result of this has been not only large cost in handling, owing to the removal of the discharged cells *en bloc* and the substitution of a freshly-charged set every few hours, but also rapid deterioration consequent upon the shaking, and the heavy electrical strains due to frequently starting the cars. With only one car to run, each set of cells has to be large enough for the maximum current taken at any time by that car, the average working current being probably not more than one-third the maximum. But when a number of cars are run from one battery, fixed either in the generating station or in a sub-station, a far less jerky load curve is obtained. Owing to the improbability of all the cars starting together, the maximum output is much lower in proportion to the average output, and the strains on the cells are much reduced. Large transformers in sub-stations are much more efficient, and with a given capacity in kilowatts will allow of a much larger lamp connection, than a number of small house transformers. In a similar way large batteries in stations or sub-stations are much more efficient, and with a given output will

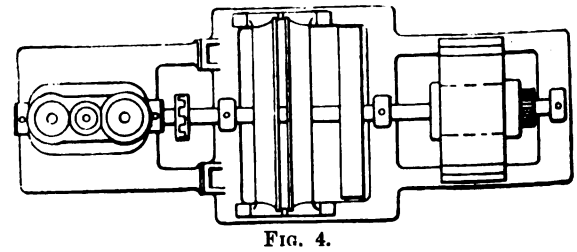

FIG. 4.

maintain a much larger car service than if divided amongst a number of cars. Owing to the rapidly fluctuating load, the plant in a traction station is generally working only at a low average load factor. The machinery running must be capable of meeting the maximum demand, while the average load does not probably exceed one-half of the maximum. The advantages of accumulators are most apparent here, and the wonder is that more traction stations do not use them. In the first place the accumulators would take the peaks of the load, thus relieving the machinery of the sudden jerks due to starting the cars, and in the second place the amount of running plant could be reduced to that sufficient for the average load. Fig. 5 will serve to illustrate this. The curves were taken from an actual tramway system, having eight cars running, and are self-explanatory. It will be seen that the pressure varies from about 495 to 510 volts, the current taken by the cars from 300 to 375 amperes, and the dynamo output (shown by the thick line, A—B) from about 115 to 150 amperes. All the output

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above that of the dynamo is supplied by the discharge of the accumulators, and the hollows below the output are filled up by a charge. Without the accumulators sufficient machinery would have had to be kept running to supply the maximum load of 375 amperes, although the average load was not greater than about 150 amperes. As it is, one dynamo will easily do the work instead of two, and can be kept at a very regular load throughout the whole time. So regular, in fact, that lighting could easily be done from the same machine. The cells in this case

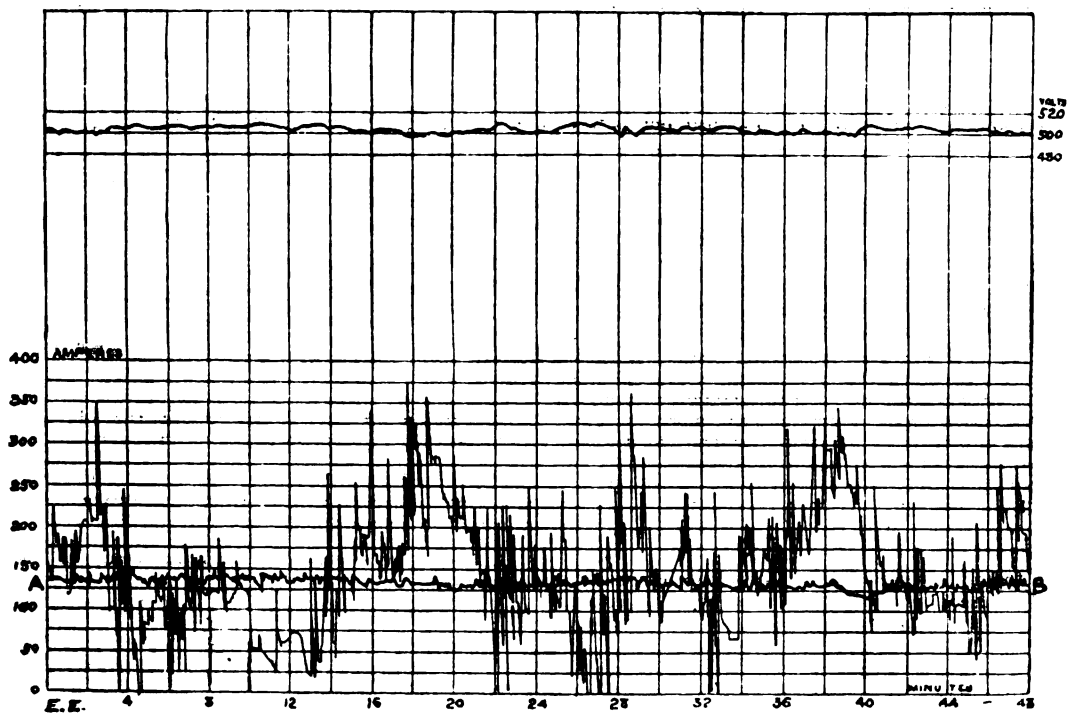

FIG. 5.

were connected as a whole directly to the 'bus bars, in parallel with the dynamo, no regulating switches being used. In order that the accumulators shall take their share of the load in this manner, it is necessary that they should be of ample size for the work, with a low internal resistance, and that the dynamo should be shunt wound with a falling characteristic. When it is required to fully charge the cells, a booster is generally used. In order to assist the battery to discharge when the total load exceeds the output of the dynamos, the series winding will change the polarity of the booster, so that it will add a pressure to the battery circuit, and thus help it to discharge. By means of the switch, S, the battery can be connected directly to the line when required. Prof. Mengarini, of Rome, uses automatic switches to vary the number of cells in the accumulator circuit, so that with a fixed machine voltage the battery may be charged and discharged at such rates as to maintain a constant output for the machines. At Leeds, also, automatic switches are used for the same purpose, worked by means of a relay and small motor. The great complication, however, introduced by the use of automatic switches, and the evils attendant upon the irregular charging of the end cells, are strong arguments against their use. Fig. 5 also shows that if the battery be large enough for its work, and the dynamos shunt wound with a sufficiently drooping characteristic, it will not be necessary to use either a compound-wound booster or regulating switches, in order to keep a steady load on the dynamos. It would be very interesting

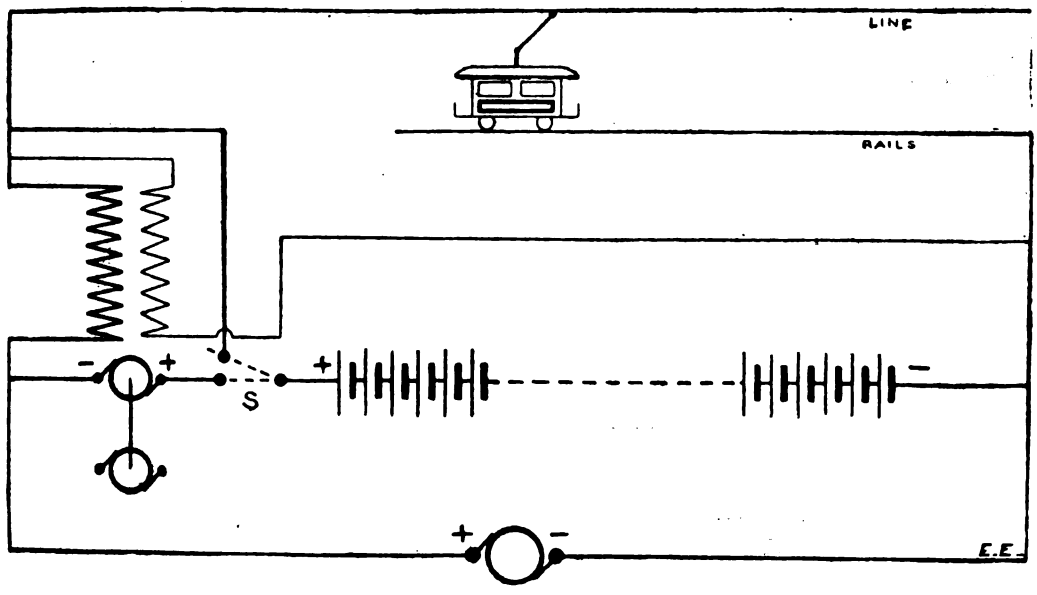

FIG. 6.

at a charge when the load is less a compound-wound booster is sometimes used in the manner indicated in Fig. 6. The booster, which in the figure is shown motor driven, has two field windings in opposition to one another. When the line current is equal to the output of the dynamos the two windings must neutralise each other, and the booster will give no pressure. Then the battery will neither charge nor discharge. When the line current is less than the output of the dynamos, the shunt winding will predominate, and the booster pressure will be in the right direction for charging the cells. When the line current is greater than the output of the dynamos, to know whether the automatic switches give any trouble at Leeds, and whether they are still used. Besides being used in the generating station, accumulators can be of great service in sub-stations, at the far end of long traction systems, for the purpose of keeping up the line pressure. They can be either charged by means of a special feeder from the generating station, or directly from the line during periods of light load, with the help of a booster. A system of some interest is the combination of cells carried upon the cars, with the use of the overhead conductor, as at Hanover. In those parts of the town where the trolley wire is not permitted, the cars are run directly from the

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cells carried by them, while outside the town the ordinary trolley system is in use. The cells can be charged in position from the trolley wire, or at the station in the ordinary way. Accumulators used in the generating station or in sub-stations should be mainly charged during the time the cars are not running, say from midnight to 6 a.m. During the remainder of the day they would be in parallel with the generating plant, to be used as required.

Combined Lighting and Traction Stations.—The addition of a lighting load to the ordinary traction station may not be of much benefit to the latter, but the combination of a tramway and lighting load will be of great service to the lighting station. Attention was drawn to the many advantages to be gained by the lighting station from this combination in a paper presented to this association at its 1896 convention, of which the writer was joint author, and a number of the practical points were considered in a contribution by the writer to *Lightning* in November of the same year. It will not be necessary therefore to deal more than briefly with the subject at the present time. In arranging a combined lighting and traction station, the one aim of the engineer should be to use as much of the plant as possible for the combined purpose. The boilers and steam piping would be common in any case, and the engines (at any rate during the daytime) could be used to drive the lighting and traction machines at the same time. The exact method of arranging the plant would depend upon the local conditions, but by adopting sets similar to Fig. 4, one machine for traction and the other for lighting, the combined load could be taken by the same engines. A battery of accumulators properly arranged would prevent the fluctuations of the tramway load from affecting the lighting. During the evening both machines could be used for lighting if desired, leaving the accumulators to deal with the traction. After midnight the battery would be charged. With a proper relation between the tramway load and the lighting load, it should be possible to have a nearly constant output for the boilers and engines throughout the 24 hours. The accumulators would look after the fluctuations in the daytime, and take the overlapping of the loads during the evening.

Before closing, the writer would like to draw attention to, and protest against, what seems to be a common practice amongst accumulator manufacturers. When maintenance rates are asked for and received, it will generally be found that, unless the capacity has been specified by the customer, the contractor will have offered to maintain the battery to not greater than from 60 to 70 per cent. of its original capacity. When a battery is put in to do certain work, it ought to be understood that its full capacity would always be required. But from the fact that most contractors will not offer to maintain 100 per cent. capacity without excessive terms, it would appear that batteries, as a rule, are rated too high in their lists.

Discussion.

Mr. W. A. Chamen said Mr. Rider was the pioneer in using accumulators in conjunction with the alternating supply system. He agreed with the statement that they were useful for steadying the load. With regard to the method of coupling mentioned, he had when at Messrs. Crompton's always found the claw coupling unsafe. In the case mentioned a coil clutch should be used. The only thing he regretted was that the system had not yet been put in operation. He hoped Mr. Rider would tell them when he had "fired the balloon."

Mr. Faraday Proctor said, with regard to stand-by plant, that he had had accumulators in use for five years, and was satisfied with them. It was a question how far they should be used for taking the tops off current curves.

Mr. J. N. Shoolbred said he advocated the use of accumulators, not only to take the tops off current curves, but to work the station in its early days entirely by accumulators. In a station which had just got over its first difficulties they had by means of cells reduced the coal bill to ¾d. per unit. Several other stations were also doing well in this way.

Mr. J. F. Snell (Sunderland) said that electrical engineers all owed a debt of gratitude to Mr. Rider for the work he had done in past years. The 5 per cent. on gas was too small; it ought to be 10 per cent. There was a great reduction of cost by using accumulators with the ordinary plant. He agreed with Mr. Rider that a booster was the right thing to use for charging the cells of the battery.

Mr. R. Hammond said he had lately had to get out some specifications for a station. The accumulator makers guaranteed that at the end of seven years the plant should do as much work as it did then. All were agreed that if accumulators made so much reduction in cost, they would play a great part in electric working in future. What a difference there would be if there were accumulators in all stations? He put them in all stations with which he had to do, but kept them separate from the rest of the plant.

Mr. J. E. Stewart said that people were chary of paying a heavy price for accumulators, which might or might not work well.

Mr. E. Kilburn Scott said that a lamp which had been run from a trolley wire jumped very much until accumulators were put on, after which it gave satisfaction.

Mr. R. C. Quin (Blackpool) wished to know what was the good of putting in batteries if the machinery gave satisfaction without.

Mr. Ruthven Murray (Worcester) said it was only in the smaller stations where there was not a very heavy load in which accumulators should be used. On the Liverpool Overhead Railway he had recently noticed how high was the starting supply. He agreed with the principle of the works being done by Mr. Rider at Plymouth, and would be interested to hear the results. He should not be surprised if there was put down soon at Worcester some traction plant of from 200 to 400 volts.

Mr. A. H. Gibbings said the use for accumulators disappeared after the supply had been taken up to any great extent. They were very good for a station just starting.

Mr. Rider, in replying, said that Mr. Chamen referred to the method of coupling. The coupling used at Plymouth would be a double drive coil clutch. He hoped soon to show them some satisfactory results from Plymouth. He was sorry he had not mentioned that it was at Bristol where accumulators were first used with other plant. He did not think an efficiency of 70 per cent. would ever be reached by accumulators. As to the maintenance clauses, he thought the makers should guarantee for 10 years. The terms of the guarantee should be that at any time in the first 12 hours after charging it should give 100 per cent. efficiency. Mr. Quin asked if they were worth putting in when the machinery could be relied on. It was possible to obtain a better all-round efficiency in this way.

This finished the third day's proceedings.

COMMUNICATION IN TRAINS.

The following is a description of the electrical passenger and guard communication on the Great Eastern Railway, for which the Board of Trade Committee appointed to consider the whole question have in their report expressed a preference, and for which we are indebted to the *Times*.

Each engine is provided with an electrical bell and indicator (compactly fitted in a brass case) and a press button, and when operated by a passenger the bell rings and the indicator points to "Stop." The engine also carries its own electrical battery—preferably a dry battery, as it is called. Each guard's van is also fitted with a bell and press button. The press buttons on the engine and also in the guards' vans are for the purpose of enabling the drivers and guards (front and rear, or both) to communicate with each other by a code of signals as may be arranged, and for testing purposes. Each compartment of a carriage is provided with a lever switch in a central position, and the lever stands normally in a vertical position, and this lever, whether turned to the right or left, it does not matter which, becomes, when it reaches the "stop," locked in that position. It is the small bolt which automatically locks it that by the act of locking joins up the electrical circuit. It cannot therefore be tampered with by ringing the bells without being locked. Once actuated and locked, the electric current continues to actuate the bells in both guards' vans and on the engine, until the train is pulled up; and, by a special key, possessed by the guards only, the switch lever is unlocked and put back into the vertical position. Over each switch in the centre of each compartment is a notice in large, bold print: "To communicate with the guard in case of urgent need move handle against either stop. Penalty for improper use, £5." At the end and outside each carriage is fixed an electrical carriage indicator, which, in its normal position when no current is passing through the coils, is holding, by means of its armature, a rod connected to two small arms or discs, one on each side of the carriage. The rod and arms, or discs, which are red, are cased in to protect them from the weather and exterior damage. This indicator coil is in electrical circuit with the lever switches in each compartment, so that when any of the lever switches of any particular carriage is operated the electric current which is transmitted by such operation must pass through the coils of its own carriage indicator. When this takes place the rod above mentioned is released and a small red arm or disc is projected on each side of the carriage, thus indicating to the guard, at whichever side he looks out, the carriage from which the call is being made. The position of the handle of the lever switch indicates from which compartment the call emanated. These arms or discs cannot be put back into their normal position until the switch that has actuated them is put back by the guard. But the principal point in the whole method of this passenger and guard communication, and that which especially commended itself to the Board of Trade Committee, was the means by which the electrical communication was carried from carriage to carriage, and to the engine also.

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The electrical connections are obtained by means of attachments, or additions to, and within, the Westinghouse automatic brake couplings. The actual contacts are placed within the metal case of the brake couplings, and are thus protected from damage and the weather. The object in view was to make the communication as effective, trustworthy, and simple as possible; not to interfere in the slightest degree with the efficiency of the brake, and to allow of the rapid exchange of a brake coupling in case of emergency without calling in an electrical assistant.

It is difficult to describe clearly how this is effected without reference to detailed drawings, but the following is probably as clear a description as can be given without drawings: A metal ring is fixed within the rubber ring or washer of the brake coupling, and this metal ring is kept in a state of tension, and flush with the face of the rubber ring by means of a flat spiral spring at the back of it, and within a metal inside-faced circular rim or box of insulating material attached by three screws to the three lugs of the metal washer which is always used to hold the rubber ring of the Westinghouse coupling in position. The rubber also serves to electrically insulate the metal contact ring from the metal outer case of the coupling. The only alteration in the appearance of the Westinghouse coupling when the two ends of a coupling are separated, is a bright milled-edge ring round the inside of the rubber ring, and which, when the two halves are put together, rub their milled edges against each other, and are thus kept so as to present a clean sharp contact to each other. They are both pressed inwards by the act of putting the couplings together, and the rubber rings close perfectly airtight around them. Now from these central insulated metal rings a flexible wire passes up the flexible brake tubes or pipes to the top, where the rubber pipes are joined on to the iron screw nozzles, which in turn are screwed on to the ordinary iron pipes leading to the air valves and cylinders. The wire connected to these central rings passes out through the iron nozzles by means of a perfectly electrically insulated and airtight connection threaded to receive a connecting nut to screw thereto an outside flexible wire, attached at its other end to, and within, a small connecting box, secured on the end of the coach. This wire is then carried under or otherwise along the carriage to a similar box at the opposite end, and from it is led a branch wire to the carriage indicator coil, as previously described, and from that point to the switches in each compartment. The second wire to each switch (which by the operation of the lever is joined to the first wire above mentioned) is connected to the return wire. This so-called return wire is formed of the iron pipes and other metal work of the Westinghouse brake apparatus. When, therefore, a wire connection is firmly soldered to the nozzle, at the top end of the flexible tube of the brake coupling, hanging between each carriage, and carried down the tube to, and firmly soldered to, the metal case of the brake coupling itself, the electrical circuit is completed by merely coupling up the Westinghouse brake coupling in the ordinary manner. The two metal cases are always when coupled up making good metallic contact with each other, but as a further precaution, more certainly to secure good electrical continuity, a strong white-metal spring is inserted in the slot of each half coupling, quite out of the way of being damaged, and, when joining the couplings up, each one rubs and depresses the other spring, thus making a very efficient electrical connection. Therefore, the main or principal wire is insulated throughout and contact made by the central ring just within the rubber ring which contains the Westinghouse coupling making an airtight connection, and the return wire (so called) is by means of the metal work of the brake apparatus and the outer metal casing of the couplings themselves. In joining up the Westinghouse brake couplings in the ordinary manner, therefore, the electrical passenger and guard communication is also joined up. By means of the press buttons before mentioned, the guards and drivers can instantly test if the apparatus is in order.

The arrangement has also been fitted in an equally satisfactory manner to the vacuum brake couplings—the same principle of insulated ring connection being effected in the same way as in the Westinghouse brake arrangement above described. It is, therefore, perfectly applicable to all interchange traffic stock throughout the kingdom. It only remains to say that it has not been patented by its designer, Mr. F. Hollins, the telegraph engineer and superintendent of the Great Eastern Railway, but is perfectly free of all royalties, so far as he is concerned, to the whole world.

PHYSICAL SOCIETY.

At the ordinary meeting of this society on June 24, 1898, Mr. Walter Baily in the chair,

Prof. Carus-Wilson exhibited an apparatus to illustrate the action of two electric motors coupled in such a way as to admit of their rotating at different speeds. The two shafts are placed in line, and each is fitted with a bevel wheel gearing into an intermediate wheel. The axis of the intermediate wheel is at right angles to the line of the motor shafts, and is free to rotate in a plane at right angles to that line. The motors can be made to rotate at different speeds by altering the strength of the magnets of either or both. The motion of the intermediate wheel depends upon the difference of the two speeds, or upon their mean, according to their relative directions of rotation. A simple graphic construction enables the action to be predetermined for any given load on the intermediate wheel. Calling the two motors A and B, and the intermediate wheel C, lines can be drawn on a base of current to represent the speeds and the torques for each motor. If the motions of A and B are in the same direction, the load or torque is the same on each, and of similar sign. Hence, as the load on the wheel C is increased, the speeds of A and B tend to become equal (if A had been running faster than B); and for a certain load on C the speeds of A and B will be equal. If the load on C is further increased, B will run faster than A. Also, there will be a certain value for the load on C at which the motion of A will reverse. A further increase of the load on C will bring C to rest, A and B then rotating at equal speeds in opposite directions. When the load on C is nothing, let the motors rotate in opposite directions, A running faster than B. The motion of C now depends upon the difference of speeds of A and B. When a load is put on C, the motion of A is retarded, while that of B is assisted; hence B takes less current, and A takes more. The torques on the two motors, due to the load on C, are now of equal amount, but of opposite sign. As the load on C is increased, the speed of A is reduced, and that of B increased, until the two are equal and C comes to rest. B is now acting as a generator and sending current into A. If the load on C is simply that due to friction, the process cannot be carried further. But if the load on C is reversed, the speed of B becomes greater than that of A, and the motion of C is reversed. In the steering gear designed by the Union Electricitäts-Gesellschaft, the intermediate wheel is made to actuate a rudder by differential action. The motion is reversed by making the speed of one motor greater or less than that of the other.

Mr. Quick then exhibited Weedon's apparatus for the measurement of the expansion of solids. This method is claimed to be independent of knowledge of optics on the part of the student. The expansion is read directly by means of a pair of micrometers. Precautions are taken to prevent errors due to radiation.

Mr. Lehfeldt asked what precautions were taken to prevent the movement of the micrometer supports.

Mr. Stansfield described a form of apparatus in use at Chelsea Polytechnic; it was a simple contrivance, in which changes of length were measured by a micrometer.

Mr. Quick, replying, thought the instrument referred to by Mr. Stansfield presupposed a knowledge of optics.

Mr. Lehfeldt then read a paper by Dr. Donnan on the "**Theory of the Hall Effect in a Binary Electrolyte.**" In 1883 Roiti investigated the subject of a possible Hall effect in electrolytic solutions. He failed to obtain any positive result. Recently the question has been examined by Bagard, who noticed certain effects in aqueous solutions of zincic and cupric sulphates. Meanwhile negative results have been observed by Florio. The author therefore discusses what effect might be expected by theory on somewhat the same lines as those of Van Everdingen, jun., taking a more general case. So far as the present discussion goes, the author's theory is wholly in favour of the negative results of Roiti and Florio. It would appear that Bagard measured a phenomenon not contemplated by the theory as stated in the present treatment. Van Everdingen originally supported the positive results of Bagard, but his work, unfortunately, was rendered incorrect by the accidental omission of a numerical factor. He has since discovered the slip in his calculations, and now agrees with the author's conclusions.

The **Chairman** proposed votes of thanks to the authors, and the meeting adjourned until October, this being the last of the session.

Rontgen Rays.—It is stated that Röntgen rays have unpleasant effects on the human skin, producing more or less dangerous eruptions, and that the preventatives hitherto devised are inadequate. German dermatologists now recommend the spreading of a glutinous mixture of zinc, cinnabar, and salt of bismuth on the parts exposed.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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MUNICIPAL ENGINEERS AT EDINBURGH.

At the recent annual meeting of the Association of Municipal and County Engineers at Edinburgh, a considerable amount of attention was given to electrical matters, and it may not be labour in vain to briefly refer to some of the matters under consideration. We have in mind three questions—one put forward by the president, Mr. O. Claude Robson, of Willesden; one by Mr. Jones, of Ealing; and one arising out of Mr. F. A. Newington's paper. It may seem curious at this late hour of the day to find differences of opinion existing upon any of these points, yet there is nothing more certain than that each party is fortified with good reasons for the opinions advocated. This points to a fact which all should recognise, but which most people are loth to admit when the matter concerns themselves—that circumstances alter cases, and that no hard-and-fast law holds good for all cases. The first question is that of free wiring, which Mr. Robson thinks desirable, and which he thinks should be undertaken by the authority. We entirely agree with these views, but—and there is a great deal in a "but"—it is necessary to recollect that what is best theoretically may present practical difficulties. One practical difficulty that is always present is as to how the Local Government Board will view the matter. It is notorious that much grumbling and heart-burning exists about the length of time allowed for the repayment of loans by the authorities, and as a loan would be necessary in the case of an authority undertaking free wiring, the views of the Local Government Board as to the length of time such a loan would be permitted to run must be ascertained before the authority could arrange terms with its customers. Here we have three in place of the usual two to make a bargain. So long as authorities approach the Local Government Board in isolated fashion, so long will they be almost powerless; but if the municipal authorities would agree to act in combination upon questions of common interest, they would probably be able to arrange suitable terms. Here, again, comes another "but"; the authorities are not themselves agreed, and the data to go upon is of the scantiest. A combined conference of municipal electrical and municipal engineers would probably thrash out the whole question in one sitting.

The second question arises upon the discussion of the calorific value, or, rather, the utilisable heat from the destruction of refuse. Mr. Jones characterised the statements flaunted broadcast throughout the land as to the amount of this utilisable heat as mere "bunkum." Councillors are led to believe in the impossible, and schemes are suggested and carried out with a lavish waste of money that ought never to have been countenanced. Mr. Jones contended that a refuse destructor should be expected to destroy refuse in a sanitary way, and if there was any waste product that could be utilised, to utilise it, but the primary object of a destructor should never be overshadowed by any secondary object. A good many councils have been considering the erection of destructors as a means of steam supply, and not of

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refuse destruction, and this, as we have said, was characterised as "bunkum."

A third question is that of a reserve. A number of central stations not only pay expenses and repay loans, but provide in addition a reserve to be used as occasion requires. Legally this reserve may reach to 10 per cent. of the capital. Without pressing the point too far, it seems to us that the earlier customers of central stations are unnecessarily handicapped, and made to pay more than in justice they ought to pay. These customers come forward, and by their example induce others to follow. In the course of a few years the station load increases, as does the revenue, but during these years the customers have been paying at a higher rate than those who come after; and it would be easy to suppose an example wherein they contribute the maximum reserve. A reserve obtained when a station is in full swing falls less heavily upon each individual customer than in its early stages.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

ELECTRIC LIGHTING.

SIR,—In a recent issue of the *Standard*, Mr. John B. Braithwaite, jun., writing on behalf of investors in electric lighting companies, laid before you some very cogent reasons for objecting to the grant of parliamentary powers for electric lighting to local authorities in districts where companies were already operating under parliamentary powers, and satisfactorily fulfilling the obligations imposed upon them by their provisional orders, unless the competing local authorities were willing to acquire on fair terms the undertaking and works of the company.

It has been my province, on many recent occasions, to act for local authorities applying for powers, and I am able to fully confirm what Mr. Braithwaite has said in reference to the rule which has hitherto prevailed at the Board of Trade, of not permitting a local authority to obtain concurrent powers, unless saddled with the obligation of purchasing the existing undertaking, and though it has been my duty, on behalf of the local authority, to endeavour to make the best terms possible with the company, I am prepared to admit fully the justice of the plea formulated by Mr. Braithwaite.

My object in addressing you to-day, however, is to go a step further, and to point out that the fixity of tenure, subject to good behaviour, which, in the opinion of capitalists, should prevail in the case of electric lighting companies, should also obtain in those cases where local authorities have laid down electric lighting works—that is to say, while admitting the justice of the plea that companies, holding statutory rights and satisfactorily carrying their obligations out, should not be competed with by local authorities, so local authorities holding statutory rights and satisfactorily fulfilling their obligations should not be competed with by companies. Yet, to my great surprise, I find many who give their complete adhesion to the former proposition are inclined to deny the soundness of the latter. Surely, if capital provided by the ordinary investor is to be protected from undue competition, this protection should also be extended to the capital provided by the community in its collective capacity.

Such, at all events, in electric lighting matters, has hitherto been the policy of the Board of Trade and of Parliament. This policy has, however, during the present week received a rude reversal by the report of the Select Committee of the House of Lords, which has granted to a company power to lay down electricity generating works at a central spot in Nottinghamshire, and to compete with those local authorities which are situated in the 2,000 square miles of territory over which the company obtains the rights of breaking up streets and roads and supplying electrical energy. In that area are located the important cities of Sheffield and Nottingham, and the large towns of Rotherham, Chesterfield, Doncaster, Lincoln, etc. All these places hold provisional orders granted by the Board of Trade, and all of them have put, or are putting, them into effect.

To take the case of the city of Sheffield, it has recently, at an outlay of a quarter of a million sterling, acquired the works of the Sheffield Electric Light Company, believing that the rule which has prevailed hitherto of leaving an undertaking free from competition while it satisfactorily carried out its work would not be annulled. Now the ratepayers of Sheffield, after having made this investment, find themselves, by the decision of the Select Committee, face to face with a competitor.

I plead for the same protection to the property of local authorities as that which your recent correspondent urged should be given to investing companies.

I am, Sir, your obedient servant,

ROBERT HAMMOND,
Member of the Institution of Electrical Engineers.
64, Victoria-street, Westminster, July 1.

LONDON'S ELECTRIC LIGHT.

Last December the Charing Cross Company approached the Commission of Sewers to secure consent to the company's obtaining a provisional order. The correspondence, etc., that this application has raised is interesting and instructive, hence we venture to give it as follows:

15, Maiden-lane, Covent-garden, W.C., July 1, 1898.

Sir,—Referring to our letter of Dec. 28 last, copy of which we send you herewith for reference, and supplementing the application of our solicitors for your consent to a provisional order being granted to this corporation by the Board of Trade for the supply of electric energy within the City of London, we desire to state that our proposal would be to supply electric energy at the following rates: (1) for lighting purposes, at 5d. per Board of Trade unit, reducible on a sliding scale, according to consumption per lamp, to 4d., and during certain hours a further reduction for motive power on a sliding scale from 3d. per Board of Trade unit to 2d., according to the times and duration of user of energy; (2) to distribute a low-pressure continuous current.

The average rates charged by the several corporations and companies referred to in this letter are given on the authority of *Lightning*, a well-known electrical paper, copy of which we send you herewith, *vide* pp. 582 and 584.

A chart of comparative pressures, showing the steadiness and quality of supply furnished by the companies supplying in the Metropolis, was published in the *Electrician* of 1895, p. 127, copy of which I also enclose.

The average rate of the City Company, which produced, in 1897, the gross income of £175,792, is 7·07d., while, had the rate charged by this corporation in the Strand and St. Martin's district obtained—viz., 4·46d.—the gross income would have been £110,896—*i.e.*, a sum of £64,896, or 58·52 per cent. less than at present paid by the consumer in the City.

The price, we understand, suggested to be charged in the event of the City purchasing the undertaking—viz., 6d. per Board of Trade unit—would, on the like basis, produce a gross revenue of £149,187, and there would still be, in favour of this corporation's proposal, a difference of no less than £38,291, or 34·53 per cent. in the price charged to the consumer.

In submitting these figures, it must also be borne in mind that our present average price of 4·46d. is obtained on the basis of a maximum rate of 6d., and a minimum of 4d., per Board of Trade unit for lighting purposes, and 4d. for motive power, and not on the lesser rates proposed in this letter.

We would also draw your attention to the fact that for

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the year 1897 the rates of the several corporations mentioned in Mr. Brooke-Hitching's circular letter, with the sole exception of Brighton, are also considerably in excess of ours, the average rate of Southampton being 6·20d.—*i.e.*, + 39 per cent.; in Liverpool, 6·03d.—*i.e.*, + 35 2 per cent.; in Birmingham, 5·28d.—*i.e.*, + 18·39 per cent.; and Manchester, 4·63d.—*i.e.*, + 3·81 per cent.; and in Brighton, 3·77d.—*i.e.*, − 18·3 per cent.

In the case of Brighton it must, of course, be borne in mind that the order was granted direct to the local authority, and that consequently there was no expense in acquiring goodwill or other expenses attendant upon the promotion of the order, and, further, that the cost of laying mains and reinstatement of roads is considerably less than it would be in London or Liverpool.

On referring to the average rates of the vestries supplying under their own provisional orders in London, you will note Islington with 6·01d., or + 34·75 per cent.; Hampstead, 5·60d. + 25·56 per cent.; St. Pancras, 5·23d. + 17·26 per cent.; all of which rates are considerably in excess of those proposed to be charged by this corporation.

So far as we are aware, the City of London Company does not by its present system afford facilities for the extensive adoption of electric energy for motive power purposes, and we think it is generally admitted that the alternating system is not suitable for such a supply, and where motive power supply is given, it is now the invariable practice to instal special plant, and to lay down direct-current mains. Your Corporation would therefore in the near future, in addition to the proposed capital expenditure of over £2,700,000 in acquiring the City of London Company's undertaking (whose plant and mains cannot obviously be considered in any sense of the word new), have to lay out a further considerable sum in order to provide a satisfactory service for the supply of motive power.

We further venture to urge that it would be a great advantage to the consumer to have not only a choice of two systems of supply, but to be able to rely upon the service of one company in the event of accident to the plant or machinery of the other.

We are at present supplying in the Strand and St. Martin's districts nearly 120,000 8-c.p. lamps and energy to a large number of consumers for driving printing presses, linotype machines, lathes, lifts, fans, and for other motive power purposes, the power supplied being in the aggregate about 350 h.p.

In the event of our obtaining a provisional order, we should, when required to do so, be prepared to undertake public lighting at the prices at present charged to your Corporation.

We beg to make the following observations on Mr. Brooke-Hitching's circular, addressed to the members of your Corporation:

We are aware of the position of your Corporation under their agreement with the City of London Company, and feel that there may be difficulty in their giving consent; but we submit that they are in no way bound to oppose an application, and may remind you that the Board of Trade has jurisdiction, if they think fit, to dispense with the consent of the local authority, and, in fact, did so in the case of our own provisional order for the Strand district. Further, if the City Corporation acquired the City of London Company's undertaking, Section 1 of the Electric Lighting Act of 1888 expressly provides for and encourages competition, even with the local authority. This principle has recently been given effect to by the House of Lords Committee in the case of the General Powers Distributing Company's Bill, under which that company will now be at liberty to enter into competition, *inter alia*, with the Corporations of Sheffield, Nottingham, Rotherham, Doncaster, and Lincoln.

It is suggested that, if we did obtain an order, the result would be either an amalgamation or, at any rate, some agreement with the City of London Company, which would restrict free competition. We may remark that we have competed vigorously and successfully with two powerful companies in the areas supplied by us for the past nine years, and never had, nor do we intend to have, any such agreement.

The point is specially dealt with in the model form of provisional order, Section 4, by which, *inter alia*, it is enacted that "the undertakers shall not purchase or acquire an undertaking of or associate themselves with any other company at present supplying energy under any license, provisional order, or special Act within the administrative county of London, unless the undertakers are authorised by Parliament to do so."

It appears to us that the remedy for any breach of this clause lies in the hands of the consumer or the Board of Trade.

Dealing with the question of the disturbance of the streets, we would remark that in our present districts, so far from there being a strong opposition on the part of the ratepayers or public to the laying of mains, which would be rendered necessary by the introduction of a competitive company, it is a fact that the petitions in favour of such competitive supply and its attendant consequences were signed by about 1,600 ratepayers, including nearly the whole of the principal inhabitants of the districts; the ratepayers, considering, no doubt, that such temporary disturbance of the streets as there might be (a disturbance which we have invariably spared no reasonable expense in minimising) was more than counterbalanced by the benefits to be derived from competition—viz., of a rate reduced by about 33 per cent., the better service engendered by competition, and the advantage and choice of two sources of supply.

We do not, of course, propose to deal categorically with Mr. Brooke-Hitching's circular. There are many conclusions drawn and statements made which we must not be taken to in any way agree to by reason of our refraining from comment.

In conclusion, we would beg that before your committee arrives at a decision as to the purchase or non-purchase of the City of London Company's undertaking, your committee would accord us the privilege of a hearing in support of our application.—We remain, Sir, your obedient servants (for the Charing Cross and Strand Electricity Supply Corporation, Limited),

EDWD. WILMOT SEALE, Secretary.

To the Clerk, the Streets Committee,
Public Health Department,
Corporation of the City of London, Guildhall, E.C.

The following circular, marked "Private and confidential; for the use of members of the Corporation only," has been sent out by Mr. T. H. Brooke-Hitching to his fellow-members of the Corporation of London, but as it has already appeared in other papers we do not hesitate to give it:

Gentlemen,—It may be remembered that in February of this year the Court of Common Council on my motion referred to the Streets Committee of the Corporation the following resolution: "To consider the desirability of applying to the Board of Trade for an electric lighting order to enable the Corporation to supply electric light within the City from a station to be established by themselves or otherwise, and also to report as to the practicability of generating electricity from steam raised by the burning of the City refuse in specially constructed furnaces in such proposed electric light station." The Court kindly added me to the Streets Committee for the purpose of assisting in the consideration of the above motion. The Streets Committee is a busy committee, dealing with a vast number of important details, and electric light matters are usually not dealt with early in its sittings. Indeed, difficulty has been experienced in keeping a quorum during the consideration of the latter part of the agenda. However, I have to thank the chairman and the committee for their kindness in giving me precedence, and on my motion the law officers of the Corporation were asked to report as to the power of the Corporation to establish a competitive electric supply in the City, having regard to the agreement between the late Commission of Sewers and the City of London Electric Lighting Company, Limited. The report of the five law officers was duly received, their unanimous opinion being that the Corporation has no power to enter into competition with the existing company.

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This opinion practically confirms the position claimed by the City of London Electric Lighting Company that they have been granted a monopoly for the City for the period of the electric lighting order, confirmed by Act of Parliament, of 42 years from 1889. The agreement with the City provides for the purchase by the City Corporation of the company's undertaking on the following conditions: (*a*) power to acquire so much of the undertaking of the contractors (the City of London Electric Lighting Company) for public lighting . . . . at the end of the said term of 21 years on giving such notice, and generally on such terms as are prescribed by Section 2 of the Electric Lighting Act, 1888; (*b*) power to acquire the like undertaking for private lighting at the like period either upon terms to be agreed on between the Commissioners and the contractors, or, failing agreement, then at a price to be fixed by arbitration . . . . and both such powers are to be without prejudice to the rights reserved to the Commissioners by the same section at the end of the period of 42 years and the subsequent period therein stated (Clause 35, p. 10, agreement). This agreement gives the public lighting of the streets into the hands of the company for a period of 21 years from the completion of the side street lighting. The city engineer is to certify such completion, but as no serious attempt has been made to complete the side street lighting, the company hold this contract indefinitely beyond the 21 years contemplated.

Shortly, then, the late Commissioners of Sewers appear to have given away to a private company for a long period an absolute monopoly to supply electric light within the City area, and in consequence of their short-sighted policy the City area, which is compact, and, if properly worked, should be the most profitable electric light area in the world, is badly served and the private consumers have to pay an extremely high price for the current. The price charged for electric current when I commenced the agitation two years ago was 8d. per Board of Trade unit. This has recently been reduced to 7d., with a rebate to very large consumers. The charge per annum for the public arc lamps is £26 each, the total payment out of rates for electric street-lighting being £11,887 per annum. These charges are nearly double those charged in Edinburgh, where the Corporation of the city own the electric light works. There the price of the current for private lighting is 3½d. per unit, and the charge per arc lamp for street-lighting £14 per annum. In Brighton the Corporation charges 7d. per unit for the first hour's consumption and 1½d. per unit for subsequent hours. In Manchester the charge for private lighting is 6d. the first hour and 1½d. afterwards. In the West-end of London the charge is 6d and 4d. In Liverpool, since the Liverpool Corporation bought up the company's undertaking there, the price is 5d. and 4d. Previously the price was 7½d. As I before stated, the uniform charge for current in the City to ordinary consumers is 7d.—a price which precludes thousands of persons in the city from enjoying the healthful and economic illuminant. The result is constant grumbling.

Now what can be done by us as the elected municipal representatives of the City to overcome the difficulties of the situation, and place within the reach of the ratepayers electric light and power at the same price as it costs citizens in the provinces? This question has presented itself to the ratepayers of Liverpool, Birmingham, Southampton, etc., and they have answered it by purchasing the interests of the companies within their areas, thus securing a monopoly of supply for the exclusive benefit of the ratepayers. Since, by the unanimous opinion of our law officers, we are precluded from competing with the City of London Electric Lighting Company, Limited, let us consider whether any other course is open to break the company's monopoly. On reference to the agreement between the late Commissioners of Sewers and the City of London Electric Lighting Company, Limited, I find the following words in Clause 26 (p. 7): "So far as the Commissioners are able to do so, the Commissioners grant to the contractors during a period of 21 years from the date hereof, the exclusive right of supplying electricity for private purposes, and wayleave for same." Does this clause prevent the Corporation, as the successors of the Commissioners of Sewers, from giving its consent as a local authority—under the Act—to the entrance of a competing company within the City area? I cannot but feel that it does. I am aware that the Charing Cross and Strand Company has given notice of its intention to apply to the Board of Trade for a competing order in the City, but I have never known the Department to grant a lighting order in opposition to the local authority, and here the Corporation is bound to oppose, by virtue of its agreement with the City of London Electric Lighting Company, Limited.

Again, the strongest opposition would be raised by the ratepayers against another tearing-up of the streets and sidewalks of the City for the purpose of laying a competing set of mains. And assuming that a competing company gained entrance to the City in spite of the City's opposition, what is there to prevent an amalgamation or a pooling of profits directly the second company is at work? In Regent-street, where the Westminster Electric Supply Company, the London Electric Supply Corporation, and the St. James's and Pall Mall Company have lighting orders, a working agreement has been entered into whereby true competition is restricted, and the result is that the first company pays 12 per cent. and the last company 14½ per cent. on its ordinary shares. After the most careful consideration I have come reluctantly to the conclusion that the best and most economical plan is for the Corporation to propose to the company to buy them out at once on the basis of the present approximate price of their shares. The total capital required does appear a large sum, but I will be able to prove that by purchasing on such terms the Corporation will make an immediate profit, and in my opinion sufficient profit will, within two years, be made out of the private lighting to pay for the lighting of all the streets in the City, thus saving some £11,887 per annum to the ratepayers, and at the same time the price can, with advantage, be reduced to 6d. per Board of Trade unit. It must not be forgotten that the Corporation can raise money at about 2¾ per cent. per annum, whereas companies are expected to yield from 4 to 6 per cent. per annum.

Mr. Brooke-Hitching goes on to explain the attitude of the Birmingham City Council and the Liverpool Corporation as regards purchasing the electric lighting companies in their respective districts, and resumes:

The City of London Electric Light Company, Limited, has an issued capital in ordinary shares of £600,000, also in preference shares £400,000, besides £400,000 debenture stock, there being paid up on Dec. 31, 1897, £1,318,574. The following table shows the phenomenal progress of this company in spite of its high charges:

—	Number of customers.	Number of 8-c.p. lamps connected.	Gross revenue.	Net revenue.	Dividends on ordinary shares.
1892	242	20,241	£12,450	£500	—
1893	1,080	65,341	39,662	16,940	—
1894	2,740	135,460	68,863	34,865	2½ %
1895	4,230	195,317	106,999	59,100	5 %
1896	5,303	247,785	146,946	87,701	7 %
1897	6,322	296,012	175,792	107,550	10 %

With the cost of production a diminishing sum, the profits may be expected to increase at a still greater ratio. There being no check on the distribution of profits, excepting a sliding reduction in the charge for current for ½d. per unit (from 8d.) for each 1 per cent. paid in dividend over 10 per cent., thus assuming the dividend to be 11 per cent., the price of current would be 7½d., 12 per cent. 7d., 14 per cent. 6d., and 16 per cent. 5d. per unit. In the course of time if 20 per cent. were paid the current would be charged at 3d., or ½d. less than the price in Edinburgh. And when we consider that the current can be generated at a cost of about ½d. per unit, it is not unreasonable for shareholders to look for a 20 per cent. dividend on these shares, and this unearned increment ought not to go to private speculators, but into the ratepayers' pockets, for electric light is becoming almost as great a necessity as gas and water. The price of the ordinary £10 shares of this company is about £25, and if the concern remains in the company's

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hands, I see no bar to their rising to £50 or £60 per share.

It may be said that the undertaking is too great for the Corporation to undertake, but I would remind my colleagues that the Corporation of London has frequently expressed itself in favour of the purchase of the water companies; and electric supply will soon have a larger revenue than water supply. (In my house and places of business I pay six times more for electric light than for water.) It is not long ago—in the sixties, I believe—that a committee of the Corporation of London negotiated for the purchase of the gas company—whose income from the City is some £400,000 per annum—on the basis of a payment sufficient to provide 7 per cent. in perpetuity on the nominal value of the gas stock. The company required 7½ per cent., and the committee—of whom, I believe, our respected colleague, Deputy Cox, is the only living member—allowed the negotiations to drop. If that purchase had been carried out, what a boon the undertaking would have proved in reduction of rates. The net gas rental in the Metropolis last year was £4,197,000. The water supply is another case in point. Nearly every city excepting the Metropolis owns its water supply.

Should the City own its electric supply? I venture strongly to urge that it should. For if the ownership pays a private company with heavy administration expenses, it is bound to yield a much larger profit to a municipality which can obtain money at 2¾ per cent. Assuming that the City of London Electric Lighting Company will accept a reasonable price for its undertaking from the Corporation, not only will the price of current be reduced, but a sufficient profit can be made to defray the cost of the entire public lighting of the City. A further profit would be made by utilising the City's refuse for the production of steam to generate electricity, which could go in relief of rates.

In connection with the above we have received the following letter from the secretary of the Charing Cross and Strand Electricity Supply Corporation, Limited:

PROVISIONAL ORDER FOR THE CITY.

Dear Sir,—We venture to trouble you with a further letter in connection with this matter, which we have addressed to the Clerk of the Streets Committee of the Corporation of the City of London.

We think you will probably regard the proposed scheme for the purchase of the City of London Company's undertaking for Three million (£3,000,000) as a matter of some public importance under the circumstances set forth in our letters of the 1st inst. and this date.—We remain, yours very faithfully (for the Charing Cross and Strand Electricity Supply Corporation, Limited),

EDWD. WILMOT SEALE, Secretary.

[COPY.]

15, Maiden-lane, Covent-garden, July 5, 1898.

Provisional Order—City.

Sir,—We should not have proposed to trouble you further as to the above at this juncture, but that our attention has been drawn to an interview of a correspondent of the *London* newspaper with Mr. Brooke-Hitching, a member of your Corporation, during which Mr. Brooke-Hitching is stated to have said that at the present rate of profit of the City of London Company, the City Corporation would, if purchasing the undertaking at the sum of £3,000,000, derive a profit of £3,500 per annum.

It is true that Mr. Brooke-Hitching bases his proposals upon the presumption that there is no alternative other than purchase, but in our letter of the 1st, we think we have shown that there is the alternative of competition. Assuming this to be so, we would propose to show the effect of Mr. Brooke-Hitching's proposals in a series of short accounts.

We would first of all point out, however, that Mr. Brooke-Hitching, in his calculations, has entirely omitted the important item of depreciation of plant and machinery, in respect of which the City of London Company, in their accounts for 1897, wrote off profits the sum of £17,000.

ACCOUNT No. 1.—At an Average Rate of 7·07d. per B.T.U.

Interest on £3,000,000 at 2¾ per cent.	£82,500	Gross revenue	£175,792
*Sinking fund	10,000	Annual loss	15,393
Cost of generation, distribution, and administration	81,685		
Depreciation on plant, machinery, etc.	17,000		
	£191,185		£191,185

ACCOUNT No. 2.—At the Suggested Rate of 6d. per B.T.U., *vide* Mr. Brooke-Hitching's Circular Letter.

Interest on £3,000,000 at 2¾ per cent.	£82,500	Gross revenue at 6d.	£149,187
*Sinking fund	10,000	Annual loss	41,998
Cost of generation, distribution, and administration	81,685		
Depreciation, etc.	17,000		
	£191,185		£191,185

ACCOUNT No. 3.—At 4·46d. per B.T.U. the Average Charge of this Corporation.

Interest on £3,000,000 at 2¾ per cent.	£82.500	Gross revenue at 4·46d. per B.T.U.	£110,896
*Sinking fund	10,000	Annual loss	80,289
Cost of generation, distribution, and administration	81,685		
Depreciation, etc.	17,000		
	£191,185		£191,185

* The sinking fund of £10,000 per annum would appear to be totally inadequate on a capital sum of £3,000,000, and any increase in the amount of the sinking fund would increase the losses.

ACCOUNT No. 4.—Showing at what price the Corporation would have to acquire the City of London Company's Undertaking to be in a position to supply Current on the same terms as this Corporation:

Cost of generation, distribution, and administration	£81,685	Gross income at 4·46d. per B.T.U.	£110,896
Depreciation, etc.	17,000		
Balance applicable for sinking fund and interest on capital	12,211		
	£110,896		£110,896

N B.—Out of a gross income of £110,896, there would remain only £12,211 which would provide interest at 2¾ per cent. on a capital of £444,056, without any provision for sinking fund being made.

ACCOUNT No. 5.—Showing Amount it is suggested should be paid by the Corporation.

Proposed purchase-money	£3,000,000	Value of the undertaking in view of the competitive rate as shown in Account No. 4	£444,036
		Excess	2,555,964
	£3,000,000		£3,000,000

Account No. 1 shows an annual loss of £15,493, which would necessitate the rate per B.T.U. being considerably increased to the consumer, or an addition to the municipal rates.

Accounts Nos. 2 and 3 show considerably heavier losses.

Account No. 4 shows that the profits would only admit of 2¾ per cent. being paid on a sum of £444,036 as purchase-money for the undertaking, and that without any provision for sinking fund.

The net result of Mr. Brooke-Hitching's proposal, therefore, practically amounts to this—that he is prepared to recommend your Corporation to pay the sum of £2,555,964 for the "municipalisation of electricity," and what, in view of Section 1 of the Electric Lighting Act of 1888, and the decision of the House of Lords Committee referred to in our letter of the 1st inst., we venture to think might be a doubtful municipal monopoly.

In referring the City Corporation to this section, and the decision of the House of Lords, we would beg to assure them that our sole motive in so doing is to answer Mr. Brooke-Hitching's objections and statements in connection with our proposed competitive supply, as an alternative to purchase, and we, therefore, beg that the Corporation will permit no other interpretation to be placed upon the same.—

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We remain, Sir, your very obedient servants (for the Charing Cross and Strand Electricity Supply Corporation, Limited), EDWD. WILMOT SEALE, Secretary.

To the Clerk, The Streets Committee,
The Corporation of the City of London, Guildhall, E.C.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

78. In a three-wire system having a pressure of 120 volts across the middle and outer wires, the positive, middle, and negative wires are each in turn connected to earth through an ammeter. If C_1, C_2, and C_3 represent in each case respectively the currents flowing to earth through the ammeter, deduce formulæ which will enable the insulation resistance, A, B, and C, in ohms, of the respective wires to be determined. Show fully how you arrive at the result, and, if possible, graphically illustrate each stage of your reasoning?—F. STOTT.

79. How would you find out the saving effected by the use of hot air and exhaust steam feed-water heaters, giving data of experience with either?—HILTON JOHNSON.

ANSWERS.

Question No. 73.—A large hall, 120ft. long by 60ft. broad and about 40ft. high, is to be lighted electrically. Compare the annual cost of lighting the same by incandescent and arc lamps from a direct-current supply at 6d. per Board of Trade unit?

Best Answer to No. 73 (*awarded* 10*s.*).—Taking the illuminating power required as one watt per square foot (for incandescent lighting), then $120 \times 60 =$ watts required, viz., 7,200, which at four watts per candle = 1,800 c.p., or, say, 36 32-c.p. lamps. Suppose the voltage to be 100, the amperes would be 72; assuming the light is required from sunset to 10 p.m.—*i.e.*, about 1,500 hours per annum—then

The annual cost of energy at 6d. per B.T.U. $= \frac{72 \times 100 \times 1,500}{1,000} \times 6d.$

= £270

Add for lamp renewals, after 750 hours' life..... 5

Total £275

Now taking the case of arc lighting, the lamps (ordinary type) being arranged two in series on 100-volt circuit, and assuming six six-ampere lamps of 400 n.c.p. each to be equivalent in illuminating power to the 36 32-c.p. incandescent lamps first considered, then

The annual cost of energy at 6d. per B.T.U. $= \frac{6 \times 3 \times 100 \times 1,500}{1,000} \times 6d.$

= £67 10 0

Add cost of carbons burning at the rate of 2in. per hour at £7 per 1,000ft. $= \frac{2 \times 6 \times 1,500}{12}$ ft. = 1,500ft

= £10 10 0

Total £78 0 0

Now coming to the case of the enclosed globe long-burning (160 hours) arc lamp. The number required will be six, as before. Let us suppose that a four-ampere lamp of this type, off a 100-volt circuit, will be equivalent in light-giving power to an ordinary six-ampere arc lamp, then

The annual cost of energy at 6d. per B.T.U. $= \frac{4 \times 6 \times 100 \times 1,500 \times 6d.}{1,000}$

= £90.

The cost of carbons at the rate of 2ft. per lamp every 150 hours, at £6 per 1,000ft. $= \frac{2 \times 6 \times 1,500}{150} = 120ft.$

= 15s. (say)

Total £90 15 0

The following gives the tabulated results:

Method.	Annual cost of energy.	Renewals of carbons.	Total annual cost.
Incandescent lamps ...	£270 0 0	£5 0 0	£275 0 0
Ordinary type arc lamp	67 10 0	10 10 0	78 0 0
Enclosed type arc lamp	90 0 0	0 15 0	90 15 0

J. F. M.

Answer to No. 73 (*awarded* 5*s.*).—As the hall is rather large, it will require a large amount of light to properly illuminate it, this depending on its area, colour of its walls and surroundings, and its height. A very good rule to work from when determining the number of candle-power required to properly light a given room is to allow 90 square feet for one 16-c.p. lamp. The area in this hall in square feet

$$= 120 \times 60 = 7,200,$$

and $\frac{7,200}{90} = 80$ lamps of 16 c.p. each.

$\therefore$ the total candle-power required $= 80 \times 16 = 1,280$.

Assume they are lamps of 3·5 watts per candle-power, therefore the total number of watts required

$$= 3{\cdot}5 \times 1,280 = 4,480 \text{ watts.}$$

As there is no specified number of hours stated in the question, I will assume the lamps are to burn four hours per day for the six months from October to March, and three hours per day for the six months from April to September. The total number of hours the lamps will burn will $= (182 \times 4) + (183 \times 3) = 1,277$ hours per annum. Now, since one Board of Trade unit (B.T.U.) is equal to 1,000 watt-hours, the (B.T.U.) consumed will

$$= \frac{1,277 \times 4,480}{1,000} = \frac{5,720,960}{1,000} = 5,120{\cdot}96,$$

and as the price per B.T.U. is 6d., therefore the cost per annum of lighting the hall by incandescent lamps is equal to £128. In order to light the hall with arc lamps it is preferable to install the enclosed one on account of its small consumption of electric energy, and as the candle-power required to properly illuminate the hall is 1,280, if three lamps were used each requiring five amperes on 100-volt circuits the watts per lamp would equal 500, therefore the three lamps require $500 \times 3 = 1,500$ watts, and as the number of hours they burn per annum is 1,277, the total number of B.T.U. they consume will

$$= \frac{1,500 \times 1,277}{1,000} = \frac{1,915,500}{1,000} = 1,915{\cdot}5 \text{ B.T.U.}$$

The cost per annum of lighting the hall with the above enclosed arc lamps at 6d. per B.T.U. = £47. 17s. 9d., therefore effecting a saving of £128 - £47. 17s. 9d. = £80. 2s. 3d., proving the arc lamps to be the least B.T.U. consumers in the ratio of 2·67 is to 1.—J. S. B.

Answer to No. 73 (*awarded* 5*s.*).—A large room would undoubtedly be best lighted electrically by arc lamps, especially when there is plenty of height, because if incandescent lamps are used they must either be suspended low down, or great expense incurred by increasing their number to get the room well lighted when they are a distance from the floor. In a large room they would not look effective if placed singly, and when in groups about 25 per cent. more lamps must be used, and consequently the cost will be increased about 25 per cent. for current. The area lighted by one 16 c.p. lamp is about 100 square feet, or another method of basing calculations is to allow from three-quarters to one watt per square foot of floor space when suspended about 8ft. or 10ft. from the floor.

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The area of room is 7,200 square feet, and if one 16-c.p. lamp is used per 100 square feet, the watts consumed will be 4,032. But if three-quarters of one watt is allowed per square foot, then 5,400 will be required. If the lights are burning for 5½ hours per day for 365 days, the total hours burning per year will be 2,000. Assume as mean of above that 5,000 watts are required, then we shall have 10,000,000 watt-hours, or 10,000 Board of Trade units, consumed. At 6d. per unit this will cost £250. Lamp renewals, about six dozen at 8s. per dozen, burning 1,000 hours each, will be £4. 16s. Therefore the total cost for incandescent lighting will be £254. 16s. per year.

The candle-power of arc lamps is very much overstated; a nominal 2,000-c.p. lamp, when working at the rate of 500 watts at 54 volts pressure, gave a light when measured of only 900 c.p., and when tried at 450 watts at 55 volts pressure it still gave 900 c.p., and then 645 watts at 60 volts gave 1,000 c.p., so that if we reckon about half the stated candle-power we shall be nearer the mark. One arc lamp taking 10 amperes at 50 volts will light 1,450 square feet well when placed at about 15ft. above the floor, and as there are 7,200 square feet, five such lamps will be required. These will consume 500 watts each, or a total of 2,500 watts. Assume, as before, 2,000 hours, then energy required will be 5,000,000 watt-hours, or 5,000 B.T.U., costing £125. To this must be added cost of carbons, which will amount to about £4. 3s., and labour for cleaning and trimming, say, about £2. This gives a total cost for arc lighting of £131. 3s., compared with £254. 16s. for incandescent lighting.

The total candle-power given out by the incandescent lamps will be 1,152 when 72 lamps of 16 c.p. each are used, while the total received from the five arc lamps of, say, 900 c.p. each will be 4,500 c p.—J. G.

Answer to No. 73 *(awarded* 5s.*).*—In order to light a hall with a ground area of 7,200 square feet and 40ft. high efficiently, about 4,000 c.p., at between 25ft. to 30ft. above the floor, will be needed. To do this, 250 16-c.p., 160 25-c.p., 80 50-c.p., or 40 100-c.p. incandescent lamps, or four 1,000-c.p. arc lamps, will be necessary.

16-c.p.	incandescent	lamps	require	about	60	watts	each.
25-c.p.	,,	,,	,,	,,	87½	,,	,,
50-c.p.	,,	,,	,,	,,	150	,,	,,
100-c.p.	,,	,,	,,	,,	250	,,	,,

From this it will be seen that to light with

	16-c.p.	lamps,	15	B.T.U.	per	hour	are	used.
with	25-c.p.	,,	14	,,	,,	,,	,,	,,
	50-c.p.	,,	12	,,	,,	,,	,,	,,
	100-c.p.	,,	10	,,	,,	,,	,,	,,

and with four 10-ampere 50-volt arc lamps two B.T.U. per hour are used.

Reckoning that the whole of the light is used on an average of two hours a day, which is equal to 730 hours per annum:

The cost of lighting with	16-c.p.	incandescent	lamps	=	£273	15	0
,, ,, ,,	25-c.p.	,,	,,	=	255	10	0
,, ,, ,,	50-c.p.	,,	,,	=	219	10	0
,, ,, ,,	100-c.p.	,,	,,	=	182	10	0
and ,, ,, ,,	arc lamps			=	36	10	0

From this table it will be seen that it is very much cheaper to use arc lamps, providing they are in keeping with the other fittings in the place, and are appropriate to the use to which the hall is to be put.—R. B. B.

[The answers to Question 73 are instructive in their diversity. Of course the question lends itself to diverse treatment in that neither intensity of light nor number of hours is specified.—Ed. *E. E.*]

QUESTION No. 70.

Sir,—The first answer to the question on "boosters" (No. 70) contains a classification of these machines. It might be interesting to others besides myself if "H. B." would give a detailed description of type (3), which is described as "one machine with a double winding on the armature and a duplicate magnetic circuit."—Yours, etc.,

F. H.

TUNBRIDGE WELLS.

The following is an abstract of the report of the borough electrical engineer (Mr. H. L P. Boot) on the second completed year's working of the electricity undertaking of the Corporation:

The central station is erected on a portion of the Corporation lower yard, in proximity to the Grosvenor Bridge. The buildings consist of engine-house, boiler-house, and lavatories, and offices in course of erection.

Engine-House.—The engine-house, a high-pitched building, is spanned by a travelling crane, designed to carry five tons and to hoist machinery from any part.

Switchboard.—The main switchboard for the control of the whole system is situated on one side of the engine-house, and is composed of massive slabs of enamelled slate, carrying the main switches, fuses, ampere-meters, and voltmeters, and all the apparatus for controlling and measuring the electricity generated. The switchboard controlling the public lighting is arranged on separate panels from the main. A Thomson recording wattmeter is provided for measuring the total quantity of electricity supplied. The switchboard has been extended during the year, and spare panels filled in.

Engines and Alternators.—The engines are of the well-known "Willans" high-speed type. There are four in number; the three large ones indicating 150 h.p. each, the smaller one (which is a day-load plant) is capable of indicating 60 h.p. The three large alternators are capable of giving an output of 80 kw. each, and the smaller one an output of 50 kw. The alternators generate current at a pressure of 2,100 volts.

Public Lighting.—Two complete sets of Ferranti rectifiers are provided for the lighting of the public arc lamps. They consist of a constant-current transformer, an ordinary step-down transformer, an alternate-current monophase motor driving the rectifying commutator, also the necessary regulating and controlling switches and arrangements for running the motor in synchronism, besides which there are five alternating arc lamps fed off the low-tension network.

Boiler-House.—There are five Babcock and Wilcox multitubular boilers, all of them being capable of working up to 240 h.p. The boilers are composed of a main cylindrical drum, from which emanate tubes at each end. The tubes are known as the "uptakes and downtakes." These are all connected with a number of nearly horizontal tubes, on which the flames and heat from the furnace play. Each boiler is capable of evaporating 4,500lb. of water, and is tested and made tight under a hydraulic pressure of 300lb. to the square inch. The working pressure is 150lb. to the square inch. Each boiler has a heating surface of 1,426 square feet. The tubes are 4in. in diameter and 16ft. long, and the joints are made tight by being expanded. Each of the boilers are provided with two safety valves, one steam-gauge, two water gauges and valves, and necessary gear for cleaning the pipes. The steam-ring—half of which passes through the engine-house, the other half going through the boiler-house, to which all the boilers are connected—is controlled by main valves, and is drained at various points by the use of steam traps and separators; any part of the ring can be shut off without interfering with the working of the remainder. The water is pumped up from a well 30ft. deep, which was sunk when the works were being built. A donkey pump, capable of delivering 2,500 gallons of water per hour, pumps the water from the well to a large feed tank, situated over the coal bunkers, to which are connected the necessary suction and delivery pipes. The condenser is capable of dealing with 9,000lb. of steam per hour, and is what is known as "Wright's evaporative condenser." It consists of brass tubes, through which the steam from the engine passes. On the outside of these tubes, water trickles down, and is evaporated by the heat of the steam inside, at the same time converting the steam into water. A small marine type of surface condenser is provided for any steam which may have passed these tubes to go through. A water-trap, with gauge glass, is fixed to prevent the steam escaping to the air-pumps. At the bottom of the condenser is a large sump, from which the cooling water is continually pumped to boxes at the top of the condenser. The hot-well and grease filter is fitted for separating the oil from the water for the boiler feed. A large double air-pump is provided, driven by a vertical compound steam-engine. The pumps have a displacement of 80 cubic feet per minute. An air and circulating pump is also erected, driven by a compound steam-engine. The air-pump cylinder has a displacement of 20 cubic feet per minute, and the circulating pump is capable of delivering 6,000 gallons of water per hour. The pumps, each capable of delivering 2,500 gallons of water per hour, are provided for feeding the boilers, and the arrangement of the feed ring and piping is such that these pumps (by the use of certain valves) can feed the boilers direct, or through the economiser. A small auxiliary engine is provided for working the scrapers belonging to the economiser for cleaning the soot from the tubes. A fuel economiser containing 128 tubes is provided, through which the feed water, before entering the boilers, is pumped, to raise the temperature. The flue arrangements are such that the waste gases from the furnaces of the boilers can either enter the shaft direct or through the economiser, thus heating the water. A shaft, 100ft. high, is provided for carrying away the smoke and gases, also for the purpose of creating the necessary draught.

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Distribution.—The system on which supply is given at Tunbridge Wells is known as the "high-tension alternate-current one"—that is, energy is transmitted from the works at high pressure—viz., 2,100 volts—and is transformed to a low pressure by suitable apparatus placed in sub-stations underneath the pavement and roadway, from which the energy is transmitted at a suitable pressure, and completely safe for supply to consumers. In the outlying districts transformers are placed in outside chambers adjoining the consumers' premises. (The total number of cables laid amounts to 107 in 57 streets.) The cables are composed of an inner conductor, then insulation, outer conductor, insulation, lead covering, insulation, steel armour and insulation, and are known as "concentric armoured lead-covered cables." There are, at the following places, underground sub-stations, in which are placed the transformer, machinery, switching and controlling gear: Town Hall, Basinghall, Mount Ephraim, Mount Pleasant, High-street, Grove Hill-road, Nevill-street, Pump-room, St. John's, Linden-park, Sandrock-road, Frant-road, Rusthall, Boyne-park, Molyneux-park, Langton-road, Upper Grosvenor-road, London-road, Broadwater-cross, and St. Mark's, besides which there are 23 private consumers having their own transformers and switching gear situated in a chamber or cellar on their premises. At certain points along the route of mains, link disconnecting boxes to enable tests to be taken on particular sections, are provided, and small (brick) pits with frames and covers are built round these boxes: on the high-pressure mains there are 50 and on the low-pressure mains 60 of these. The public arc lighting is provided for by a separate and distinct cable from those supplying private consumers, which cable starts from the switchboard at the works, and is laid through all the streets lighted by arc lamps. Pressure is maintained during the 24 hours on the cables, and light, or energy for driving motors, heating, cooking, etc., can be obtained throughout any hour of the year. On the consumers' premises, the Corporation fit a double-pole cut-out, and suitable sized meter, which meter has to be calibrated, standardised, and tested before leaving the works. There are at present 30 arc lamps, each giving 2,000 c.p. nominal; 27 special reflector lamps (Boot's patent), and 65 incandescent lamps of various candle-powers.

Engineering Progress.—The works were started with a capital expenditure of £13,000; since then an additional £12,000 was borrowed, and was spent as follows: for the enlargement of the building, which is now one-third larger than it was originally; in the engine-house two more steam alternators were put down, the switchboard extended, the main steam-ring extended; in the boiler-house three more boilers were put in, and in the distribution department mains have been laid, transformers purchased, additional meters and cut-outs, so that the total mileage of mains already laid is over 30.

Mains.—The total mileage of cable laid has been doubled, and the work of trenching, laying, and making good, as well as building pits and sub-stations, has been undertaken by the electrical department's own staff.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of Electricity.			
Fuel	1,386	6	9
Oil	79	5	8
Water, waste, and petty stores	34	7	4
Wages—Generating	447	3	10
,, Repairs	16	7	11
,, Public lamps	78	0	8
,, Mains	4	17	8
Repairs—material	61	7	0
Public lamps—Carbons	26	19	10
,, ,, Repairs	16	18	11
	2,151	15	7
Total Works and Distribution Cost.			
Rents, rates, and taxes	126	11	7
Management expenses	437	7	6
Insurance	34	6	0
Miscellaneous	0	11	0
	2,750	11	8
Total Expenditure for the Year.			
Dividend on stock	742	11	6
Redemption fund	671	17	4
Provision for bad debts	25	0	0
	4,190	0	6
Net profit for year 1897-98	1,632	2	10
	£5,822	3	4

Cr. Income.	£	s.	d.
Balance from bad debts	5	18	6
Sale of current per meter	4,703	12	7
Minimum charges	36	17	6
Public lighting (arcs)	435	11	11
Public lighting (incandescent)	185	18	4
Attendance, repairs, and carbons	257	19	5
Rental of meters	170	2	9
Sale of ashes	19	16	4
Extra tests	6	6	0
Total income for the year	£5,822	3	4

STATEMENT OF ELECTRICITY GENERATED SOLD, ETC.

Quantity generated in B.T. units	320,605
Sold for public lamps	63,878
Sold to consumers by meter	194,763
Total sold	258,641
Number of public lamps	902
Total maximum supply demanded—kilowatts	240·3

REPORT.

The object I have in view in bringing before your notice the analysis of the cost in pence per unit of every item is to show the relative importance and the weak spots in our undertaking, and by so analysing the costs it can be seen at a glance which items might be reduced in the future. I would like my balance-sheet to be considered as a further analysis of the borough accountant's statement. In my analysis of the numerous items which go to make up the total cost of electric energy I would draw your attention to (1) fuel, which, as you will see, is responsible for no less than 1·28d. per unit out of the total of 1·99d. It is, of course, only to be expected that in a town which is unfortunately situated with respect to the price of coal and its railway rates that this should be much heavier than many other towns, but I am not at all satisfied with this figure, although I am able to say it is a reduction this year of ·12d. per unit, representing a saving of £126 on the year's output. I therefore recommended you to put down a condenser, which condenser has now been working about two months, so that next year I hope to be able to reduce the fuel cost considerably. It is essential in an undertaking where the cost of fuel predominates over all other charges that every possible care and economy should be practised, and I hope in the future to seriously consider the question of using liquid fuel, or, better still, the town's refuse. We are handicapped in comparison with other towns for the following reason: We are not allowed to burn anything but "Welsh smokeless steam coal" on account of the nuisance, although it would be considerably cheaper for us to burn Nottingham or Derbyshire hard steam. It is for this reason absurd to compare our coal figure per unit with other towns like Leeds, where it costs them 2s. per ton, even making due allowance for the difference in calorific power. The railway rate we have to pay for fuel is more than 100 per cent. upon the value of the article, the coal costing between 8s. and 10s. at the pit's mouth, whereas the railway rate varies between 11s. and 12s. per ton, and I am afraid it is impossible to obtain a reduction. If we were given our coal, we should then be paying five times more than Leeds has to pay for theirs in carriage alone.

Oil, water, wages, and repairs are not affected to such a large extent by the railway rate, and are in accordance with good practice, and compare favourably with other towns. Wages will increase, as it is only just to our men that they should share in our good fortune, and I hope the Corporation will from time to time welcome increases in the wages of the men who have proved themselves good, loyal, and faithful servants, believing in the policy that, having secured a good man, it is the cheapest in the end to retain him.

Repairs and Maintenance.—During the past year it has been my practice to keep the machinery and mains in good order, and several parts in the engines and boilers have had to be renewed, but the Corporation have the satisfaction of knowing that the plant is running more smoothly than the day it was first started. This figure of ·056 will increase as the machinery gets older.

Water.—The water we have to deal with is exceedingly bad, and it has been pronounced by an expert on steam-raising to be one of the worst that has ever been submitted to him for analysis. If the charges were not so high, it would pay us to use town water. For this reason it behoves us to set aside a sum for the renewal of our boilers and fittings, as it is certain that the life of these will be short. There is a reduction in the total works and distribution cost this year of ·31d. per unit. It is interesting to note the works costs of the towns south of the Thames, which are as follows:

	Per unit sold.	No. of units sold.
Portsmouth	1·32d.	839,392
(Price of coal per ton, 10s. 10d.)		
Brighton	1·33d.	1,992,527
Hove	1·49d.	268,243
Tunbridge Wells	1·88d.	258,641
Bournemouth	2·16d.	338,658
Southampton	2·27d.	131,843
Richmond	2·33d.	138,916
Taunton	2·50d.	126,840
Kingston	2·75d.	194,268
Hastings	2·84d.	338,705
Dover	2·89d.	234,074
Eastbourne	3·07d.	240,806
Ealing	3 14d.	246,902

The distribution costs in each case have been deducted.

Rent, Rates, and Taxes.—This item has nearly doubled itself, owing to increased assessment, so that we are not so well off as the towns mentioned above in this respect.

Management Expenses.—In the management expenses every item is included, with the exception of 75 per cent. of my salary; and since there has been criticism with respect to charging this small amount to capital, I think it advisable to state the reasons for so doing. It is a practice in towns to charge a proportion of (1) the chief engineer's salary, (2) the assistants, (3) the clerical department, (4) general expenses, stationery, stamps, etc., to capital account, for the following reasons: The chief engineer devotes a large proportion of his time in advising the committee on extensions of boilers, engines, and machinery in general, drafting specifications, making drawings, together with supervising the laying of mains, the ordinary testing and clerk of works' duties, otherwise

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this would necessitate the employment of a consulting engineer and a clerk of works, whose fees and salaries respectively would be rightly charged to capital account, since their necessity has been rendered by the extensions and increased capital expenditure. Instead of allocating a certain proportion of the salaries of (1) the chief engineer, (2) the assistant engineers, (3) the draughtsman, (4) the clerks, 75 per cent. of my salary, and mine only, has been charged to capital account which, if anything, is rather under than over estimated, but where a consulting engineer, draughtsman, and clerk of the works are employed, of course the whole salaries of the resident staff should be charged to the revenue account. The total expenditure per unit for the year works out at 2·537d., or a reduction of ·34d. per unit. The total cost per unit sold, including all expenses, the dividend on stock, the redemption fund, and provision for bad debts, works out at 3·859d. per unit, as against 4·59d. per unit last year, showing a reduction of ·631d. per unit.

Electricity Generated and Sold for the Year ending March, 1898.—The progress has been satisfactory. Last year we sold 174,053 units, this year we sold 258,641 units, or an increase of 84,588 units. The number of lamps now connected to the mains is 18,044, being an increase of 4,092 for the year. I have been considerably hampered in obtaining machinery, owing to the deplorable engineers' strike, which has prevented the lighting of Mount Ephraim, and the delay in getting the condenser to work. The total income for the year is £5,882. 3s. 4d. It is interesting to see the average price obtained per unit sold to private consumers. The average price obtained is 5·74d., which shows that many of the consumers obtained some of their units at 4d.

Public Lighting.—The price per unit obtained for public lighting works out at the rate of 2·33d. per unit, which figure cannot be considered by any means exorbitant, and is below that obtained by many towns. It is necessary to draw special attention to this figure, as an idea is prevalent among some people that we are making our profits out of the public lighting, which is erroneous. The figure 2·33 is the quotient obtained by dividing the revenue by the number of units sold for public lighting, after deducting attendance, repairs, and carbons. The amount of public lighting in Tunbridge Wells is very small when compared with other towns owning their electricity works. Furthermore, there is room for improvement in the public lighting generally of our streets, and I would advise the Council to undertake public lighting on a larger scale than heretofore. The cost is much less when undertaken on a larger scale than in the manner it is here, and I would respectfully urge upon you the necessity of lighting the streets in a way that is worthy of the nineteenth century and the advancement of science. Wherever electricity cables are laid (in most of the streets), public lighting should be undertaken. There has been considerable discussion with reference to arc lighting, and I would kindly ask those councillors who are bitterly opposed to this form of lighting, to ascertain what is being done in other towns and abroad; they would, I venture to think, then alter their opinion. There is not a single town that has municipal works that has not more than doubled, and in many cases trebled, the number of arc lamps. I would not advocate the use of arc lamps for side streets, but only for main thoroughfares.

General Working.—During the year the low-pressure networks have been changed over to the higher pressure—viz., 220 volts—with considerable increase to our distribution efficiency, and we have been enabled to supply consumers on the low-tension system which hitherto were unapproachable. In years to come it cannot but have a salutary effect on the economical conditions of working, besides providing greater safety. The supply being continuous necessitates the adoption of the shift system, and the men work eight hours per day (56 hours per week), with a day's holiday once every three weeks on the change of shift; there are also the men employed on outside work, such as laying the mains, testing, keeping in order, jointing, inspecting, meter reading, trimming public lamps, cleaning ditto, and various other duties; in the offices the clerical work is undertaken, where the correspondence is executed, the books kept, and records of all results. The work in this department is somewhat heavy on account of the capital expenditure, as beyond the fact of attending to our ordinary consumers, the plans, extensions, and correspondence with the different firms about those extensions have to be undertaken. Owing to the extensive area of the borough, we have more cable laid than in any town of its size in the kingdom. At present, taking the number of yards of cable laid, dividing it by the number of consumers on the register, shows that for every consumer we have 176 yards of cable, or three yards of cable per 8 c.p. lamp installed.

Financial.—To ascertain the true financial position of an undertaking, it is necesary to consider that undertaking a limited liability company, and see at what price the undertaking can be sold above what it has cost the town to date. The capital expenditure in round figures is £30,000, being an increase for the year of £7,000. For our purpose we will divide the capital up as follows:

Fifty 4 per cent. debentures making	£5,000
Two thousand 5 per cent. preference shares (divided into £5 shares)	10,000
Three thousand ordinary shares (divided into £5 shares)	15,000
	£30,000
The gross profit on the year's working is	£3,046
Interest on £5,000 of 4 per cent. debentures, £200; interest on £10,000 of 5 per cent. preferences, £500	700
Available for dividend on the ordinary shares	£2,346

which is equal to a dividend of 15½ per cent. However, a wise board of directors would pay 10 per cent. dividend, and carry forward the remainder to a reserve fund, after allowing for directors' fees. To obtain the selling price of the undertaking, I find that according to the electric companies' share lists, stock and share market, that the debentures would be standing at

£102 (profit on debentures)	£100
Preference would be standing at £6 (profit on preference).	2,000
Ordinary would be standing at £10 (profit on ordinary)	15,000
	£17,100

or in other words, the value of the Tunbridge Wells electricity undertaking is £30,000 plus £17,100, making a total of £47,100. This would not be considered bad business for two years and nine months working in commercial circles. It is, I venture to think, well understood that our loan is granted for a period of 25 years—that is to say, we are practically purchasing the works on the easy payment system, by setting aside each year a certain sum, so that if it were unnecessary to expend further capital, at the end of 25 years the whole of the works would become the property of the ratepayers. The works will then produce a larger profit, as they will not have to find interest or sinking fund charges before arriving at the net profit.

Appropriation of Profits.—There is an available surplus at the end of March, 1898, of £2,338 for disposal. I am strongly of the opinion that profits made out of any municipal undertaking is the property of that particular undertaking, and, therefore, should go to the benefit of it, and not in a general reduction of the rates. When the Corporation undertake to supply a commodity, let it be electricity, gas, water, or any other daily necessity, it should be their golden rule to supply that commodity at cost price, as the object of the Local Government Board in granting them loans for these purposes is for the benefit of those who use that commodity obtaining it at a cheaper rate than if a monopoly were formed, and therefore, if a profit is made, it shows that the commodity could be supplied at a lower price, and it is manifestly unjust to make the consumers pay more for it to enable a reduction in the municipal rates to be made. Clearly, then, the profit made is the property of the consumers interested in the undertaking. One of the best (if not the best) governed cities in Great Britain—viz., Glasgow—strongly believes in this principle for all the departments to practice. Glasgow owns the gas, electricity, tramways, and waterworks—all departments showing handsome profits—which are not put to the general reduction of the rates, but to the good of that department. Even let us suppose that every ratepayer uses electricity, but they all will not use electricity in an exact proportion to their rental, which is the basis of municipal assessment, and therefore the large consumer would pay away more than he would receive back in the form of reduced taxation, whilst, on the other hand, a small consumer might get a rebate of taxation out of proportion to his consumption, and that at the expense of the larger consumer. This is neither fair nor equitable, and in a town where some of the ratepayers are not consumers the injustice becomes more flagrant. The proper way of disposing of the surplus is to set aside that surplus for extra depreciation of plant in the form of a reserve fund. I have communicated with the towns that have been fortunate enough to make a net profit on their electricity undertaking, and find that they have started a substantial reserve fund out of the profits, and they are of the opinion that "this reserve fund can be used for any deficiency arising in the income by the breakdown of machinery and mains, or the rapid depreciation thereof." I would advise the Council to substantially reduce the price of electricity in the borough. It will, of course, be impossible to supply electricity at as low a rate as is being done in a few towns—(1) on account of the high price of fuel; (2) the scattered area of supply, as is shown in a previous paragraph by the number of yards of cable laid per consumer. If a profit is made, that profit should go to the good of that department to demonstrate to the public that it is doing its best to provide, and provide successfully, for the wants of the people, and the best evidence of this is to be found in a low charge for current rather than a continuous large surplus to be appropriated by other departments at the end of each year. In the gas department of the city of Glasgow they contend "that what has been taken away from the consumer in excess of the cost of production and distribution should be given back to him at once and directly, through the department, in the form of a reduced charge in the immediate future." In their electricity department last year there was a surplus of £18,000, and it is interesting to see how they set aside their surplus: "Every penny of that surplus was appropriated for the good of that department," and they maintain that the citizens benefited quite as much as if the bulk of it had been devoted to the relief of the rates. Those citizens that do not reap the direct benefits have only to become consumers to do so. The argument is often used: "That if there had been a deficiency, the general ratepayers would have been called upon to make it good," and therefore the general ratepayers who are not consumers think they are entitled to the profits on the speculation, but they must not forget that the consumers are buying, by easy instalments, the electricity works for the good of the community, and they are therefore already giving a considerable surplus to the general ratepayers in the form of a redemption fund. However, had there been a deficiency, it need not have been made good out of the rates, as it could have been carried forward until the profits were sufficient to wipe off the deficiency, as has been done in many other towns; but I maintain, as there is no loss, there is no need to consider a "white elephant" which does not exist.

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The Future of the Undertaking.—It is, as a rule, unwise to prophesy, and for that reason in my last year's report I was careful not to do so. However, I may state that so far as one can judge there is a prosperous future before the undertaking if it is well managed. One of the great drawbacks to the general adoption as an illuminant has been the expense of having it fitted up in one's premises. There is a scheme which will entirely overcome this and bear the initial cost for a consumer, charging him a slightly increased rate (something between ½d. and 1d. per unit). I refer to the well-known "free-wiring system," which has been adopted in several towns with success, and I hope at no distant date to bring before the committee the importance of introducing it into Tunbridge Wells. It would undoubtedly be a great boon to persons owning leasehold property, who naturally do not like to expend a large sum in having their houses fitted for their freeholder's benefit eventually. Another advantage to the works would be a large extension of public lighting.

Refuse Destructors.—The results of the Shoreditch Vestry electricity undertaking have now been published, which are satisfactory, and the item which calls for special attention is the 23d. per unit for fuel. This has been achieved by use of a dust destructor, and if such can be done in a place like Shoreditch, where the calorific value of the refuse is low compared to a town like Tunbridge Wells, where its value should be high, owing to the waste of fuel, etc., by visitors, it would be advisable for the Corporation to consider the question of going in for a refuse destructor for raising steam in conjunction with coal at the electricity works.

Tramways.—The question of introducing electric traction into Tunbridge Wells is being mooted in different quarters, and I can foresee that if such is undertaken it will provide a very beneficial load to our lighting works in the daytime, when they are practically idle. There are many considerations with respect to tramways being introduced which require careful consideration, and I have been asked by the General Purposes Committee to draw up a special report for them on the subject, so that it is unnecessary to go into details here. Free wiring, dust destructor, and tramways—these undertakings will help to supplement the success of the electricity undertaking in the borough, as they can be worked in conjunction.

LEGAL INTELLIGENCE.

THE MICA INSULATOR COMPANY v. THE ELECTRICAL COMPANY, LIMITED.

This was a patent action heard before Mr. Justice Kekewich, and was brought by the plaintiff company to restrain an alleged infringement of their patent by the defendant company. The patent in question was granted originally to Arthur Henry Salisbury Dyer, an American electrician, in 1892, and was for the construction of sheets made or built up of small flakes, scales, or laminæ of mica, these sheets being then manufactured into tubes, cylinders, pole-end covers, commutator rings, and other articles for use as insulators on electrical machines. It was stated that previously to Dyer's invention great difficulty had been experienced by electricians in providing effective insulators, mica being the only substance that would resist carbonisation, but the difficulty was in getting sheets of mica of sufficient size and strength for the purposes required. This difficulty was got over partially by sandwiching canvas or cloth between overlapping layers of mica, the whole being united and solidified by shellac or other adhesive substance between the layers, but the interposition of the fibrous substance was found to be unsatisfactory, and the material to be brittle and incapable of being readily bent or moulded. To get rid of the objections to this class of insulating material, and to provide a more effective and at the same time a cheaper kind, Dyer brought forward his invention, which was one affording a remarkable instance of the utilisation of waste substances. He took the small and apparently useless refuse scales of mica chopped off the large blocks in course of manufacture, and built them up into sheets of superposed and overlapping particles, united by shellac, copal varnish, or other insulating glues, and subjected to pressure. The material thus constructed was called "micanite." It was plastic in substance, and could be readily moulded into insulating fittings, which proved to be of great durability and perfectly efficacious for the purpose intended. It was stated in evidence that articles manufactured under Dyer's patent, which had been vested by assignment in the plaintiffs, had now become absolutely necessary for electrical machines, and were coming universally into use. On the point of economy it was stated that whereas mica in blocks cost from 30s. to 40s. per pound, the particles of mica used in Dyer's patent cost a fraction of a penny per pound. It was contended on the part of the defendants, who had constructed a similar material for a similar purpose, that the principle of construction of the plaintiffs' article was an old one; in short, that the patent was bad by reason of "anticipation" and prior user, and witnesses were called on behalf of the defendants to prove that they had, long prior to Dyer's patent, manufactured sheets of mica upon the same principle, the only difference being that their sheets were more expensively constructed, being built up of comparatively large slices of mica, whereas Dyer's sheets were made in the economical method above mentioned. On the other hand, it was said that until Dyer's invention it was not possible to mould insulating fittings out of the mica sheets then in use, on account of their brittleness, but that such fittings had to be built up in sections, whereas moulding, which was only possible under Dyer's invention, was cheaper and more effectual.

Mr. Fletcher Moulton, Q.C., Mr. Jenkins, Q.C., and Mr. Ward Coldridge appeared for the plaintiffs; and Mr. T. Terrell, Q.C., and Mr. A. J. Walter for the defendants.

Mr. Justice Kekewich said it was an undoubted fact that the material known as micanite was an invention of great merit and great utility, but the question was whether it was properly protected by the plaintiffs' letters patent. There were several grounds of objection to the validity of the patent, but he would only mention two—anticipation and prior user. His Lordship then reviewed the evidence, and came to the conclusion that the two grounds of objection had been made out. He accordingly dismissed the action with costs.—*The Times.*

COMPANIES' MEETINGS AND REPORTS.

UNITED RIVER PLATE TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of this Company was held on the 5th inst. at Winchester House.

Mr. J. Irving Courtenay, who presided, went over the items in the balance-sheet to show the progress of the concern, pointing out that the profit was particularly satisfactory. The balance from the previous year, £7,576, was the largest they had ever brought forward; the profit, £23,539, was larger by £3,000 than for any previous year, and the amount refunded on account of taxes, £6,240, provided a substantial sum towards a reserve fund. The total of £37,355 left a practical reserve, after paying 6 per cent. dividend of £20,000.

The report was adopted, and the **Chairman** afterwards pointed out the desirability of the issue of the remainder of the debenture stock, £48,267, for the purpose of purchasing improved plant. The issue is to be confined to the shareholders.

MONTE VIDEO TELEPHONE COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on the 6th inst., at Winchester House, Old Broad-street, E.C., to reduce the capital of the Company.

Mr. Herbert Ward, who presided, reminded the shareholders that the prospects of the Company, which looked so promising in 1888, became sadly shattered by the collapse which befell the State of Uruguay. The payment of 6 per cent. on the preferred shares had been too heavy a task, and the Board considered there was but a remote hope of the Company ever attaining such a position. They had a sound business, as was demonstrated by the fact that the preference shareholders had now received for four consecutive years a return of 4 per cent. on the nominal amount of their holding. The scheme of rearrangement proposed was that £140,000 of preference shares would become £84,000 preference shares, non-preferential as to capital, bearing a 5 per cent. cumulative dividend, and £56,000 of ordinary shares. The dividend of 5 per cent. on the reduced preference would require £4,200, leaving a dividend of only 2 per cent. required on the ordinary shares, absorbing £1,120 to equal the return which the present preference shares received of 4 per cent.

A formal resolution to alter the articles of association, empowering the Board to reduce the capital of the Company upon the lines described was carried unanimously.

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

Directors: John Irving Courtenay, Esq. (chairman and managing director); Sir Daniel Cooper, Bart., G.C.M.G.; Frederick Green, Esq.; Sir James Pender, Bart., M.P.; Frank King, Esq., M.I.E.E. Chief engineer: H. W. Butler. Secretary: David Smith.

Report of the directors to be presented to the shareholders at the ninth ordinary general meeting to be held on Thursday, July 14, 1898, at the offices of the Company, 4, Great Winchester-street, E.C., at 2.30 p.m.:

The net profit for the year is £4,389. 6s. 5d., which, with a balance of £242. 0s. 2d. from last year, amounts to £4,631. 6s. 7d., out of which the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb £4,274. 16s., leaving £356. 10s. 7d. to be carried forward. Provision has been made for the maintenance of buildings, plant, tools, etc., at a cost of £2,610. 12s. 1d. A considerable portion of the area obtained during last year for the extension of the Millwall works has now been built upon, and the shops fitted with newest types of machinery. The increased facilities thus obtained have enabled the Company to keep pace with the growing demands for its manufactures. The Company is now producing nearly all standard British and Continental types of secondary batteries, provided with Planté formed or pasted plates, and is thus in an exceptional position for executing contracts to the various requirements of consulting and acting engineers throughout the country. The directors are pleased to announce that during the year a Royal warrant has been issued appointing the Company storage battery makers to her Majesty the Queen. This is the first and only Royal warrant which has been granted for any electrical appliances. Owing to ill health, Mr. Frank King, who has been manager of

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the present Company since its formation, has tendered his resignation. Your directors have accepted it with the utmost regret, and have unanimously elected him to a seat on the Board. The retiring director is Sir James Pender, Bart., M.P., who offers himself for re-election. The auditors, Messrs. James Meston and Co., chartered accountants, also offer themselves for re-election.

BALANCE-SHEET, MAY 31, 1898.

Liabilities.	£	s.	d.
Share capital authorised—20,100 shares of £5 each, of which 100 are founders' shares	100,500	0	0
Shares issued—			
66 founders' shares of £5 each, fully paid	330	0	0
15,220 ordinary shares of £5 each, fully paid	76,100	0	0
3,132 ditto of £5 each, £3 called (exclusive of five shares forfeited during year)	9,396	0	0
18,418	85,826	0	0
Debenture issue authorised	30,000	0	0
Debentures issued—231 debentures of £100 each	23,100	0	0
Sundry creditors	8,320	4	0
Reserve fund—amount at credit	9,756	18	11
Contingent fund—amount at credit	1,350	0	0
Profit and loss account—balance at credit May 31, 1897, after paying dividend at 5 per cent., £242. 0s. 2d.; add profit for year 1897-8, £4,389. 6s. 5d.	4,631	6	7
	£132,984	9	6
Assets.			
Patents, goodwill, etc., as per last balance-sheet	85,770	0	0
Added this year	700	0	0
	86,470	0	0
Buildings, plant, tools, fixtures, etc. (including £4,038. 7s. 3d. for buildings, plant, etc., added this year), £6,937. 15s. 9d.; less depreciation written off this year, £289. 18s. 10d.	6 647	16	11
Stock on hand—at cost or under	17,813	11	2
Sundry debtors (less reserve for discounts and doubtful debts)	12,272	8	8
Bills receivable	1,171	14	5
Investments in other undertakings	1,400	0	0
Cash—at bankers, £7,116. 13s. 8d.; in hand, £92. 4s. 8d.	7,208	18	4
	£132,984	9	6

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Melbourne (Victoria).—The Town Council invite tenders for a supply of arc lamp carbons. Particulars may be obtained of, and tenders addressed to, the Town Clerk by Aug. 16.

Belgrade.—Tenders are invited for the electric lighting of the town. Specifications, etc., may be obtained from the Department of Public Works in Belgrade. Tenders by 21st inst.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns. Tenders by Aug. 10.

St. Pancras.—The Vestry invite tenders for condensing plant, steam-pipes, etc., for the Regent's Park Generating Station, 47, Stanhope-street, N.W. Further particulars appear in our advertising columns. Tenders by July 12.

Brussels.—The Belgian Government will shortly invite tenders for the introduction of electric traction on their line from Mons to Boussu. The estimate is £26,000, £9,600 of which is for rolling-stock. The line has a length of six miles, exclusive of branches.

Stavelot (Belgium).—The Municipal Authorities invite tenders for the installation and working of an electric plant for light and power for 30 years. Conditions, etc., may be obtained for 2s. 8d. from the Town Clerk, at Stavelot. The deposit is £120. Open until Aug. 2.

Exeter.—Tenders are invited by the Corporation for about four miles of high and low tension concentric mains, four transformers, about 50 meters, and a feed-water heater of about 1,000 gallons capacity, for particulars of which refer to our advertisement columns. Tenders by 25th inst.

Shoreditch.—The Vestry invite tenders for the supply and erection of additional continuous-current motor-transformers, with switch gear, and extension to switchboard, at the Vestry's electric generating station, Coronet-street, for particulars of which refer to our advertisement columns. Tenders by 18th inst.

West Hartlepool.—The Town Council of West Hartlepool invite competitive plans, designs, and tenders for the erection of refuse destructor, boilers, etc., adjoining the electric light station, Burn-road. Conditions, etc., can be obtained upon application to Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on July 27.

Newington.—The Electric Lighting Committee of the Vestry invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc., in connection with the Vestry's electric lighting station, Penrose-street, Walworth, for particulars of which refer to our advertisement columns. Tenders by 22nd inst.

Glasgow.—Tenders are invited by the Corporation for providing and erecting the following plant required for their new generating station at Port Dundas—viz.: (1) cast-iron and mild-steel tanks; and (2) cast-iron hoppers, chutes, bolts, etc. Particulars, etc., may be obtained on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by July 28.

Hull.—The Technical Instruction Committee invite tenders for wiring the municipal technical school, Park-street. The specification and plans may be seen at the office of Mr. J. T. Riley, D.Sc., 7, Albion-street. Tenders, endorsed "Tender for Wiring Technical School," are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office, Town Hall, Hull, before noon on July 18.

London, E.—Tenders are invited by the Shoreditch Vestry for the supply and erection of dry-back marine-type boilers, steam and feed pipes, and sundry ironwork at the Vestry's electric generating station, Coronet street, Shoreditch. Specifications, etc., can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders by 4 p.m. on 12th inst.

Northwich.—Tenders are invited by the Guardians of Northwich Union for the electric lighting of their workhouse. The premises may be viewed on an appointment being made with the Master of the Workhouse, who will supply each person proposing to tender with a copy of the specification and schedule of lights. Forms of contract may also be inspected at the Workhouse. Tenders, endorsed "Electric Lighting,' must be delivered to Mr. Algernon Fletcher, union clerk, Northwich, by 14th inst.

Brighton.—The Council invite tenders for the supply of unarmoured and armoured lead-covered cables at the Corporation electricity works for one year from July 31. Specifications and forms of tender may be obtained at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, addressed to the Clerk, and endorsed "Tender for Cable," must be sent in by 10 a.m. on July 11.

Middlesbrough.—Tenders are invited by the Tees Union Shipping Company for the construction and erection of an electrical coal-hoist upon their wharf at Middlesbrough. Plans may be seen at the office of Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W., and a copy of general plan and specification to be obtained upon payment of £2. 2s., which will not be returned. Tenders to be delivered to the Secretary, Tees Union Shipping Company, Middlesbrough, marked "Tender for Coal Hoist," by July 15.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of one 150-kw. high-speed engine and alternator coupled direct, and sundry additional steam and exhaust pipes. Copies of the specification, with general conditions and forms of tender, may be obtained at the office of Mr. A. H. Miller, town clerk, Town Hall, Yarmouth, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Copies of drawings and any further information may be obtained at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster, S.W. Sealed tenders, endorsed "Electric Light Plant," must be delivered at the Town Hall by 10 a.m. on 19th inst.

Achnasheen.—Tenders are invited for the erection of a line of wire, 10¾ miles long or thereby, on the estate of Arthur Bignold, Esq., of Loch Rosque, Achnasheen. The line to have two terminal instruments and four intermediate ones complete. The first four miles of line to be on poles, followed by 2¾ miles underground cable, the remaining four miles to be submerged in Loch Fannich. Intending contractors must satisfy themselves as to the nature of the ground and the means of access thereto. On receipt of a post-card two days previous, Mr. J. Patterson, Loch Rosque, Achnasheen, will show contractors over the grounds, and conditions and specifications may be had from him on application, and sealed tenders, marked outside "Telephone Tender," are to be lodged with Mr. J. Patterson by July 22.

RESULTS OF TENDERS.

Lancaster.—The tender of the Blainscough Colliery Company, Limited, has been accepted for coal for the electricity works during the ensuing 12 months.

Tunbridge Wells.—The Corporation have received the following tenders for the wiring of the new baths, Monson-road, for electric lighting:

Benham and Sons, London	£207	5	0
G. F. Ratcliff and Co., London	170	0	0
Electrical and General Engineering Company, London	153	0	0
Fowler, Lancaster, and Co., Birmingham	152	10	0
J. Hills and Son, Tunbridge Wells	125	10	0
Storey and Preston, Tunbridge Wells (accepted)	97	0	0
W. J. Fryer and Co., London	83	0	0
S. E. Haward and Co., Tunbridge Wells	79	19	6
W. V. Scott and Co., Limited, London	79	1	0

Electric Works Company.—Notices have just been issued under the Electric Lighting Acts of 1882 and 1888 to the various public authorities interested by the Electric Works Company, Limited, of their intention to apply for a provisional order for the electric lighting of the parishes of Frimley, Farnborough, Windlesham, Winkfield, with Ascot. The Company intend to commence operations as soon as the provisional order is confirmed by Parliament.

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BUSINESS NOTES.

Bray.—The installation of the electric lighting of the marine parade has just been completed.

West India and Panama Telegraph Company.—The receipts of the Company for the half-month ended June 15 were £4,704, against £2,196.

Ipswich.—The Guardians have adopted the report recommending that the new workhouse be lighted by electricity, generated by means of gas-engines.

Yarmouth.—An electrical motor wagonette, the first licensed to ply for hire in the borough, has just been introduced at Great Yarmouth with success.

Brisbane.—The Government of Queensland has received a proposal from a copper company to utilise the Baran Falls to provide power for electrolytic works at a cost of £50,000.

Bridlington.—Mr. R. Railston Brown has resigned his position as electrical engineer to the Bridlington Urban District Council, having obtained a similar appointment in the town.

W. T. Glover and Co., Limited.—The transfer books and register of members of the above Company will be closed from Thursday, the 7th inst., to Friday, the 15th inst., both days inclusive.

St. James's and Pall Mall Electric Light Company.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 10 per cent. per annum on the ordinary shares.

Appointments Vacant.—A chief electrical engineer is required by the Bournemouth and District Electric Supply Company. For particulars of this and various other vacancies we refer our readers to our advertisement columns.

H. M. Salmony and Co., Limited.—We have been informed that one of the directors of this Company has just returned from America with agencies of several leading firms, full particulars of which will be shortly announced.

Cork.—Two tramcars arrived on the 3rd inst. by the ss. "Glengariffe," and were temporarily placed on the quay side at the opening of the South Jetties. The carriages are painted in green, with gold edging, the Cork arms occupying a prominent position.

Notting Hill Electric Lighting Company.—The Notting Hill Electric Lighting Company, Limited, has declared an interim dividend for the half-year ended June 30 at the rate of 6 per cent. per annum on both the ordinary shares and ordinary preference shares.

Runcorn.—The Electrical Power Distribution Company, London, have notified their intention to apply to the Board of Trade for a provisional order to supply electricity in the district. The Council, believing such power should be vested in the Council, have decided to make a similar application in opposition.

Colchester.—A workman who, while engaged in building a very high shaft at the electricity works, had been injured by the falling of a brick was awarded 15 weeks' wages, £2. 6s. for the doctor's bill, and £2. 2s. for nursing—a total of £18. 7s. 2d.—against the contractors under the Employers' Liability Act.

Bedford.—We hear that the Council have been preparing careful estimates of what it would cost to provide a telephone service of its own. It is prepared to connect up 100 subscribers within a mile of the centre of the town at £2 per subscriber per annum, and show a profit. The Corporation anticipate 500 subscribers.

Rotherhithe.—At a general meeting of the Vestry on Tuesday last the minutes of proceedings at the conference of representatives of the London County Council and the London local authorities at the County Hall on June 14, 1898, *re* telephone service and generating stations for supply of electricity in bulk, were discussed.

Argentine.—A German electric light and traction company has been formed, with a capital of £1,000,000. They have acquired the tramways of the capital, and are constructing a central station which will, according to the *Boletin de la Union Industrial Argentina*, cost £160,000. Mr. Gaster Fredersking is the moving spirit in the matter.

Cosham.—The Light Railway Commissioners will report favourably to the Board of Trade on the application of the Hampshire Light Electric Railway Company for power to contruct a light electric railway from Cosham to Horndean *vid* Portsdown Hill, Purbrook, and Waterlooville.

Dundee.—At a meeting of the Gas Committee on the 6th inst., a report was submitted by the electrical engineer with regard to the proposed extension of the electric lighting area of the city. After consideration, the committee agreed to recommend the erection of 27 lamps at an estimated cost of £838. 17s., the running cost being £550 per annum.

Outing.—The employés of the London Electrical Fittings Company (late A. and W. Hopkins) held their annual beanfeast at Bourne End on the 2nd inst. The party, which was a large one, spent a very enjoyable day, dinner and sports being provided by the firm. We understand this firm is extremely full of orders, and is contemplating an enlargement of their works.

Grimsby.—The Public Lighting Sub-Committee have considered the report of Prof. Kennedy on the electric lighting of the borough, and have decided to have another interview with Prof. Kennedy respecting the matter. It is stated that the question will be shortly brought before a full meeting of the Lighting Committee, and that it will be pushed forward as quickly as possible.

Peterborough.—The engineer has been instructed to furnish a further report as to the desirability of erecting electric light works at Albert-place Meadow, describing therein the relative advantages of the Albert-place Meadow and the Queen-street premises as alternative sites for the erection of such works. He is also to further extend the trial hole at the northern end of the meadow.

The Share Market.—The *Financial News* says investors continue to buy electrics; but, as they confine their attention to a few of the better companies, general business is on a restricted scale. Westminster, Citys, and St. James continue in favour, but without change of price. The debenture issue by the British Electric Traction has been well received, although no premium is at present quoted.

Removal.—We are informed that, owing to the necessity for increased accommodation, Messrs. E. P. Allam and Co., electrical engineers, have removed their offices and stores from 14 to 11, Hatton-garden, E.C. (Holborn end).—The Brush Electrical Engineering Company, Limited, late of 6, York-place, Edinburgh, have removed to larger premises at Prudential-buildings, 2, St. Andrew-square.

Dover.—The Corporation have accepted the offer of the electric lighting company to light the sea-front on the following terms: £45 for the installation, and £20 per week, and £1. 10s. per hour extra, which were the same as last year. The question of not illuminating the sea-front on wet evenings was left with the surveyor. The lighting is to be for two months, starting from the middle of July.

Hastings.—We hear that Mr. W. M. Murphy will renew his application to the Light Railway Commissioners in October for permission to lay down a system of electric traction between Bexhill and Hastings. Although the Commissioners refused to permit the laying down of lines over the whole borough, it appears that there probably will be no objections to a connection of the towns of Bexhill and Hastings.

Halifax.—Sir Francis Marindin and Major Cardew visited Halifax last week for the purpose of inspecting the new electric tramways recently completed. It was announced later in the day that the results of the official inspection were highly satisfactory, and they could commence running the cars at once if they chose. On the same night, therefore, freights were carried from Commercial-street to the Fairground in Gibbet-lane.

Electric Construction Company.—The directors have recommended a dividend on the ordinary shares for the year ended May 31 at the rate of 6 per cent. per annum, one-half payable on July 30, 1898, and the other on Jan 31, 1899. The transfer books for the first mortgage debentures and 4 per cent. perpetual first mortgage debenture stock will be closed from July 8 to 14 inclusive, and for the ordinary and preference shares from July 7 to 21 inclusive.

Enfield.—At the last meeting of the Urban Council several notices from electric lighting companies of intention to apply for orders for the supply of electric light to the district were received. The Chairman hoped the Council would go in for a provisional order on their own account. The amount of money they had paid each year to the gas company would capitalise at £42,000, which would go a long way towards providing the light. The subject was referred to a committee.

Southampton.—The Corporation have now taken over the whole tram and 'bus system in the borough. The cost has yet to be fixed, and arbitration to this end is going on between the company and the Corporation. An Act of Parliament has been provided for the transfer. The whole of the employés will remain in their positions for the present. In six months' time it is proposed to abolish horse traction and use only electricity, as the Corporation have their own electric works.

Paisley.—Mr. Francis Teague, the burgh electrical engineer, has issued his report on the electric tramways question, and is of opinion that electric tramways are the tramways of the future; that the overhead system of electric traction is the only system that might reasonably be expected to yield a return in Paisley; and that greater public benefit is likely to result from private enterprise like that proposed by the British Electric Traction Company than from municipalisation.

New Companies.—Companies have been registered during the week as follows: Whitstable Electric Light and Power Company, Limited, with a capital of £5,000; Camborne Electricity Supply Company, Limited, with a capital of £1,000; Twickenham and Teddington Electric Supply Company, Limited, with a capital of £25,000; Lymington Electric Light and Power Company, Limited, with a capital of £10,000; Sandgate and Hythe Electric Company, Limited, with a capital of £1,000.

Wednesbury.—At the meeting of the Town Council on Monday, the Sanitary and General Purposes Committee submitted the following for approval: "That Clause 5 of the agreement with the Midland Electric Company be altered to give the company liberty to proceed with their works as soon as they can get the order, and that the committee accordingly recommend the Council to consent to the grant of the order under the title of 'The Midland Electric Power Distribution and Lighting Order, 1898.'"

City and South London Railway Company.—The accounts for the half-year ended June 30 have just been issued. After providing for the debenture interest and the dividend on the preference shares, the directors recommend the payment of a dividend on the consolidated ordinary stock at the rate of 2¼ per cent. per annum, carrying forward a balance of £1,005. The dividend for the corresponding period last year was at the rate of 2 per cent. per annum, the balance carried forward being £1,035.

Nottingham.—The City Council have passed the following resolution: "That the proceedings of the special committee now reported to the Council be confirmed, and that such committee

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be instructed to continue to oppose vigorously in the House of Commons the Bill of the General Power Distributing Company therein referred to." At the Chamber of Commerce the same question was debated, and a vote of thanks was passed to Mr. Acton, who had represented the Chamber at the enquiry.

Whitechapel.—At a meeting of the Board of Works on Monday last a letter was read from Mr. Sydney Morse, enclosing a notice of the intention of the County of London and Brush Provincial Electric Lighting Company, Limited, to apply to the Board of Trade before December 21 next for a provisional order to supply electrical energy within the Whitechapel district. A special committee is to be appointed to consider the subject of the electric lighting of the district, and to define the duties of such committee.

Inverness.—The Free East Church, Inverness, has just been fitted with a complete electric light installation. The work has been carried out by Messrs. P. C. Middleton and Co., Aberdeen. There are about 70 lights of 16 c.p. each fixed in the church. The current is being supplied from a central station which has recently been established by Messrs. Middleton in the new Arcade-buildings, from which the firm, we are informed, are at present supplying the electric light in quite a number of business places in the vicinity of Inverness.

Grahamstown (South Africa) Exhibition of Arts and Industry. The British and Continental agency for this international exhibition, to be held December-January, 1898-1899, is in the hands of Messrs. William Savage and Sons, of Port Elizabath, S.A., and of Blomfield House, London-wall, London, E.C. This firm has arranged with the South African and Transvaal Advertising Company, Limited, Effingham House, Arundel-street, Strand, London, W.C., as sub-agents, from whom all information relative to space for exhibits may be had.

Lambeth.—The Vestry have received a letter from Mr. S. Morse, enclosing notice of the intention of the County of London and Brush Provincial Electric Lighting Company, Limited, to apply for a provisional order for the purpose of taking their mains through Lambeth, so as to connect the detached portion of Wandsworth district with the main portion. The report of the resolutions passed by the conference of representatives of the London County Council and of London local authorities was read at the meeting of the 7th inst.

Worthing.—At a former meeting of the Town Council the recommendation of the committee to appoint Messrs. Burstall and Monkhouse as consulting engineers for electric lighting purposes, on terms to be arranged with them by the committee, was adopted, but the Electric Lighting Committee on the 5th inst. advised the Council that, in the opinion of the committee, Mr. Wright should be appointed consulting engineer, and that the resolution of the Council appointing Messrs. Burstall and Monkhouse should be rescinded. The resolution to rescind was rejected by the Council.

Concentric Wiring.—The Brixton Bon Marché has recently been considerably extended, and the contract for the electric light wiring of the whole building has been entrusted to Messrs. Geipel and Lange, to be carried out to the specification of Mr. Albion Snell, with Andrews's patent concentric wiring. This system of wiring is being adopted in many other important works, and, among others, is being used throughout the new factory of Messrs. Fullers, Limited, at Hammersmith, where the contract for the lighting and supply of power has been placed with the same firm.

Morecambe.—The electric lighting on the front was inaugurated on Wednesday last, and proved very satisfactory. The members of the District Council and a few residents assembled at the new works, when the switches were turned on by Mrs. Thomas Baxter, wife of the chairman of the District Council. At present there are 55 arc lamps in operation, extending from East-view to the West-end pier. The cost of the undertaking is estimated at £40,000, and as the Council have more applications from private consumers than they are able to supply, further extensions are anticipated shortly.

North Berwick.—At the monthly meeting of the North Berwick Town Council on Monday last the question of electric lighting for the town again came up for consideration. A report was received, at the request of the Board, from Messrs. Burstall and Monkhouse, Westminster, giving detailed information respecting the scheme generally. The system proposed is the low-tension current one, the pressure at the consumers' lamps being the same as used in Edinburgh. The capital cost for an installation of the requisite size is estimated at £7,600. It was agreed to have an early special meeting to deal with the question.

Kirkcaldy.—At a special meeting of the Town Council to consider the electric light and tramway scheme for the burgh, a letter was read from the Edison Light Company, intimating their intention to apply for an order to put down electric light plant for Kirkcaldy. The Provost explained that the question for them to decide was whether or not the Council should take up the scheme. He felt warranted in saying that the scheme as prepared by Prof. Kennedy would pay, and he was in favour of the Council taking up the matter. The meeting agreed to remit the matter back to the Joint Committee to consider and report to the September meeting.

Glasgow.—A note in the *Daily Chronicle* on tramway extension and electric traction says: "The Corporation is carrying out very important extensions, running its lines into suburbs, and is now contemplating a still more ambitious scheme, for which powers will be sought in Parliament next session. It is also pushing forward with its electric equipment of the Springburn and Mitchell-street route 'as a demonstration of the overhead electric traction.' Arrangements are also being made to equip another line, and the cars are being built in Corporation workshops. The traction poles erected will be as ornamental as possible, and will be used as electric light lamps."

Barnsley.—Another open-air meeting was held under the joint auspices of the local Socialist society and Trades and Labour Council last week to protest against the proposal of the Town Council to hand over the right to establish tramways in the borough to a private company. The following resolution was declared carried: "That this meeting of ratepayers of Barnsley strongly condemns the action of the Town Council in proposing to hand over the projected tramways to private ownership, and we demand that they be established and worked by the Corporation." It was stated that a petition signed by 200 tradesmen and workmen had been presented to the Mayor, requesting that a public meeting should be called on the subject.

Taunton.—At a special meeting of the Town Council, the Electric Lighting Committee recommended the acceptance of a tender, amounting to £4,456. 16s. 2d., for the carrying out of certain work, subject to the sanction of the Local Government Board to the proposed loan of £11,500, but with power for the committee to arrange with the tenderers to at once carry out urgent works included in the tender, and also for the committee to proceed with the sub-station and a portion of the mains to supply the Staplegrove and Rowbarton districts, the whole of such urgent works amounting to about £3,000. The committee also recommended the acceptance of a tender, amounting to £1,525, for electric arc lighting. Both recommendations were adopted.

Birkenhead.—The special committee appointed to report to the Council as to the desirability of reconstructing and extending the system of tramways in the borough, and in regard to other matters in relation to tramways submitted a report at the Council meeting on Wednesday stating: "That the Council be recommended to instruct the Parliamentary Committee to incur all necessary expense, and to prepare, with a view to confirmation in the next session of Parliament, a provisional order or provisional orders, with plans, particulars, and other information, authorising the Council to lay down and maintain the various (nine) lines of tramways in the borough, and to equip the same as electrical tramways on the overhead trolley system, the Council working the tramways."

Brompton and Piccadilly-circus Railway Company.—The prospectus is now published of the Brompton and Piccadilly-circus Railway Company. An authorised share capital of £600,000 is to be issued in 60,000 shares of £10 each at par. The prospectus states that the Company was incorporated by Act of Parliament last year for the construction of an underground electric railway from the South Kensington Station of the Metropolitan and the District Railways to Piccadilly-circus. The line will be two miles in length, and will be laid in two separate tunnels. It will connect with the District line at South Kensington, and it is proposed to seek power to interchange traffic at the circus by a subway with the electric railway from Baker-street to Waterloo, now in course of construction, thus affording a communication with the South-Western Railway and with the Great Central line near Baker-street. There will be five intermediate stations on the route.

London United Tramways, Limited.—At St. John's Hall, Southall Green, on June 29 the scheme of the London United Tramways, Limited, to promote a light railway between Hanwell and Uxbridge, by way of extension of what they hope will be eventually a Shepherd's Bush-Ealing line, came before the Light Railway Commissioners, the Commissioners sitting being the Earl of Jersey (chairman) and Colonel Boughey, R.E. C.S I, with Mr. H. A. Steward as secretary. Mr. J. Clifton Robinson, C E., managing director and engineer to the Company, gave the formal and descriptive evidence in regard to the origin and the history of the Company's West Middlesex project and as to the quality of the road as a medium for a light railway with electric traction cars on the overhead wire system, and was cross-examined at considerable length. The Chairman said at the end of the enquiry that the Commissioners were prepared to recommend an order to the Board of Trade.

Foreign Orders.—The *Financial Times* has an excellent note on this point, which we quote *in extenso*: "We strongly advise representatives of British firms travelling in Russia to accept the advice of our Consul at Warsaw and call at the consulate in each town they visit in order that they may obtain and verify information. Other foreign travellers, we are told, take advantage of the invitation, and, of course, benefit accordingly by so doing. Our Consul does not seem too well pleased about certain hints he has thrown out not having been followed up to a practical issue. In February of this year he reported that the town of Warsaw was considering proposals for electric lighting, tramways, etc. This report, it appears, was reprinted in various trade and technical papers, but with characteristic indifference no English firms seem to have made any offers, although Belgian, German, and others are already to the fore. Seeing that Warsaw can boast of 600,000 inhabitants, the business is one of no mean importance."

Westminster.—At a meeting of the Vestry yesterday a resolution was passed concurring in the resolutions passed at the conference, held on June 14, between representatives of the London County Council and of London local authorities with reference to the telephone service; and also one in regard to the provision of generating stations for the supply of electricity in bulk. They also decided, pending the present enquiry by Parliament into the subject of the telephone service, not to grant an application of the National Telephone Company to open Piccadilly. A committee reported upon the action taken with reference to the communication recently addressed by the National Telephone Company to the large number of their subscribers whose telephone service has

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been disconnected as a result of the recent fire in Heddon-street, in which it was alleged that had the Vestry granted permission for wires to be placed underground, an accident of this kind would have been impossible. No objection was offered to the St. James's and Pall Mall Electric Light Company and the London Electric Supply Corporation proceeding with the laying of various mains and constructing street boxes.

Accident.—An accident occurred last week on one of the sidings of the new underground electric railway connecting Waterloo and the City, resulting in the death of one man and injury to another. A train has been run between Waterloo and the City for experimental purposes. At the same time a number of trains and carriages were standing in an uncompleted state, and were being worked upon by the contractors' men. On one siding stood a whole train, and a few feet off was a single carriage, which was tilted up to enable the fitters to work upon it. Between the stationary train and carriage two men were at work drilling holes for fitting the electric motor. The train from the City arrived at Waterloo, and was sent down into the depôt to have its air reservoirs filled, when it crashed into the stationary carriage and hurled it upon the train behind. The workmen had no warning of the danger, and were caught between the two carriages. Although help was immediately forthcoming, one of them (F. Farmer) was found to be dead, whilst the other (J. Moody) had to be removed to St. Thomas's Hospital. After treatment he was able to return home in a cab. It appears that either the train was sent on to the wrong siding or that the brake failed to act, and thus allowed the train to run back too far.

Hammersmith.—At a meeting of the Vestry on Wednesday last the Law and Parliamentary Committee reported that they had received a notice from the House-to-House Electric Light Supply Company, Limited, of their intention to apply for a provisional order for the supply of electricity for public and private purposes within the parish of Hammersmith. The Vestry Clerk presented similar notices received since the meeting of the committee: (1) from Messrs. Deacon and Co., of 9, Great St. Helen's, E.C., on behalf of the Kensington and Knightsbridge Electric Lighting Company, Limited; (2) from the Metropolitan Electric Supply Company, Limited. Upon the conference convened by the London County Council *re* telephone service, etc., the committee state that they are of opinion that while it may be advisable to maintain the veto of local authorities as to the erection of overhead wires, given by Section 14 of the Act of 1882, in respect of other electric wires, it is not advisable that in the case of overhead wires for traction purposes the local authority, other than the London County Council and county boroughs, should have an absolute veto. While due weight should be given by the Board of Trade to the representations of local authorities, the committee think that in the case of wires for purposes of traction it would be sufficient to give a *locus standi* to such local authorities.

Balmoral Castle.—The arrangements for lighting Balmoral Castle by electricity, already referred to by us, are now being carried into effect. The *Times* says during her Majesty's recent stay there considerable progress was made with the estate work in connection therewith. Half a mile of iron pipes of large diameter has been laid for bringing the water from the upper portion of the Gelderburn to the site of the turbine-house, which is situated near the old sawmill, about a mile and a quarter from the castle. In some places ways 12ft. deep had to be blasted through the rock for laying the pipes. Provision is being made for two Gilkes Vortex turbines, which, with a fall of nearly 80ft., will give 80 h.p. combined. This power will be utilised in driving the dynamos for charging a large battery of accumulators at the castle, and also for lighting the lamps direct. The current will be transmitted by large cables laid underground all the way. The electric light will at first be limited to the Queen's private apartments, the ball-room, and a few of the principal rooms in the castle, and the installation is expected to be in working order by the time her Majesty returns to the North next month. Eventually more than 600 lights will be installed in the castle alone, but if electric lighting is extended to the stables and outbuildings about 1,000 lights will be required. The whole of the work, with the exception of fixing the turbines, is being carried out by the commissioners' staff at Balmoral, assisted by some of the household electricians, under the direction of Mr. William Massey, of Twyford.

Cheltenham.—The ubiquitous Transatlantic gentleman, Mr. R. Bickerdike, of Montreal, has written to the Town Council to cable him an order for a tramway system. Another communication came from Mr. T. Nevins, stating that he was prepared to renew the application previously made by him for power to construct an electric tramway between Cheltenham and Winchcomb upon the following terms, provided he received the support of the Council—viz.: the line to be at least from the Great Western Railway Station, along Clarence-street, North-street, Portland-street, and Prestbury-road, to The Rising Sun, with any further extension in the town desired by the Council and agreed upon, and to Winchcomb through Bishops Cleeve, provided the consent of the County Council is obtained. The agreement between the Council and himself previously come to be adopted as it now stands. If the Council were prepared to accept his proposal, he would make the application forthwith, and commence construction of the line as soon as the necessary powers were obtained. On the proposition of the Deputy Mayor a special committee was appointed to consider and report on these applications. The Council resolved on Monday last to apply to the Local Government Board for sanction to borrow a further sum of £3,000 to cover the additional outlay for lighting extensions already sanctioned, and that application should be made to the Board of Trade to extend the electric lighting area to the borough boundaries, and to confer upon the Council power to borrow £25,000 for the purpose of carrying out the undertaking.

Edinburgh.—At the last meeting of the Town Council, according to the *Glasgow Herald*, Mr. Waterston asked, with reference to the delay in the tramway operations: (1) Were all the contracts issued in time for their reasonably being finished, and, if not, who is to blame? (2) Who is accountable for the great delay, what are the contracts now to be completed, and what steps are being taken or have been taken to secure that there shall be no further delay? (3) Was any definite system for working the cables at the junctions agreed upon before it was resolved to proceed with the work, and, if not, when was any system agreed upon, and is there any hope of its proving satisfactory? (4) Does the penalty clause in the agreement between the city authorities and the contractors (seeing that the contracts are still unfinished) cover the entire outlays up to this date, and is the clause to be enforced so that the city may be recouped for the loss of interest on the enormous sum of £401,538. 3s. already expended? The Town Clerk replied as follows: (1) The contracts were issued as soon as practicable after the resolution of the Council to proceed with the work. (2) It is expected that all the work will be completed in the spring of next year, and everything practicable will be done to secure this. (3) There was a definite scheme of working the important junctions explained to the committee at the outset, and subsequently detailed plans of these were shown. There is every reason to believe that the mode of working the junctions now being put in will be successful. (4) Interest is being charged on all the sums expended from the date when they were paid. Each contract is separate, and the operation of the penalty clause in it can only be considered when the work is completed or there is fault on the part of the contractor.

Parliament.—The Select Committee of the House of Lords, presided over by the Earl of Northbrook, has decided that the preamble of the Bill of the Chelsea Electricity Supply Company, Limited, was proved.—The Select Committee of the House of Lords have declared the preamble of the Electric Powers Distribution Bill proved. The Chairman said the committee were prepared to consider any clause which a corporation may suggest for the purpose of obtaining greater power than they now have in respect of the mains of the company going through the streets, when the company desires to take electric energy through the area of a corporation. The committee desired a clause to be inserted enabling corporations to take energy in bulk. The Chairman also intimated that it was desirable to have a clause limiting the period for the construction of the works at the main station, to show that the company were *bonâ fide* dealing with the district. It was also decided to draw up a clause empowering local authorities or private persons to approach the Board of Trade for a revision of the company's rates after a period of, say, five years.—The Bill by which the Manchester Carriage and Tramways Company seek power to work all their lines outside the city of Manchester and the borough of Salford electrically came before a committee of the House of Lords, presided over by Lord Northbrook, last week. The Corporations of Manchester and Salford have already got powers to run over their own lines. All the local authorities oppose on the ground that when the period for purchase arrives the terms will be unjustifiably enhanced. After hearing Mr. Pope, Q.C., for the promoters, and two witnesses, the committee threw out the Bill so far as related to the granting of power to work the trams by electricity.

Manchester Tramways.—A representative of the *Manchester Weekly Times* has interviewed the directors of the tramways company, and writes that much curiosity has been aroused as to the position of the Manchester Carriage and Tramways Company now that the committee of the House of Lords has found the preamble of their Bill not proved. It will be remembered that the Bill proposed to grant powers to the company to erect electrical plant in the out-districts and supply motor power to the tramcars. At the same time a clause was granted to the local authorities to the following effect: "Nothing in this Act contained shall authorise the use of any mechanical powers within the district of any local authority without the consent under the seal of such local authority, and in the event of such consent being obtained, then only in accordance with the terms and conditions of such consent." Recently, a representative of the *Evening Mail* interviewed Sir John Harwood, who is a director of the company, as to the position which it would now occupy. Sir John was very candid, and said that the Bill, if it had passed, would have been practically inoperative, for the clause which the company had granted to the local authorities made it so. The city itself was the key to all the positions in the out-districts, and without having powers to run to the city any company which worked from the out-districts could not hope to succeed. In view of the strong public feeling in favour of municipalisation, it was hopeless to suppose that the Manchester Corporation would give the consent required by the clause in the Bill; and, therefore, if it had passed it would have been useless to the company. "Then," said the representative, "municipalisation seems inevitable?" "There is no alternative," said Sir John. "That is the programme. To attempt to work outside the city, even if we get the consent of the local authorities, would not be wise. It is the journeys to and from the city and the short journeys in the city itself that are profitable." "Then the matter is simply as it was?" "Precisely," was Sir John's answer. Subsequently, the reporter met Alderman King, chairman of the Carriage and Tramways Company. It was rather premature to speak, he said, without previously conferring with his colleagues on the directorate. He agreed that the position was not very much altered owing to the clause in the Bill which required the consent of local authorities; but he declined to say whether it was

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likely that the company "would take any further action in their own interests." On enquiring among independent members of the Corporation, it was gathered that they considered the position satisfactory.

Darlington.—The report prepared by Prof. A. B. W. Kennedy, London, for the Corporation on the electric lighting of the borough has been received, and from the local papers we extract the following: "After opening with a preamble dealing with the electric lighting order which was secured by the Corporation in 1890, and the application this year for an extension of the first schedule of the Act to the whole borough (excepting certain detached portions), the conditions under which the Corporation are to supply electrical energy within the borough are recounted. The list of streets scheduled is, Prof. Kennedy says, a somewhat wide one, and he suggests that in starting the electric lighting scheme the Corporation should, in the first instance, lay mains in the following streets: Houndgate, Horse-market, Market-place, Tubwell-row, Crown-street, North-gate, High-row, Prebend-row, Bondgate, Woodlands-road, Stanhope-road, Coniscliffe-road, Skinnergate, Grange-road, Blackwellgate. In laying the mains for the supply of the districts mentioned, it would be preferable that the conductors should be of sufficient section to carry current for an extended demand, without the necessity of lighting the streets later on as the demand increased. It would be most advisable to adopt a continuous-current three-wire system, with lamps working at about 320 volts. This system Prof. Kennedy was now using at Chester, Edinburgh, and Aberdeen. There had been some talk of obtaining water power to some extent, but on examination into this it did not appear that there was any water power of sufficient magnitude to be taken seriously into account, or that would by its utilisation sensibly reduce the working expenses. Prof. Kennedy, therefore, proposed that the plant adopted should be of the ordinary type, worked by steam, the dynamos being driven direct by the engines, and a battery being provided to take the load during the long light hours during the summer, and also during the night. As to the demand, he thought that within a couple of years the limited area would take up about 7,000 lamps of 8 c.p. The plant required would be for about 400 h.p., and the cost of plant, with the land and engineering charges, he advised should be covered by borrowing £22,000. If a smaller plan were adopted to supply 5 000 lamps, the cost would decrease £3,000. He advised that the larger scheme be the safer to proceed with. The Corporation had power to charge 8d. per unit, but it would be undesirable to start with so high a price, and many corporations had fixed 6d. as the highest rate. Each lamp wired would use at least 15 units per annum in Darlington, thus giving an income of £2,625. The whole of the station expenses would not exceed £1,150 per annum, and the total outlay, including capital charges, would be £2,300 per annum, against the income of £2,625, leaving a profit of £325. These figures should be taken as being based upon the actual working of similar stations in the hands of corporations. The circuit of the Market-place, in addition to the High-row, might, he thought, be lit by eight arc lamps. There would be no difficulty in putting down plant at the station, which could be available for the purpose of supplying current to the tramcars if required.

Electric Lighting at Manchester.—The Electricity Committee have prepared a report of their work for the year ended March 31, 1898. The report states, according to the *Manchester Guardian*, that the number of consumers at the close of the year was 1,981, being an increase of 400 as compared with the previous year. The total number of lamps connected was—incandescent, 149,176 (of 8 c.p.), arc 1,399, as compared with 120,142 and 1,172 respectively. There were also 214 motors in use, representing 496 h.p., being an increase on the previous year of 92 motors, equivalent to 279 h.p. The total length of mains now laid is 80,102 yards, or 45 miles 902 yards of mains. The amount of energy measured and accounted for was 3,641 599, being 93 11 per cent. of the total generated at the works. The financial results of the year had been satisfactory. The net profit, after defraying all charges for cost of production, etc., providing for renewals, sinking fund, and interest on loans, amounted to £13,522. 17s. 4d. On Sept. 30 last the price of electrical energy was reduced from 6d. to 5d. per unit consumed, and the fixed charge to long-hour consumers was reduced from £9 to £7 per annum per unit of demand. The long-continued dispute in the engineering trade during the later months of 1897 impeded the construction of a large combined engine and dynamo of 2,500 h.p., which had been ordered from the Electric Construction Company, Limited, for delivery at Dickinson-street station in October last, and the committee were reluctantly compelled to issue a notice to the effect that no new applications for a supply of electric energy could be connected to the mains until the spring of this year. This action, although under the circumstances unavoidable, resulted in a serious loss of revenue to the department, and caused much disappointment to a large number of firms who had wired their premises in readiness for the electric energy. In order to cope with the increasing demand for the supply of electric energy for lighting and motive power the following extensions of plant had been ordered and were in course of construction for the Dickinson-street station—viz.: six Lancashire boilers, with mechanical stokers; four tubular boilers, two economisers, and two direct-driven electric generators, of 2,500 h.p. each. Progress was also being made with the extension of mains. Preparations were being made to supply electric energy in the districts of Moss Side, Withington, and Levenshulme during the coming winter. The committee had recently acquired an eligible plot of land alongside the canal in Stuart-street, Bradford, containing 41,955 square yards, which would be equipped as a generating station in due course; the ultimate capacity of this station would be about 100,000 h.p. In addition a plot of land in the Polygon, Ardwick, had been purchased, on which it was intended to erect buildings for the storage of cables and various instruments, also for workshops and transformer station. For the purposes of the foregoing and other extensions which were contemplated further borrowing powers would be necessary, and, in accordance with a resolution of the City Council, application had been made to the Local Government Board for sanction to raise an additional sum of £200,000. May 20, 1897, marked the commencement of arc lighting in the streets, on which date the electric energy was switched on to the arc lamps in Albert-square, St. Ann's-square, and Piccadilly. In compliance with instructions from the City Council, a considerable number of arc lamps would shortly be erected in many of the principal thoroughfares of the city.

Mechanical Engineers.—The summer meeting of the Institution of Mechanical Engineers will be held in Derby, and will commence on July 26. The following papers have been offered for reading and discussion: "Manufacture of Aluminium Articles, with Description of the Rolling Mills and Foundry at Milton, Staffordshire," by Mr. Emanuel Ristori, of London; "Water-Softening and Purification by the Archbutt-Deeley Process," by Mr. Leonard Archbutt, analytical chemist, Midland Railway, Derby; "Mechanical Testing of Materials at the Locomotive Works of the Midland Railway, Derby," by Mr. W. Gadsby Peet, chief of the locomotive testing department; "Electric Current for Lighting and Power on the Midland Railway, and driving direct by Electric Motor without Shafting," by Mr. W. E. Langdon, superintendent of the electrical department; "Narrow-Gauge Railways, 2ft. and under," by Mr. Leslie S. Robertson, of London; "Results of Recent Practical Experience with Express Locomotive Engines," by Mr. Walter M. Smith, of Gateshead. The directors of the Midland Railway Company have very handsomely granted to all classes of members of the institution, as well as to those candidates whose names are in the ballot list, and to those also from whom completed proposal forms have been received, the privilege of free travelling during the week of the meeting between Derby and any one station on the Midland Railway, and in the various excursions to places on the line. The following is an outline of the programme—July 25: the secretaries' office will be open from 3 p.m. to 6 p.m. in the Midland Railway Institute, Derby; at 9 a.m. on the 26th and 27th, and at 8.30 on the following days, for the registration of addresses, etc. Mr. R. Mountford Deeley and Mr. George J. Pratt will act as honorary local secretaries. July 26: 10 a.m., reception in the Midland Railway Institute, reading and discussion of papers; 1 p.m., luncheon at the Midland Railway Station, Derby, by invitation of the directors of the company; 2 p.m., visit to Derby works, open to the members; 6.30 for 7 p.m., institution dinner in the carriage department of the Midland Railway, Derby. July 27: 10 a.m., reading and discussion of papers; 1 p.m., luncheon at the Midland Railway Station, Derby; 2 p.m., visits to Derby works, open to the members, alternative excursion to Burton-on-Trent by special free train, on the invitation of Messrs. Bass, Ratcliffe, and Gretton, to visit their brewery; 1.35 and 3.15 p.m., alternative excursion to Duffield to see the model railway in the grounds of Duffield Bank, by invitation of Sir Arthur Percival Heywood, Bart. (in these and various other visits members may be accompanied by ladies, for whom railway tickets at reduced fares may be obtained at the railway booking office); 8.30 p.m., conversazione at the Derby Free Library and Art Gallery, by invitation of the local committee. July 28: 9 a.m., alternative excursion to Loughborough—special free train by invitation of the directors of the Midland Railway, visit the works of the Brush Engineering Company, thence by contractors' train over the new Great Central Railway to see the new Swithland waterworks of the Leicester Corporation (light refreshments by invitation of Mr. Alderman Wood, chairman of the Waterworks Committee); 9, alternative excursion to Stoke-upon-Trent and Milton, visit Messrs. Minton's china works, and by train to Milton to see the British Aluminium Works; 9, 9.30, or 10 25, alternative excursion to Nottingham—ordinary trains (free) from Derby Station to visit various works—cold luncheon at the George or Albert Hotels; 3.30 to 7 p.m., reception and garden party at Nottingham Castle and Museum, by invitation of the president. July 29: 9 a.m., excursion to Creswell Colliery and village by special free train; 10 and 11 a.m., drive through the Dukeries, cold luncheon at Welbeck Abbey, by permission of his Grace the Duke of Portland, G.C.V.O.; 6.15 p.m., plain tea at Mansfield.

Ealing.—The District Council have had a little family trouble, which really should never have been made public at all. However, as it has been published, we give the following account, which appeared in the *Acton and Chiswick Gazette*, this being the fullest report we have seen of the matter. We refrain from any further comment on the subject, and leave to our readers to judge for themselves upon the nicety or otherwise of the points involved. "The Trouble at the Electric Lighting Works.—The Electric Lighting Committee reported that it had carefully enquired into the complaints made by some of the officers at the electric lighting works as set out in a letter to *Lightning*, purporting to be signed by Messrs. Bush, Recano, and Saunders. The enquiry extended over several hours, and in consequence of what transpired at the first sitting, it was deemed advisable to obtain the original letter from *Lightning*. Upon the letter being submitted to Mr. Saunders, he adhered to a statement he had previously made, that the signature was not his. Messrs. Bush and Recano still maintained that the letter was signed by Mr. Saunders in their presence. The committee compared Mr. Saunders's alleged signature to the letter with other duly authenticated signatures of his, and found the former so unlike the latter that they

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felt obliged to accept Mr. Saunders's denial. The committee was, therefore, reluctantly compelled to come to the conclusion that under these circumstances the statements made by Mr. Bush and Mr. Recano could not be relied upon, and consequently the committee was of opinion that the charges made by these gentlemen were unproved. Desiring to act leniently, the committee recommended that Mr. Recano's resignation should be accepted, that Mr. Bush should be asked for his resignation, and that Mr. Saunders should be reinstated. Letters were received from Mr. Bush and Mr. Recano asking for their wages up to the 10th inst., and the Surveyor said these would, of course, be paid. Mr. Griffin said he thought the committee had come to a very proper determination, and he proposed that the report be adopted. Mr. Groome seconded. He was, he said, present at the proceedings, and he thought the committee acted in a very impartial manner. Mr. Norris agreed that, so far as it went, the committee conducted the enquiry patiently and fairly. He said 'so far as it went,' because he assumed that they were not discussing the grievances of the officers against Mr. Knight. He had hoped that Mr. Bush and Mr. Recano would have apologised, and that the Council might then have been merciful; but as they had not done so, the Council could do nothing in the matter except adopt the committee's report. Mr. Armriding: I think Mr. Norris forgets the more serious part of the business. The accusations of these men against Mr. Knight were very serious. Mr. Norris: We are not going into that. If we were I should have something to say. The report of the committee was then adopted. Mr. Tyer then asked whether Mr. Norris, after being present at the meeting of the Electric Lighting Committee, although not a member of that committee, communicated, by letter or other means, to any one of the employés of the Council whose conduct was the subject of the enquiry, the result of the deliberations of the committee, or in any way conveyed to him the decision at which the committee had arrived. The Chairman was a little doubtful as to the propriety of the question, but he eventually allowed it to be put. Mr. Norris said he did not see why he should answer the question. It would open the door to all sorts of other questions. Mr. Tyer: I think it would be to the satisfaction of the committee and everybody if you answered the question. Mr. Norris: Yes; I did communicate the result to one of these men. After the last meeting of the committee he ran after me and asked me, 'Can you tell me what was done?' I was disgusted with the whole business, and I told him as briefly as I could what had happened. I couldn't very well refuse, and I can't see that it matters what I told him. Mr. Tyer said it was a most important question, and he gave notice that at the next meeting he would move a vote of censure on Mr. Norris. The Chairman: As a matter of general principle I think all of us admit not only that members of the Council present at committee meeting should not divulge the decisions of the committee, but that even the committeemen themselves are not entitled to discuss outside or give information about their proceedings until they have been reported to the Council. Mr. Norris: I suppose I can ask whether members of the committee have discussed matters with Mr. Knight? There need be no end to these questions. The Chairman: It does open up a big field. Mr. Norris: If this sort of game is going to be started we can all play at it."

Bury.—A meeting of the members of the Bury Tradesmen's Association was held in the Bury Coffee House last week. Councillor Pickup, in the course of a lengthy address, stated that as tradesmen they might congratulate themselves that they lived in a town that was blessed with a forward policy on the part of the municipal authorities. Referring to the question of electric lighting, the speaker said he thought they would admit that they had got very good buildings and a very good plant. The expenditure in capital amounted to about £25,000; the buildings and site cost £7,000, plant and machinery already laid down at Whitehead Bridge £9,000, and the cables and mains already laid down and those agreed to be laid within the next two or three months would cost the remaining £9,000. They had had a year's work on which they had a loss of over £500, but when they took into consideration that the sinking fund and the interest on the capital expended amounted to over £1,100, they would see that on the first year's working they had lost about half the amount of the sinking fund and the interest on the capital expended, and in that sense they bore very favourable comparison with other towns. He was pleased to tell them that the Corporation were able to report progress. A year ago that night they had 3,100 8-c.p. lamps installed—they had doubled that figure in the year, and that night they had 6,400 8-c.p. lamps attached to the Corporation's electrical works. That was not a bad record. He now came to the question as to whether the Corporation ought to sell the electric light and electric current for power at cost price. Speaking for himself, he thought that they ought to put on one side a little reserve fund so that they could keep up their plant. Beyond that he did not think Bury ought to make a profit for those ratepayers who would not exercise the right they had in having the electric light. It was only fair that they should supply electricity for street-lighting at as near to cost price as possible, so as to give good lights in the principal streets of the town. If they would have confidence in the Corporation's system of charging, and shopkeepers would take the light, he undertook to say that when the advantages of the switches, the cleanliness and health of the rooms, were considered, electric lighting at the end of the year, if they also took into account the cost of beautifying, etc., was quite as cheap as gas, either in Bury or any other town. He then called upon Mr. Watson, electrical engineer, to explain the charts showing how the cost of the electric light was worked out. Mr. Watson said it was advisable, before considering the special conditions under which electricity was generated, to approach he question of costs with an open mind, and not to consider because in the case of gas it had been found expedient to charge all consumers alike at a uniform price, it must naturally follow that electric light being largely used for a similar purpose the charges should be made on the same lines. Electricity works, owing to the many difficulties in the storage of energy in bulk, must have plant capable of dealing with the greatest possible demand likely to be made for many hours at a time, and must, in addition, be amply provided with spare machinery to be called into use in cases of emergency. It would, therefore, be understood that the bulk of the 24 hours' income had to be earned during an average of less than three hours per day—that was to say, the yearly income was earned during about 1,000 hours' work, while for the rest of the 7,760 hours which made up the year the plant, and consequently capital, was unremunerative. To put the same idea in another form, he would mention that taking their output for last year, which was about 65,000 units, the plant installed at the works could generate that amount without difficulty is about a fortnight if used continuously. The standing charges made up some 90 per cent. of the total costs, while the remaining 10 per cent. represented the running costs. To illustrate what he meant he would take the accounts of the Bury undertaking for last year. The capital account stood at about £22,000, and the plant was capable of an output of 180 kw., or 180 units per hour. The maximum output reached was, however, only 90 kw., or at the rate of 90 units per hour. They had, of course, to pay interest and sinking fund on the whole of the capital borrowed, but for the sake of that illustration he had taken the capital as only £11,000, to coincide with the outlay necessary for plant capable of but 90 kw. output. The units sold for the year ending March 31 last were about 65,000, and the total revenue £1,300. The total costs would be made up as follows, assuming the capital to be £11,000: interest and sinking fund on £11,000, £550; other standing-by charges £625. £1,175; running costs—65,000 units at about ½d. per unit, £125; total costs, £1,300. As previously mentioned the largest output reached during the past year was 90 kw., or at the rate of 90 units per hour, therefore to make each consumer who used a portion of that plant which gave 90 kw. pay his fair and proper share of the expenses it was necessary to have a revenue of £1,175, or £13. 1s. per kilowatt used, to cover the standing charges plus ½d. per unit consumed for the running costs. Mr. Watson then explained the charts, and said that from those examples it would be seen that the losses on the short-hour consumers and the profits on the long-hour consumers were out of all proportion to the actual costs. In conclusion, Mr. Watson made a few remarks to aid shopkeepers in their endeavour to get a large number of units at 3d., or less than 6d., and said that no place of business keeping the usual closing hours could fail to get a large number of units at 3d. After some further discussion the proceedings concluded with a vote of thanks to Mr. Pickup and Mr. Watson for their attendance and explanations.

PROVISIONAL PATENTS, 1898.

JUNE 27.

14204. Improvements in electric batteries. Michael Martin Bair, 45, Southampton-buildings, Chancery-lane, London.

14211. Improvements in or relating to excitant solutions for electric batteries or the like. Arthur John Ward, 111, Hatton-garden, London.

14212. Telephone transmitter. Forest A. Ray, 24, Southampton-buildings, Chancery-lane, London.

14213. Improvements in dynamo-electric machinery. Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

14217. Improvements in electric miners' lamps. William Outterson Wood, 77, Chancery-lane, London.

JUNE 28.

14237. An improved electrical safety fuse and cut-out. Cecil James Cooper, Albert-road, Bournemouth.

14245. An improved method of generating electricity or other forces by the agency of compressed air and vacuum, such compressed air and vacuum to be obtained by utilising the rise and fall of tide or river flow. Francis Charles Southard, 47, Northam-road, Southampton.

14255. Improvements in electric telephony. Charles Adams-Randall, 63, Chancery-lane, London.

14293. Improvements in systems of electrical distribution. Reginald Belfield, 322, High Holborn, London. (Charles Felton Scott and Benjamin Garver Lamme, United States.)

14294. Improvements in regulation of rotary transformer direct-current electromotive force. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 10, 1898, being date of application in United States.)

JUNE 29.

14316. Improvements in and relating to dry and other galvanic batteries. Alfred Ernest Joseph Ball, West Hooe, near Plymouth.

14318. Improvements in dynamo-electric machines and motors. Sidney George Brown, 9, Queen's-road, Bournemouth.

14331. Improved diffuser and economiser of electric light. Samuel Thomas White, 16, Dean-street, Portland-square, Bristol.

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14361. Improvements in and relating to the coupling of alternating-current dynamos or alternators and the like. John Alexander McMullen, 323, High Holborn, London.

14362. Improvements in rising and falling pendants for gas, oil, or electric lamps. Edward John Shaw, 60, Queen Victoria-street, London.

14363. Improvements in electric switches. Chaimsonovitz Prosper Elieson and William Slater Naylor, 4, South-street, Finsbury, London.

14380. Improvements in electric batteries. Edgar Giglio, 6, Lord-street, Liverpool.

14399. Improvements in or connected with electric measuring instruments. Alexander Bewicke Blackburn and Wilfred L. Spence, 47, Lincoln's-inn-fields, London.

JUNE 30.

14427. A new or improved filament for electric incandescent lamps and process of manufacturing the same. English Industrials, Limited, and George Edward Heyl-Dia, 55, Market-street, Manchester.

14433. Improvements in electric bells and bell fittings. Burton Abel Phillipson, 10, Lower Baggot-street, Dublin.

14455. Improvements in secondary batteries. Thomas Albert Briggs Carver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JULY 1.

14513. A method of, and apparatus for, producing electrical spectacular effects. Charles Horace Cox, 10, St. George's-crescent, Liverpool.

14514. Improvements relating to switchboards. Charles Horace Cox, 10, St. George's-crescent, Liverpool.

14542. Improved means for attaching shades to electric incandescent lampholders. John Newton Moore, 24, Jasper-road, Upper Norwood, London.

14548. Improvements in electrical contact makers. Edward Wingfield Bowles, 6, Bream's-buildings, Chancery-lane, London.

14566. Improvements in electrical resistance devices. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Stralsunder Bogen-Lampenfabrik, Gesellschaft mit Beschränkter Haftung, Germany.)

14573. Improvements in suspension or hanging switches for electric lighting purposes. Leo Sunderland, 165, Queen Victoria-street, London.

JULY 2.

14599. Improvements in anodes employed in connection with the electro-deposition of metals. Fred Greenfield, 24, Temple-row, Birmingham.

14614. Electricity meter for alternating-current motors. Fritz Laarmann and Hermann Brockelt, 40, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

14022. Electric furnaces for the manufacture of carbides. Memmo.

14272. Compositions containing casein for electric insulating and other purposes. Hansen and Westengaard.

14421. Apparatus for supplying or measuring a current of electricity. Watson and Humphreys.

14568. Electrically lighted devices for advertising and other purposes. O'Brien and Grant.

15419. Electrical distribution fuse boards. Veritys, Limited, and Cottrell.

18289. Ignition of gas-lights by means of electric sparks. Urquhart. (Actien Gesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm, J. C. Spinn and Sohn and von Romocki.)

18371. Electric demand meters. Wright.

18666. Material for the manufacture of electric conduits. Hannay and Thom.

20781. Generation and distribution of electricity by means of alternating currents and appliances connected therewith. Atkinson.

1898.

264. Electric lighter for pipes, cigars, and cigarettes. Whittle.

3209. Electrical signalling apparatus. Leopold.

3368. Secondary batteries. d'Arbel.

7725. Holders for incandescent electric lamps. Huisman and Gover.

9154. Electric lamps. Hill and Peto and Radford, Limited.

9637. Process for the production of chemical compounds by electrolysis. Richards and Roepper.

9638. Process for manufacturing metallic sulphides electrolytically. Richards and Roepper.

9692. Resistance apparatus for regulating electro-motors. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

10333. Electric signalling and similar apparatus. Crandall.

10650. Electric arc lamps. Gilbert and Lundin.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended July 3 were £1,566, as compared with £1,416 in same week of 1897, being an increase of £150.

Birmingham Tramways.—The traffic receipts for the week ending July 2 were £3,900. 0s. 7d., as compared with £3 649. 7s. 7d. for same week in 1897, being an increase of £250. 13s. 0d.

Dover Tramways.—The traffic receipts for the week ending July 1 were £182. 19s. 4d. The total receipts for the year 1898 are £3,203. 15s. 0d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending July 1 were £2,884. 11s. 1d., compared with £2,461. 3s. 9d. for same period of last year, being an increase of £423. 17s. 4d.

South Staffordshire Tramways.—The traffic returns for the week ending June 24 were £620. 1s. 10d., as compared with £767. 0s. 0d. in same week of 1897. The aggregate receipts for the year are £15,101. 2s. 9d., as against £15,452. 19s. 7d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended July 3 were £988, compared with £1,031 for same week of 1897, being a decrease of £43. The total receipts for the half-year amount to £27,506, compared with £27,676 for the same period last year, being a decrease of £170.

Dublin S.D. Tramways.—The traffic receipts for the week ending June 30 were £663. 18s. 8d., as compared with £724. 2s. 3d. in the corresponding week in the previous year, being a decrease of £60. 3s. 7d. The number of passengers carried was 99,134 in 1898 and 102,975 in 1897. The aggregate returns up to date are £13,114. 7s. 1d., as compared with £13,924. 3s. 2d. last year, being a decrease of £809. 16s. 1d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	17-17½
—— 6 p.c. Cm.Pf.,30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2-2⅛
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	99-102 xd
Callender's Cable Company, Debentures	100	108-111 xd
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9⅞-10⅛ xd
——	6	5⅞ 6⅛ xd
—— Pref. Half-Shares	1	1-1⅛ xd
—— " "	5	4¼-4⅜ xd
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5⅞-6⅛
Chelsea Electricity Company	5	8-9 xd
—— 4½ per cent. Debentures	100	113-116 xd
City of London, Ordinary	10	25½-26½
—— Prov. Cert. 90,001-100,000	5	25-26
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	125-130 xd
City and South London Railway, Consolidated Ordinary	100	68-71
—— Ordinary	3	2⅞-3⅛
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15-16
—— " " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	12½-13½
—— " " " "	6	8-9
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅝ 2⅛
—— 5 per cent. Debentures	—	88-93 xd
Crystal Palace District, Ordinary 5 per cent. Stock	100	128-130
—— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103 xd
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	3¼-4¼
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	3⅛-3⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-108
Elmore's Copper Depositing	1	⅛ ¼
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	8 9
—— 7 per cent. Preference	5	9½-10½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	12-14
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120 xd
National Telephone, Ordinary	5	5⅝-5⅞
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5⅝-5⅞
—— 3½ per cent. Deb. Stock, Red.	100	101-105 xd
Notting Hill Company	10	14½-15½
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	7⅛-7⅜
—— £4½ shares	4	6⅛-6⅜
Oriental Telephone and Electric Company	1½	⅞-1
Royal Electrical Company of Montreal	—	141-144 xd
—— 4½ per cent. First Shares Mortgage Debentures	100	103-106 xd
South London Electric Supply, Ordinary	2	1⅞-2⅛
St. James's and Pall Mall, Limited, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	86-89
—— 5 per cent. Bonds	100	100-103 xd
Waterloo and City Railway, Ordinary	100	122-127
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8⅝-9⅛

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NOTES.

Newcastle "Lit. and Phil."—The Newcastle Literary and Philosophical Society appears to be a flourishing concern. They have just acquired the property adjoining their hall at a cost of £10,000.

Electrical Patents.—We are informed by the secretary of the Institution of Electrical Engineers that arrangements have been made with the Patent Office under which there will be placed on the library table at the Institution every Monday morning a copy of each electrical patent specification published during the preceding week. The specifications will remain on the table for three weeks, and will then be filed.

Travel and Entertainment.—We have received from Mr. W. Towle a little book with the above title. It consists of a well-written description of the hotels owned by the Midland Railway Company, and of the comforts to be enjoyed in them or in the luxurious dining-car trains on that line. The tariffs are most useful for reference, as are also the notes about places of interest in the various towns in which the hotels are situated.

The Pender Medal and Bursary.—At a recent meeting of the West of Scotland Technical College, held at Glasgow, it was announced that Mr. John S. Nicholson was to be awarded the Sir John Pender gold medal, and the committee on teaching and staff had also recommended that the Pender memorial bursary should in future be given to the most distinguished student of the year, and that this year it be awarded to the same gentleman.

Brussels Art Congress.—Information has been received by the Science and Art Department, through the Foreign Office, of a congress of public art which will be held at Brussels from Sept. 24 to 28 next. This first international congress on art has been organised by L'Œuvre Nationale Belge. The subjects to be discussed at this congress will fall under the three following sections: public art (1) from the legislative point of view; (2) from the social point of view; and (3) from the technical point of view. The address of the general secretariat of the congress is Hotel Ravenstein, Bruxelles.

The Conversazione. — We hear rumours that inadequacy of the refreshments at the conversazione this year was entirely the fault of the Ascot races. These races were fixed before it was known by the refreshment contractors that the Electrical Engineers would require to be catered for on June 16. The result was that the usual contractors had to call in outside assistance, and the new people were not conversant with the appetites of the average electrical engineer. Our information acquits from all blame both the council and the usual contractors, who are refunding about a half of their contract price on account of the dissatisfaction expressed.

Erratum.—In our note last week headed "Electricity at Earl's Court," the naval spectacle was referred to, and it was stated that the vessels engaged in the miniature naval battle were operated by cable paid out on board. This is not correct, as each vessel is large enough to contain one bluejacket extended full length. The motive power is provided by electric accumulators, which propel the vessel under the control of the commander, captain, first officer, gunner, engineer, and steersman in one. The manœuvres were arranged to comply with the naval service regulations, and have been highly spoken of by many of the highest naval experts. As Admirals Markham and FitzGeorge superintended the first 14 rehearsals, each commanding one fleet, the commendations were to be expected. Still, the display is greatly to the credit of Mr. Karl Leps, the inventor, and to Messrs. T. N. Singh and Co., who have the exclusive right of using the invention.

Guildhall School of Music.—A new wing of this school was opened by the Lord Mayor on Monday last. The extension shows a handsome stone front to John Carpenter-street, and consists of a theatre 47ft. wide, 55ft. long, and 30ft. high, fitted with a stage and all scenic appliances. The auditorium, which will seat about 900 people, is chastely decorated and brilliantly lighted. Beneath the theatre are dressing-rooms and a real green-room, while the upper floors are divided into 30 classrooms, which, it is hoped, will, with the accommodation in the older building, fully meet the demands of the 3,650 students at present in the school. The electric lighting was carried out by Messrs. Bergtheil and Young, under the supervision of Mr. W. C. C. Hawtayne.

The London Chamber of Commerce.—The sixteenth annual general meeting of the above Chamber of Commerce will be held in the hall of the Salters' Company, St. Swithin's-lane, Cannon-street, on Tuesday next, 19th inst., at 2.30 p.m. The business includes the reception of the report of the council for the past year and the statement of accounts. The meeting will proceed to elect a president for the ensuing year, to fill up vacancies in the council, appoint members of the council of reference, and to elect two honorary auditors. Other business, of which notice has been given, may also be discussed. We also note that Mr. Albert George Sandeman is to be proposed as president for the ensuing year, and that Mr. W. Curling Anderson, Colonel G. R. Birt, Mr. T. F. Blackwell, Sir Edward H. Carbutt, Bart., Mr. James Chambers, Mr. Frank Debenham, Mr. E. J. Gillespie, Mr. W. Becket Hill, Mr. A. J. Hollington, Mr. H. W. Price, Mr. J. Innes Rogers, and Mr. A. Serena are to be proposed as members of the council.

What we can do.—Prof. Gray is responsible for quoting the following poem, if not for its authorship:

In the olden time, along the street,
A glimmering lantern led the feet,
When on a midnight stroll;
But now we catch, when night is nigh,
A piece of lightning from the sky,
And stick it on a pole.

Time was when one must hold his ear
Close to the whispering voice to hear,
Like deaf men, nigh and nigher;
But now, from town to town he talks,
And puts his nose into a box,
And whispers through a wire.

In other days we took a car
Drawn by a horse, if going far,
And felt that we were blest;
But now the conductor takes the fare
And sticks a broomstick in the air—
The lightning does the rest.

House-Moving Made Easy.—The *Financial Times* publishes extracts of a patent issued to Harry J. Lawson in 1896 for an automotive house. The text is amusing, and the claims are as follows: (1) a portable house or structure of the nature described; (2) a house containing within it the motor by which it travels; (3) an automotive house; (4) a house capable of travelling by its own power as distinguished from a caravan or similar vehicle adapted to be drawn by horse or other independent power. Rapid motion is not a point of the inventor. The idea opens out many delightful prospects, as Mr. Lawson wishes to make large movable houses, and not merely auto-caravans. Thus, in the event of these houses becoming fashionable, we shall hear in the daily intelligence that No. 26, Portland-square has moved to Eastbourne for the summer, or that the Law

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Courts got jammed in trying to get out to Clapham Common for the annual spring cleaning. Eligible standing sites at the seaside will go up in value like the house-boat stands at Henley.

Series Arc Lamps on a Railway Circuit.—The following remarkable and unique incident has recently been reported from Kansas City. On Saturday, May 14, this town was visited by a very severe hailstorm. The ground was covered with hailstones, the smallest being about the size of moth balls, and ranging from that size to 2½lb., and somewhat larger than door knobs. As can be imagined, the electrical wires suffered materially. At about 10.30 on Sunday morning the station manager at the plant of the Kansas City Electric Light and Power Company was surprised to receive a telephonic enquiry of "Why don't you shut down your arc circuit?" An investigation showed that three arc circuits had become crossed on the trolley and that 30 arc lights had been burning since 5.30 a.m. As it happened, the lamps got the current "upside down," and the result was 30 beautiful examples of the heating effect of the electric arc and 30 lamp bases molten into as many lumps of brass. The above details were supplied by Mr. J. L. Morgan, the city electrical engineer, to our New York namesake.

War Tax on Telephones.—The Spaniards are not the only nation to tax electrical properties for the present war, as we find that the United States expect to raise about £140,000 per annum by their tax on telegraph and telephone messages. The tax in the case of telegrams amounts to one cent, or, say, ½d. per message, while a similar charge is made for all trunk-line messages on the telephone. In the first case the collection is effected by the issue of one cent stamps which have to be affixed to each telegraph message. In the telephone system the collection is not so easy, and the regulation for this purpose reads as follows: "Telephone messages: It shall be the duty of every person, firm, or corporation owning or operating any telephone line or lines to make within the first 15 days of each month a sworn statement to the collector of internal revenue in each of their respective districts, stating the number of messages or conversations transmitted over their respective lines during the preceding month, for which a charge of 15 cents or more was imposed, and for each of such messages or conversations the said person, firm, or corporation shall pay a tax of one cent; provided that only one payment of said tax shall be required, notwithstanding the lines of one or more persons, firms, or corporations shall be used for the transmission of each of said messages or conversations."

Foreign Lessons.—We are never too prone to advocate the importation of foreign methods and customs into our ways of dealing, but although "they don't know all things down in Judee," they now and then strike upon a thing worth imitating. Just now an industrial association has been formed in Belgium which intends to achieve through private enterprise what the Imperial Institute would do here if that "white elephant" did not so notoriously fail to effectually serve the purpose for which it was created. Offices will be opened in foreign ports to collect the information required by manufacturers and dealers of all kinds, and reports will be issued periodically to tell them where best to buy or sell. Sample-rooms will be established where anyone may get information referring to exporting firms, and where samples of the special requirements of the various foreign countries will be shown and detailed information supplied. The members of the association are classified into 14 sections, and from the programme just issued in the *Bulletin Commercial* it appears that Section 1 (called the mechanical section) embraces machinery and material for all industries, while the second section is given entirely to electricity, and the third to railways, including rolling-stock. The fourth deals with metallurgy, the fifth with public works, the sixth with building materials, and the twelfth with indiarubber and chemicals.

Clark Standard Cells.—The following is an abstract from the *Journal* of the Chemical Society of a paper on the "Variation of the E.M.F. of Different Forms of the Clark Standard Cell with Temperature and with Strength of Solution," by Hugh L. Callendar and H. T. Barnes. The authors describe a lengthy series of experiments carried out with different forms of the Clark standard cell. A modification has been adopted which is termed the Board of Trade "crystal" cell, in which the cell above the mercurous paste is filled with moist crystals, instead of with saturated solution. These cells have no appreciable diffusion lag, and are not surpassed in quickness by any other form. Over the range 0deg. to 28deg. we may take the formulæ $E_t = E_{15} - 0{\cdot}001200\ (t-15) - 0{\cdot}0000062\ (t-15)^2$, as representing the temperature variation of the E.M.F. of these cells within about one-twentieth of a millivolt between these limits. Several forms of hermetically-sealed cells are described of a W or an inverted Y pattern. Determinations have been made of the densities of zinc sulphate solutions and of the solubility of zinc sulphate at different temperatures. At about 38·8deg., a break in the solubility curve and a change in the continuity of the curve representing the temperature variation of the E.M.F. were observed, and referred to the change of the hydrate $ZnSO_4 + 7H_2O$ to the hydrate $ZnSO_4 + 6H_2O$.

Money is Power.—A new version of the old story of "tips *versus* duty" was heard recently before Judge Addison, of the Southwark County Court. The defendant was the electrician at a London music hall, of whom it may not be said that he loved darkness for its own sake, but who certainly nearly caused a performance to take place in an atmosphere of invisibility all on account of a "tip" which he thought due to him. When Mr. Cinquevalli had finished an engagement, the electrician expressed the hope in the usual altruistic manner, accompanied by the invariable apologetic cough, "that everything had been satisfactory." The reply was in the affirmative, with the added remark that he would leave a souvenir with Mr. So-and-So behind the scenes. This consisted of a sovereign, and the engineer considered he was entitled to a share of it, but to his chagrin the others divided it among themselves. Hence the darkness. He asserted that the "boys" had "done him" out of his money—meaning tips—on several Saturdays, and, of course, he was in a temper. He accordingly left his place without notice, and the manager was thus compelled to hire a substitute at considerable expense, and sued for damages. The electrician sorrowfully admitted that, owing to "temper," he was out of place and out of tips, and had no means of paying the 30s. to which his Honour thought the management were entitled. The Judge thereupon reduced the fine to 10s.

American Lightning.—The history of the effects of lightning on men and things is neither consecutive nor concordant. Thus artists for generations have known exactly what a flash of lightning looks like, and have painted accordingly, but the camera has failed to corroborate their representations. Next we came to lightning guards, and here again experts differ, and what in one case is considered to be perfectly safe may in another be absolutely dangerous. Still, the records of what is said to have happened through the agency of lightning are interesting, and those given below from the columns of the *Electrical World* are especially so. Thus "it was reported some time ago that

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a bolt of lightning struck a tree standing in a yard near Nevin, the tree standing near a large pond; shortly after the bolt of lightning the water began receding, and in a few days afterwards the pond had entirely disappeared. In another case which was reported in a religious paper, the lightning was said to have struck the side show of a circus containing both black and white persons in the audience, and it killed every negro, but not a single white person. In another case in Nyack, lightning 'violently removed' a slipper from a girl without injuring her. The *Norristown Herald* some time ago had the following: 'Someone says that a man who is struck by lightning cannot swim. He does not want to swim. What he needs in nine cases out of ten after being struck by lightning is a cheap and unostentatious funeral.'"

Tramway Paving.—The question of the paving of the space between the tramlines in Sheffield has caused some trouble, and, if we remember rightly, some outside experts were inclined to give free advice to suit the purpose of certain obstructive members of the Council. At any rate, the proposal to use macadam was brought forward, and Mr. C. F. Wike has had to condemn the proposal in strong terms. He points out the impossibility of keeping an even surface to the road where there are macadam and setts, but it would be far worse if the setts were abandoned, because (*a*) the rails and macadam are of different degrees of hardness; (*b*) it is scarcely possible to make a good joint between the two; (*c*) the vibration of the rails would soon shake the macadam loose. The road would have in consequence to be almost constantly under repair, causing additional expense as well as inconvenience to frontages along the routes. Again, the macadam between the rails could not be satisfactorily rolled, and would always be loose. It would be difficult to put down on account of the setts or rails. It would soon wear hollow and hold the water. On gradients this hollow would in times of heavy rain act as a watercourse, and the macadam would gradually be washed away. Further, the track could not be properly cleansed, and it would be nearly impossible to keep the rails free from mud in wet weather. This is much more important with electric traction than with horses, and the rails would wear much more quickly.

Magnetic Leakage in Dynamos and Motors.—Mr. Rothert contributes to the *Elektrotechnische Zeitschrift* a long article discussing the subject of leakage as far as it concerns the designer. He gives the law of the magnetic circuit in the following terms: "Every line of force must be encircled by as many ampere windings as correspond to the sum of the magnetising forces, expressed in ampere windings, of all the individual parts of its closed path." The magnetic circuits will close themselves through the nearest path of least resistance; this is discussed and illustrated, showing that the law is analogous to Ohm's law. He discusses the leakage in various apparatus; for transformers he uses the well-known Kapp diagram, showing how the leakage may be graphically deduced therefrom; in well-constructed transformers the leakage is of very little importance, and he dismisses it briefly. In multiphase motors, which he discusses at some length, the conditions are the same as in the transformer, except that the leakage is quite great and the quantities in the diagram are vector quantities; the amount of the leakage in such motors is a very important factor for the constructor; he shows that the solution offered by Kolben some years ago and now generally accepted is not always correct—namely, that the number of "ampere wires" per cubic centimetre of the periphery of the armatures should not exceed 100 to 150. The results for multiphase motors are readily applied to single-phase motors, in which the leakage is of still greater importance. He then discusses multiphase and single-phase generators, concluding briefly with continuous-current machines, which are merely special cases of the others in which the frequency is very small, so that the leakage is in general quite small; for the leakage from the magnets it has been customary to assume a certain leakage factor for each type, but this, he shows, is not correct, as it will vary quite appreciably in different machines of the same type, depending upon the size of the pole-pieces, the air-gap, the excitation, etc., and it is therefore better always to calculate the leakage; in one case he found it to be 3 to 5 per cent., and in another 30 per cent. The above abstract of the paper is taken from Mr. Carl Hering's digest in the *Electrical World*.

The North-Western Electrical Association.—This American association held its annual meeting last month, and arranged for it a trip by steamer from Chicago to Lake Superior and back. This trip lasted nearly a week. At the principal towns a halt was made and a few papers discussed. Another feature of the meeting which seems to us to be novel is that of having a question box into which questions likely to lead to technical discussion could be placed. Thus one question read: "What success has been realised in substituting incandescent lamps in place of wire resistance in direct-current enclosed arc lamps?" In reply, Mr. J. W. Mabbs, of Chicago, stated that he had had some experience in that line, having placed six 10-c.p. lamps in multiple with each other and in series with the arc, each incandescent lamp consuming about one ampere, the whole giving very good results. The incandescent lamps had an initial economy of about four watts, the breakage of any one still allowing sufficiently low wattage in the other five to prevent their all giving away at once; the burning out of two, however, generally burned out the whole group. Another speaker mentioned the experiments carried on in Hartford, where about 50 arc lamps were connected up in that way, the incandescents being sold at specially low rates for the illumination of passages, stairways, etc. Another question was as to whether "On an overhead three-wire system of low-tension distribution, does it afford additional protection against lightning to ground the neutral wire at various points throughout the system?" On the president's request, Mr. Wurts gave his opinion on this matter as follows: "The grounding of the middle wire, if effected near the station, might and probably would protect the generator against lightning discharge coming in over that wire, but would not affect the liability of damage from the two other wires. To protect all the apparatus on the circuits from lightning discharges on the neutral wire, this wire should be frequently grounded. In other words, the grounding would practically relieve one of the necessity of placing lightning arresters on that wire near the point where grounded." These replies we take from the columns of the *Electrical World*, and they show how valuable such a question box may be.

Liverpool Self-Propelled Traffic Association.—The report of the second session of the Liverpool branch of the above association was presented at the annual general meeting held on Tuesday last, and it shows that the branch is loyally carrying out the objects of the parent association. At the meeting votes of thanks were passed to the retiring officers, and also to the Rules Sub-Committee, the judges, the observers, the Mersey Docks and Harbour Board, Mr. John Thos. Wood, and others for their valued assistance in connection with the trials of motor heavy traffic. The work of the first session was opened by Mr. Worby Beaumont, who delivered an inaugural address entitled "Self-Propelled Vehicles, 1896-97," in the course of which the progress made during the previous 12 months was

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reviewed. The other papers read were as follows: "Roller Bearings," by Mr. W. Hugh Woodcock, M.I.C.E.; "Some Points in the Design of Automobile Vehicles intended for Heavy Traffic," by Mr. Geo. Herbert Little; "An Account of our Trials and Experiments, with the Conclusions drawn therefrom," by Messrs. D. H. Simpson and W. L. Bodman; "Steel Springs," by Mr. Joseph Bedford; "Recent Improvements in Accumulators and their Application to Traction on Common Roads," by Mr. J. T. Niblett, M.I.E.E.; and "The Arrangements for the May Trials," by Mr. E. Shrapnell Smith (hon. local secretary). The report contains a brief *résumé* of the recent trial of heavy motor vehicles, but the report of the council on the subject is not yet finished. Still, the results of the recent trials are regarded as so highly satisfactory that it has been decided to organise another series of trials of motor vehicles for heavy traffic to take place in the month of September of next year. The following resolution was unanimously adopted by the council at a meeting held shortly after the recent trials: "That the Liverpool council of the association is of the opinion that the existing maximum of three tons tare imposed by the Locomotives on Highways Act, 1896, very seriously hampers, and in many cases prohibits, the construction of vehicles of the types required for the heavy traffic of this district, and a recommendation is hereby made to the general council that the whole forces of the association shall be immediately directed towards the obtaining of an amendment to the Act, whereby (*a*) all restrictions upon weight shall be removed; or, if it be deemed inexpedient to remove all limitations, (*b*) a limit upon the total moving weight, or upon the weight per axle, shall be substituted for the present limit of three tons tare; or, if it be considered imperative to retain a limit upon the tare, (*c*) the tare permissible shall be increased to at least four tons." It is hoped that joint action will be taken shortly to give effect to one of these clauses.

The Waterloo and City Railway.—The Duke of Cambridge formally opened this railway on Monday last, but the ceremony was evidently somewhat too early, as the public will not get the use of the line for two or three weeks yet. The Duke arrived at Waterloo, and was, with other guests, taken to the City and back again to Waterloo by the trains on this new line. The journey each way was performed in about five minutes, but this does not represent the possible speed, as we believe the record at present stands at about 3 minutes 20 seconds. After the double journey the Duke was entertained at lunch in the booking hall of the new line at Waterloo. Two trains were required to take the company to and fro, and both gave every satisfaction in working. In fact, the many small details which conduce to smooth running on a new railway are now being settled; and the company commented on the running of the trains. The atmosphere in the carriages was all that could be desired, and the absence of vibration and the provision of good light rendered reading at all times possible. We notice that many of the daily papers speak of the lightness of the carriages, but in reality they are heavy, and this contributes in no small degree to the absence of small vibrations. In fact, the whole construction and equipment of the line does great credit to all concerned. We, as an electrical journal, naturally put the excellent work supplied by Messrs. Siemens Bros. and Co. in the foreground. In the design of the electrical gear great originality has been shown, which we shall refer to in detail at a later date. One special feature is the series-parallel controller, and another the automatic switch which cuts off the current if the engine driver proceeds against signals. The congratulatory speeches which followed the dinner showed that the magnitude of the work accomplished was duly recognised by those in authority. The guests included, beside the Duke of Cambridge, Lord Stalbridge, Lord Colville of Culross, Earl Russell, the Earl of Lauderdale, Mr. H. M. Stanley, M.P., Mr. C. A. Cripps, M.P., Sir F. Dixon-Hartland, M.P., Mr. Aird, M.P., Mr. E. Hubbard, M.P., Sir Courtenay Boyle, Sir Francis Marindin, Colonel Yorke, General Albert Williams, Sir J. Whittaker Ellis, General Sir C. Du Plat, Sir Douglas Galton, Sir Charles Scotter, Sir J. Monckton, Sir Henry Oakley, Sir Allen Sarle, General Marshall, Sir R. Farrant, Sir Benjamin Baker, Sir Alexander Binnie, Mr. W. H. Preece, Mr. L. V. Harcourt, Mr. C. Steel, Mr. A. Ross, Mr. Alexander Siemens, Mr. J. F. S. Gooday, Mr. Charles J. Owens, Mr. Fred. J. Macaulay, Mr. G. T. White, Mr. George Dixon, Captain G. H. Lewis, Mr. J. E. Hawkins, and many other officials representing the London and South-Western, the Waterloo and City, and other railway companies.

Obituary.—Another distinguished electrical man has joined the great majority. We refer to Dr. Cornelius Herz, although that gentleman's political fame at last exceeded that in electrical matters. He was born at Besançon in 1845. His parents were of German origin, and when he was but four years of age they emigrated to America, and nationalised themselves. Dr. Herz was, therefore, always an American citizen, and, indeed, served as a lieutenant in the United States Army. When the Franco-German War broke out he served as surgeon-major on the staff of General Chanzy, and was made Knight of the Legion of Honour for his distinguished services. Soon after the war he returned to America, and for a time gave himself up to medical work. His attention, however, had been drawn to the adaptation of electricity to practical purposes—a subject then in its infancy—and he founded the Californian Electrical Works. Again he came back to France, and at once became the head of the great movement for extending the use of electricity, which had its headquarters in Paris. Of his overwhelming activity at that time some idea may be gleaned from an account of his labours given in an article by Sir Edward Reed, which appeared in the *Fortnightly Review* of January, 1897. "In 1878," says Sir Edward, "he created and was elected president of the well-known French syndicate of electricity, which founded vast electrical organisations in Europe, and culminated in the great scheme worked out by Dr. Herz and carried out by the French Government at his urgent request—the first International Exposition of Electricity (Paris, 1881), that marvellous record of the scientific progress of the age. He founded and edited the first scientific reviews on electricity, *La Lumière Electrique* and the *Journal d'Electricité*. At this time he also, with the most important banks of Paris, founded societies for electric lighting and for telephony in many European countries. In conjunction with the banking house of Rothschilds, the Northern Railway of France, and the Creuzot Works, he established the Society for the Construction and Maintenance of Electrical Machinery, Apparatus, Cables, etc., the Society for Brazing by Electricity, the Society for the Manufacture of a Special System of Small-bore Guns, the Society for the Application of Electric Light to Railway Trains, the Society for the Construction of Telephonic Apparatus, etc. He was the originator and principal founder of the Society for Working the State Telephonic-Telegraphic Trunk Lines, with a capital of 100,000,000fr., a gigantic scheme to interconnect the 36,000 communes of France by a perpetual day and night uninterrupted telephonic-telegraphic service, and to connect villages and the smallest hamlets at a uniform rate

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(names and addresses free) of ½d. per word." This list does not exhaust, it only illustrates, the colossal industry of the man. He was raised to the rank of Commander of the Legion of Honour in France in 1878,and made Grand Officer in 1886. He received high distinctions from the Government of Bavaria, from the King of Italy, and various learned societies in the world.

Light Railways Act.—In the House of Lords on Tuesday last the Earl of Camperdown drew attention to some faults he had noticed in the procedure under the 1896 Light Railways Acts. He said that by the Act power was given to the Board of Trade to confirm or alter orders made by the Commissioners for the construction of light railways, and such orders when confirmed had the effect of an Act of Parliament. When the Act was passing through the House objection was taken to the want of definition of a light railway, but still the Act became law, leaving the Board of Trade absolute power to say what was and what was not a light railway. Though Parliament had surrendered its powers in reference to light railways, it had not at the same time surrendered all interest in the subject, and so when the report was laid before the House it was right and natural that the House should consider how far the intention of the framers of the Act had been carried out. For that purpose it was necessary to know not only the orders as confirmed, but the orders as proposed by the Commissioners, with the modifications made by the Board of Trade. Three orders were laid on the table of the House in 1897, and three more in the present year. In regard to everyone of those orders the Commissioners were of opinion that continuous brakes were not required, and in everyone of those cases the Board of Trade had incorporated continuous brakes. Then, with regard to signalling. In all those cases the Commissioners were of opinion that no signals were required except at places where the lines joined a main line of railway. In all those cases that clause of the Commissioners had been struck out, and clauses had been inserted proposing signals of different sorts. He thought he had said enough to show that in some of the essential principles the Board of Trade had departed from the recommendation of the Commissioners. He would like to know by what tribunal these alterations were made, how far the opinions of the Light Railways Commissioners were taken into consideration, and whether they were consulted as to the alterations before they were made. He moved that the orders of the Commissioners as submitted to the Board of Trade be in future presented to this House together with the orders as confirmed by the Board of Trade. Earl Stanhope, in supporting the motion, said the result of the amendments of the Board of Trade was that these light railway schemes were hung up indefinitely. The Earl of Dudley said that the Board of Trade agreed that care should be taken not to strangle or stifle light railway enterprises. Although the public were aware of the requirements of the Board of Trade, the applications for orders instead of decreasing had been increasing, and the Board had been asked to sanction more than 1,000 miles of light railways throughout the country. It was said that the Board had insisted on continuous brakes where the Commission had not thought them necessary. But in many cases the promoters had said that no matter whether the Board of Trade insisted on continuous brakes or not, they intended to use them, because without them the manager of the line ran great risk of accident and criminal prosecution in cases of accident. But the Board of Trade being responsible for the public safety must lean more to stringency than laxity. The Light Railways Act specially placed on the Board of Trade responsibility in this respect, and although the Board had every respect for the able work of the Light Railways Commission and the views they put before them, the Board could not divest itself of the responsibility Parliament had imposed upon it to take every precaution against the possibility of accident. The speaker then dwelt on the satisfactory relations existing between the Board of Trade and the Light Railway Commissioners, and the motion was negatived by consent.

Mr. W. H. Preece on Telephones.—Mr. Preece's evidence before the Select Committee is worthy of careful reading, as is evidenced by the following abstracts. Thus, comparing the telephone service in Germany with that in England, Mr. Preece said that, taking the countries as a whole, and comparing the population with the number of instruments, we are in advance of Germany. He admitted that in certain towns in Germany—Berlin, Hamburg, and Cologne—the telephone had been developed to a phenomenal extent, and there they are far in advance of us. But, taking the country as a whole, we are not in so bad a position with regard to other countries as has been represented. Continuing, Mr. Preece said that not only were some German cities much in advance of us, but the rates were lower. This was explained by the fact that the telephones in Germany were in the hands of the Post Office, which was unhampered by any restrictions. In Germany, however, no night service was given. Mr. Preece condemned the automatic exchange, but not for mechanical reasons. The invention had been on its trial for 20 years in America, and had been constantly improved. The latest form was a beautiful piece of mechanism. But one of the objections to this arrangement was that the subscriber could not tell whether the person he called was out of his office or whether the instrument had broken down. He was abreast of the technical literature of America, and he could find no trace of an extension of the automatic system in America. He was entirely of opinion that there should be a very much greater development of the telephone system in this country, and especially in the direction of allowing payment by message to be made. That system had been a great success in New York, where it was worked by a company, and the number of subscribers continued to increase enormously. The Post Office was only too anxious to have an opportunity of extending the telephone service, but it required a free hand. He was strongly opposed to licenses being given to municipalities as further complicating a very complicated question. Mr. Preece put the case very clearly when he stated that the desire to hand over the telephone service to the municipalities was based on three assumptions. First, that the Post Office could not do the work properly and cheaply; secondly, that the Telephone Company did not do the work properly; and, thirdly, that the municipalities could do the work better and cheaply. All these three assumptions were wrong. The Telephone Company were doing the work most perfectly; and they could only compete with the Post Office in Leicester, Newcastle, and Hull by making their system equally efficient. In those towns they had adopted the metallic circuit. Wherever the company was allowed to lay its wires underground they did their work as well as it was done anywhere abroad, and certainly better than in Germany. Again, whatever were the difficulties and anomalies of the present arrangements, where there were two parties concerned, they would be greatly intensified by the introduction of a third party. Ultimately the Post Office would have to buy two systems instead of one. He thought that one reason why the telephone system had not spread much in London was that the local telegraph system was so magnificently organised.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXVI.

According to the usual and approved method of construction, if the total number of plates in an accumulator be (n), the number of peroxide plates will be $\frac{n-1}{2}$, and the number of spongy-lead plates $\frac{n+1}{2}$. But, from what has been above stated, it will be seen that the aggregate capacities of each set of plates, and the areas of their active surfaces, should be proportionate to $(n-1)$, and should thus be equal. Moreover, if the weights, per unit surface of the grid or other conductive supports, and of the active materials, be the same in the two cases, the weight of the $\frac{n-1}{2}$ peroxide plates will be equal to that of the $\frac{n+1}{2}$ spongy-lead plates. In this simple case—which possibly may sometimes occur in practice—the total weight of the lead supports will be $w \cdot a\,(n-1)$, where (a) is the area of each plate (not the area of its two surfaces) in square inches; and the total weight of active material (of both kinds) will be

$$\left(p_1+\frac{p}{2}\right)\times 2\,a\,(n-1).$$

If the plates be ordinary grid elements, $p_1 = 0$, and the weight of active material becomes

$$p\,a\,(n-1)=(6{\cdot}56\ t-w)\,\frac{\text{sp. g.}}{11{\cdot}14}.$$

Thus, in the case under consideration, the total weight of the peroxide and spongy-lead plates in a cell or battery will be

$$(w+2\,p_1+p)\,a\,(n-1).$$

If to this we add the weight of electrolyte, the sum will be the total weight of the contents of the cell or cells. Now, if the electrolyte be dilute sulphuric acid of specific gravity 1·265, becoming ultimately reduced to specific gravity 1·145, the volume of this acid corresponding to one ampere-hour (CVIII.) is 1·015 cubic inch, or, say, one cubic inch. And the weight of one cubic inch of acid of the above initial specific gravity will be the weight of a cubic inch of water multiplied into this specific gravity, or ·577 × 1·265 = ·73oz. Now the mimimum weight of peroxide of lead we allow per ampere-hour (III.) is ·53 × 1·155 = ·612oz.; and, according to this, the weight of electrolyte should be 1·2 times the minimum weight of peroxide active material. Or if, as in the present case, the weight of the spongy-lead active material is the same as that of the peroxide material, the weight of electrolyte per square inch of peroxide surface should be ·6 times $2p_1+p$. And thus, in this case, the total weight of the contents of a cell is

$$\mathfrak{W}=[w+(2\,p_1+p)\times 1{\cdot}6]\,a\,(n-1)\ (\text{oz.}).$$

But for the more usual case in which the weights (w and w_1) of the grids or other supports for the peroxide and spongy-lead active materials respectively are not equal, and in which the weights of these active materials may also be unequal, the formula for the weight of a cell, exclusive of the containing receptacle and accessories, becomes

$$\mathfrak{W}=\left[w+w_1+\left(p_1+\frac{p}{2}\right)\times 2{\cdot}2+s_1+\frac{s}{2}\right]a\,(n-1).$$

Here s = the weight of spongy lead within the perforations of the support; and s_1 (a value which, like p_1, disappears in the case of an ordinary grid "pasted" in the ordinary way—*i.e.*, not embedded in active material) is the weight of spongy lead external to the perforations. The weight of electrolyte allowed is 1·2 times the weight of peroxide active material, the electrolyte being initially of specific gravity 1,265, containing 34·7 (N) per cent. of H_2SO_4, and, finally, of specific gravity 1,145, containing 19·6 (n) per cent. of H_2SO_4.

CXVII.

In designing light cells for traction purposes, and more particularly for traction on common roads, the temptation to adopt a very high ratio of weight of active material to weight of conductive support must be held under careful restraint, and yielded to with great caution. By thus "increasing the proportion of active to inert material," striking *primâ facie* results—high ratios of capacity to weight—may easily be obtained; but recent experience has shown that the results so obtained cannot be permanently maintained under the conditions of practice. When the weight of the lead conductor is insufficient, the latter must be deficient in extent of surface, in thickness, or in both. Deficiency of surface means defective contact with the active material; and, although by careful charging the whole of the latter may at first be rendered effective, increasing quantities of active material ultimately become in practice ineffective through not being traversed by the current of charge after the battery has once been over-discharged—such portions not being in the line of least resistance, or in the path of a charging current, more especially when this is too great in strength and of insufficient duration. Thus, what was intended to be active material becomes sulphated dead-weight, and the ratio of capacity to weight rapidly diminishes. On the other hand, when the lead conductor becomes unduly attenuated, though the cross-sectional area may originally be sufficient for conduction, the peroxide grid or support may be all too rapidly rendered ineffective by corrosion due to local action (V.). It is true that means for obviating or reducing this destructive local action have been devised, and the importance of adopting some such means has been insisted upon by the scientific Press; but the methods proposed have never been tested outside of the laboratory, and have hitherto been utterly ignored in practice. It should be borne in mind that great durability may be purchased too dearly where, as in the case of a traction battery, weight is a great disadvantage; but, nevertheless, durability is a point of great importance, and care should be taken that the peroxide support shall be of sufficient thickness to resist local action, under any given conditions, for a sufficient length of time.

CXVIII.

Whilst great care is necessary, whatever may be the purpose for which a lead reversible battery is intended, to avoid undue attenuations in the case of the peroxide support, both theory and practice indicate that the support for the spongy-lead active material should be as light as may be consistent with the required conductivity. Excepting the cases in which the spongy-lead active material is obtained by means which conduce to a great extent of "shedding" or other modes of disintegration, a spongy-lead or "negative" plate should require renewal only at very distant intervals of time, provided the battery be handled with sufficient care and knowledge to avoid extensive sulphatation. In this case the local action is confined to the spongy metal, and there is absolutely no corrosion of the metallic support. To break down a properly-constructed "negative" element by means of a succession of charges and discharges, limited as to density of current and as to over-discharge and gassing, is an operation which could not be effected within any stated period of time. But in the case of accumulators—such as were used on the Birmingham tramline—it has been estimated that the spongy-lead plates would require renewal when they had outlasted two peroxide plates.* Since it is quite certain that the spongy-lead support would be unaffected by corrosion, such an estimate could, I think, be based only on the rate of loss or deterioration of the active material.

CXIX.

The following figures relate to a lead secondary cell con-

* "In estimating the cost of renewal of batteries, I see that Mr. Epstein allows for the renewal of the positive plate only. I do not know whether it is an oversight, but it would appear that he is reckoning upon the negative plate going on for ever, and that, of course, is quite outside the question. I think a fair estimate would be to allow one negative plate to every two positive plates." (Mr. Wallis-Jones, *Journal* of the Institution of Electrical Engineers for February, 1898, p. 750.)

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structed by Mr. A. M. Keays, A.I.E.E., with a view to the requirements for a traction battery, and approximately in accordance with certain principles hereinbefore enumerated:

250 Ampere-hour Cell.	lb.	oz.
Total weight of peroxide plates	16	8
„ „ spongy-lead plates	18	4
„ „ electrolyte	13	14
Weight of ebonite box and lid	5	2
„ connections and terminals	1	4
Total weight of cell	55	0

Normal rate of discharge ..... 20 amperes.
Maximum „ „ ..... 100 „

But the cell is not injured by a discharge current of 155 amperes for periods of from 3 to 10 minutes.

Normal rate of charge ..... 30 amperes.
Maximum „ „ ..... 60 „

In his report, Mr. Keays observes that "The cell can be charged to its full capacity in 3 hours and 15 minutes; and, if charged at this rate, will give 80 per cent. of its full capacity if discharged at 25 amperes—that is, at a little above the normal rate. As far as the tests have gone, there is every reason to expect a long life for the plates; the highest rates of charge and discharge having failed to break down the plates or cause shedding of the active material away from the lead supports."

Shortly after the cell was formed it was charged with 20 amperes for 11 hours, and was then discharged at the normal rate of 20 amperes. This current was maintained constant for 10 hours, when the P.D. at the battery terminals had fallen to 1·84 volts. At this period the capacity of the cell at the normal rate of discharge was therefore 200 ampere-hours.

The next discharge was at a constant current of 25 amperes. In 8 hours and 15 minutes the P.D. had fallen to 1·85, when the circuit was broken. The cell was evidently improving by use, since although the rate of discharge was increased, the effective capacity was now 207 ampere-hours, or 3·76 ampere-hours per pound of cell.

The third discharge was at a constant current of 62·5 amperes, or at the rate of 1·13 amperes per pound of cell. In 2 hours and 45 minutes the P.D. at the battery terminals had fallen from 1·93 to 1·8 volts. The ampere-hour capacity was thus 171·87, or 3·12 per pound of cell; whilst the watt-hour capacity was nearly 5·93 per pound of cell.

The capacity of the cell at the normal rate of discharge was next verified by high independent authority. It has been found to be considerably higher than the estimated 250 ampere-hours, the initial P.D. being 2·1 and the final P.D. 1·8 volts; whilst the final E.M.F. of the cell is 1·864 volts.

The main point, however, is that these results were not obtained through any device, such as that referred to above, by which strikingly high values for capacity and rate of discharge may be exhibited *pro tem.* by the sacrifice of certain conditions having an important bearing upon the permanent effectiveness of the cell.

ELECTRIC SIGNALLING WITHOUT CONNECTING WIRES.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

(Concluded from page 14.)

Production and Utilisation of Electric Oscillations of Very Short Wave-Length.—The advantages accruing to the use of electric oscillations of very short wave-length for the purpose at present under consideration may mostly be traced to the way in which the propagation of the resulting radiations approximates to that of ordinary light waves. By means of a lens of only a few inches diameter light radiating from a luminous point may be reduced to a beam which will remain sensibly parallel over a considerable distance. The advantage thus gained is obvious, since nearly the whole of the energy which passes through the lens may be recovered at the distant point. In fact, the illumination due to a luminous point, as is well known, varies inversely as the square of the distance from that point, whilst with a parallel beam the illumination at any point will be independent of the distance from the source. The possibility of thus producing a parallel beam depends on the shortness of the wave-lengths of the radiations composing ordinary light. With longer radiations, lenses or reflectors, to be of the slightest use, must be made on a very much larger scale, owing to diffraction beginning now to play an important part. This can be clearly realised if a flat piece of wood 2in. or 3in. broad be held vertically, so that one end dips below the surface of the water of a pond. A sudden motion of this piece of wood in a direction perpendicular to its plane will start a train of waves which are sensibly rectilinear at points near the wood, but which become nearly circular at remoter points.

Since all electric radiations are propagated with one speed—that of light—and since the time, T, occupied by a complete vibration is given by

$$T = 2\pi\sqrt{KL}$$

(where L is the coefficient of induction of the oscillator circuit, and K is the electrical capacity of the same), it follows that to obtain short waves T must be made small, and, therefore, K and L must be diminished as much as possible.

But now another complication occurs. When R, the resistance of the oscillator circuit, is greater than $2\sqrt{\frac{L}{K}}$, no oscillations can be produced, a dead-beat discharge taking their place. In small oscillators possessing a spark-gap, R possesses of necessity a value by no means negligible. Consequently L must be made large, or K very small, in order that oscillations may be generated. In most of those cases where a discharge takes place between small metallic balls, if oscillations are produced at all, it is only the first one or two that are of any importance, owing to the rapidity with which damping takes place.

It would be possible to signal by means of such electric waves—at any rate, over short distances. But, on the other hand, such signals would become common property—anyone within the limiting radius could detect them by means of a galvanometer and a tube containing iron filings, together with the necessary connecting wires, placed in an ordinary room. The function of the "line" wires in a telegraph circuit is to lead the energy generated at one place to some other definite situation where the impulses may be noted, and translated into the message sent. If, however, energy is to be projected broadcast into space, some means must be contrived that no effect may be produced except at the station to which the signals are directed. Otherwise little advantage would be gained over heliographic or searchlight signalling, except in foggy weather. It is questionable whether oscillations of sufficiently short wave-length have yet been generated to admit of focussing on a very distant point; and even if it were possible to produce an electric ray which was approximately parallel, matters would not be greatly improved: a message could then not only be read at an intermediate point, but the whole of the energy might by a suitable contrivance be intercepted there.

The most obvious method of overcoming these difficulties appears to lie in the use of the principle of resonance. If electrical disturbances propagated as waves through the ether fall on an electrical oscillator whose period of vibration is equal to that of the waves, a very considerable effect may be produced. The reason of this is similar to that employed to explain why, if the period of rotation of a quickly revolving shaft which is slightly out of balance should happen to coincide with the vibration period of any stationary part of the machine, vibrations of a serious magnitude may be produced. It must, however, be noticed that for this to take place a number of impulses occurring at the stated period are necessary; in other words, in order that the electrical resonator should respond to the oscillator, both must have equal periods of electrical vibrations, and, moreover, both oscillator and resonator must be capable of producing consecutively a large number of vibrations due to an initial electrical disturbance.

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Prof. Lodge's Syntonic System.—In order that an electrical oscillator should produce a large number of consecutive vibrations due to an initial disturbance of its electrical equilibrium, R, the resistance of the system, must be small in comparison with $2\sqrt{\frac{L}{K}}$. In order to make L as large as possible, a coil of wire is introduced into the oscillator circuit. But making L large will increase the period of the electrical oscillations produced, and hence both oscillator and resonator must be constructed on a large scale. Fig. 1 is a rough diagrammatic representation of one of Prof. Lodge's oscillators. A B C, D E F are two large triangular plates made of copper of the highest conductivity obtainable. These correspond to the two coatings of the Leyden jar mentioned in the first of the present series of papers. Joining these is a coil, A D, of the best stranded copper wire. The function of this coil is to increase the induction of the circuit. Two knobs connected with an induction coil are placed close to the knobs, G, H, on the oscillator. On a spark passing from the coil to the oscillator violent electrical oscillations will be produced, and if a similar piece of apparatus be placed at a distance oscillations will be generated in that also, provided that its period has been accurately adjusted to be equal to that of the oscillator. It follows that only a very small alteration is necessary to convert a transmitter into a receiver, or *vice versâ*.

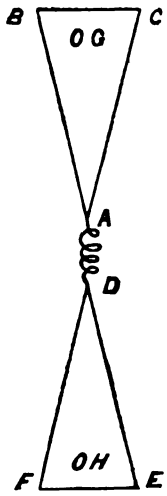

FIG. 1.

Detecting Electrical Oscillations—Coherers.—Prof. Lodge several years ago found that if an electrical discharge passes between two metallic points placed close to each other, but not in electrical contact, an electrical connection is established, so that a continuous current can subsequently pass. A slight tap renders the circuit once more non conducting. Prof. Lodge originally supposed that electrical welding took place. In Branly's coherer, which consists of a non-conducting tube filled with metallic filings, connecting wires projecting into the ends, a similar action takes place, except that the idea that welding takes place is rendered somewhat doubtful by the fact that after a violent discharge has passed, and the coherer has thus been rendered highly conducting, a smaller subsequent discharge decreases the conductivity.

Prof. Lodge finds that the sensitiveness of a coherer decreases with the number of metallic particles; a spring pressing against a needle point is therefore the most sensitive.

All that is necessary to convert a transmitter into a receiver is to switch off the induction coil and replace it by a coherer. The latter has to be carefully protected from external influences. A galvanometer or other current indicator is then connected through a battery with the coherer, and, therefore, in parallel with the resonator.

Dr. Muirhead has adapted a siphon recorder to work with Prof. Lodge's syntonic system. The whole apparatus was exhibited in working order at the recent conversazione of the Royal Society. Distance seems to have little effect on the effectiveness of this arrangement. Signals can be transmitted over a distance of a mile almost as readily as across a room. Of course, this statement applies only to distances such that the convexity of the surface of the earth introduces no new complication.

It remains to be seen whether transmitters and receivers can be tuned to each other with such accuracy that a number of systems similar to the above could be simultaneously worked in the neighbourhood of each other without mutual interference. It is known that a very accurate adjustment has to be made in order that one tuning fork may generate a note in another one by resonance. If similarly, a very slight want of adjustment is found to render a receiver incapable of responding to impulses from a given transmitter, the problem of the transmission of electrical signals without the aid of connecting wires may be said to be satisfactorily solved.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

80. What are the essentials of a good fuse to protect the street mains from the effects of a short-circuit on a consumer's premises? Give sketches.—P. T.

81. Give comparative figures or curves as to permeability of cast iron, wrought iron, and cast steel respectively.—K. S. (Preference will be given to recent figures with dates of tests attached.)

ANSWERS.

Question No. 74.—In what way would you test lubricating oils, and how would you find out if they were animal, mineral, or vegetable?

Best Answer to No. 74 (*awarded* 10*s.*).—Before adopting an oil for lubricating purposes several tests must necessarily be made.

1. Safety with regard to fire, which is determined by the flash point, this being the lowest temperature at which it gives off inflammable vapour, a good margin between this and the working temperature being allowed—for ordinary bearings a flash point of not less than 350deg. F., whilst for cylinder oils the flash point should not be below 500deg. F. To determine the flash point of any oil, put a small quantity into an evaporating basin, placed on a retort stand above the flame of a Bunsen gas-burner, with a piece of gauze between the flame and the basin, so as to prevent the flame coming into contact with the oil. A thermometer that will indicate about 550deg. F. is placed in the clip of the retort stand so that the bulb dips into the oil at the bottom of the basin. Immediately any vapour begins to come off, a small flame is brought within the vapour about 3in. above the basin. When the flash point is reached, the vapour will be seen to take fire around the small flame introduced, when the Bunsen flame is removed and the readings of the thermometer taken, which will be found to be the lowest temperature at which inflammable vapour is given off.

2. Specific gravity: This test will be found very useful in giving a rough idea of any irregularity of different samples of the same class of oil, and in some cases is a valuable indication as to its purity. Specific gravity must always be taken at a standard temperature of 60deg. F., as changes in temperature affects the gravity considerably. The determination of specific gravity is conducted as follows: Attach a glass sinker to one of the pans of a balance by means of a silk thread or fine wire, counterbalance this with sand in the other pan, fill a glass vessel with the oil to be tested, and place it under the sinker so

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as to completely submerge it; now add weights to the pan from which it is hung until equilibrium is restored. Let the weight required equal W. Now fill the vessel with water, and let the weight required to restore balance be represented by W_1,

Then $\frac{W}{W_1}$ = specific gravity.

3. The oil must be tested to ascertain the viscosity or body: This is determined by the time taken in seconds for a standard quantity to flow through an aperture, the oil being kept at the working temperature during the test. The best way of executing this test is to draw out a piece of ½in. glass tube, by means of a Bunsen flame, to a fine opening, and fill this with the oil to be tested and count the number of drops per second, then pour in the standard oil and compare the number of drops.

4. Its tendency to gum: This is found by exposing a thin layer of the oil to a temperature of 212deg. F. for 48 hours.

5. The action of oils on metals: Oils and grease vary greatly in their actions on metals, as will be seen from the following list, and may be found experimentally. Mineral oils have no action on copper or zinc, very little on brass, but most on lead. Olive and tallow oils act most on copper and least on tin; rape oil acts most on copper and least on iron; cotton-seed oil acts most on tin and least on lead; sperm oil acts most on zinc and least on brass; lard oil acts most on copper and least on zinc; seal oil acts most on copper and least on brass; whale oil acts most on lead and least on brass, and has no action on tin. The action upon the various metals is due to the oils containing acid in a greater or less degree, although not necessarily in a free state. To test an oil for acidity mix one volume of oil with five volumes of water, and heat to about 200deg. F., and before the oil comes to the top test the liquid with litmus paper.

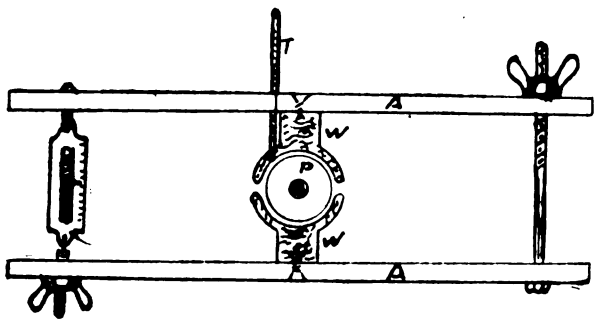

FIG. 1.—A A are Flat Steel Bars, W W are the Two Wood Bearings, T the Thermometer, P the Pulley.

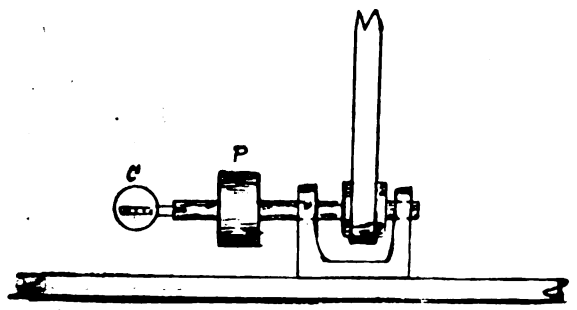

FIG. 2 Shows Counter C and Pulley P Without Bearings, also Mode of Driving.

The preceding tests furnishes useful information regarding the nature of a sample, but do not determine which of a number of oils equally satisfactory, so far as these tests are concerned, would prove the most economic lubricant in actual use. This must be determined by a mechanical test in imitation of the conditions existing in actual practice. And for this purpose oil-testing machines have been constructed on the principle of Prony's brake. The essential parts and the use of them will be gathered from the diagram and details given. The machine is lubricated with a known small quantity of the oil to be tested, a known weight is applied, and it is kept running at a speed of 1,000 revolutions per minute. The rise of temperature is noted for a given speed and time and a standard quantity and quality of oil, and the results of this test is kept for comparison.

To test for the nature of the oils—that is, whether animal, mineral, or vegetable. Mineral hydrocarbon oils are of three kinds. Scotch oils obtained from shale or coal by distillation can be distinguished from the others by their strong smell, low viscosity, and are hardly ever used by themselves for lubrication. Russian mineral oils have a high viscosity at ordinary temperatures. In the case of animal and vegetable oils, these can be distinguished by mixing them in proper proportions with caustic soda, sulphuric acid, and nitric acid, and taking note of the reactions. The following table shows the reactions which take place when one volume of caustic soda is added to five volumes of oil, mixing and heating almost to boiling:

Dark coloration.				Light coloration.			
Fish.		Vegetable.		Animal.		Vegetable.	
Sperm Seal Cod liver	Red	Hemp-seed	Thick brownish yellow	Neats-foot	Dirty yellowish white	Rape Poppy French nut Sesame	Dirty yellowish white
		Lin-seed	Fluid yellow	Lard	Pinkish white	Castor Indian nut	White
						Gallipoli Olive	Yellow

The principal use of this table is to distinguish fish from animal and vegetable oils, owing to the distinct red the former assumes, and which is so distinct that 1 per cent. of fish oil can be detected in any of the others.

Test, with sulphuric acid specific gravity 1·475. The mode of testing the sample of oil with the above consists in stirring one volume with five volumes of oil, and after standing 15 minutes the appearance is taken as the test reaction, which will be seen from the following table:

No coloration.		Coloration.			
Animal	Vegetable.	Fish.		Animal.	Vegetable.
Lard.	Indian nut	Sperm Seal	Light red	Neatsfoot (yellow tinge)	Olive Gallipoli Sesame	Green tinge
	Rapeseed Poppy Castor	Cod liver (purple)			Linseed	(green)
					Hemp-seed	Intense green
					French nut	Brownish

The most striking reactions in this table are those presented by hempseed and linseed oils, for the green coloration which they acquire is such that if they were used to adulterate any of the others they would be detected if only present to the amount of 10 per cent. The red colour assumed by the fish oils is also sufficiently marked to enable us to detect one part in 100 of any other.

Test with nitric acid specific gravity 1·180. One part of this acid is mixed with five parts of oil, and the appearance after standing five minutes is given in the following table:

No coloration.			Coloration.			
Fish.	Animal.	Vegetable.	Fish.	Animal.	Vegetable.	
Cod liver	Lard	Indian nut	Sperm (slight yellow)	Neats-foot (light yellow)	Olive Gallipoli	Greenish
		Rapeseed			Hempseed	(dirty green)
		Poppy			French nut Sesame	Yellow
		Castor	Seal (pink)		Orange Linseed	

This test is sufficiently delicate to detect distinctly 10 per cent. of hempseed in linseed oil as the mixture assumes the greenish hue so characteristic of the former. Although olive oil acquires a greenish colour, still its shade is such that it is entirely distinguished from that of hempseed.—J. C. B.

Answer to No. 74 (*awarded* 5*s.*).—Lubricants should possess the following qualities: (1) *Viscosity* or *body* sufficient to keep the surfaces from coming in contact under the maximum working pressure. This quality is dependent

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upon the adhesive and cohesive properties of the lubricant. (2) *Fluidity* of such a degree as may be consistent with the foregoing requirement. (3) Great capacity for absorbing and dissipating heat in order that the surfaces may be kept cool. (4) High temperature of evaporation of decomposition. (5) Must not oxidise or decompose by exposure to air, otherwise gumming and clogging of surfaces and bearings will follow. (6) Must be free from acid, otherwise the metal surfaces will be corroded away.

As in general practice, lubrication is carried out either under ordinary atmospheric conditions or at high temperatures, and in contact with steam, the above qualities must be considered in connection with these conditions, and also with regard to high or low speeds and light or heavy machinery. The following tests should be carried out in connection with oils used for lubricating purposes: (1) specific gravity test; (2) alkali test; (3) sulphuric acid test; (4) free acid test; (5) viscosity test; (6) flashing point; (7) evaporation test; (8) iodine test. The last three tests are applicable only to mineral and mixed oils.

1. To make this test properly and accurately, special appliances are necessary, but if a sample of pure oil be accessible, a doubtful sample may be readily compared with it by means of the hydrometer, which will generally be found in a central station. The hydrometer must be thoroughly clean, and should have a scale ranging from at least 0·850 to 1·000. The oils should be compared at a temperature of 15deg. C. (60deg. F.).

2. This test will show whether the oil be (*a*) pure fat, (*b*) hydrocarbon, (*c*) a mixture of the two. (*a*) The oil, if a pure fat, will, when treated with a solution of caustic potash (specific gravity 1·340) in the ratio of two volumes of solution to four volumes of oil, form an emulsion or saponify when shaken well. (*b*) Hydrocarbon oils, when similarly treated, form a very slight emulsion, and on the solution standing the oil and aqueous layer separate out. (*c*) If the hydrocarbon is in excess of the other oil, it will, on standing, form a layer on top of the aqueous solution, which will remain emulsified. If the fat is in excess of the hydrocarbon, if a few drops of a weak solution of caustic potash in alcohol be added to the mixture and the whole boiled, if then a few drops of distilled water be added, the solution will remain turbid if even such a small quantity as 2 per cent. of mineral oil be present, whereas with fatty oils only the solution would have been clear.

3. A colour test (described later) and a temperature test can be made, but the latter only will be described here. Put 20 cubic centimetres of the oil into a beaker and note its temperature with a thermometer. Add eight cubic centimetres of strong sulphuric acid (specific gravity 1·849), and stir with the thermometer until the temperature ceases to rise. The initial temperature subtracted from the final temperature will give the rise due to the action of the acid on the oil. Compare this rise with the following table, the values of which have been given on the authority of Mr. G. H. Hurst, of Manchester:

Oil.	Rise in temperature in degs. Centigrade.
Olive oil	44
Sperm oil	37
Rape oil	35
Cotton-seed oil	65
Neatsfoot oil	32
Tallow oil	38
Castor oil	56
Rosin oil	25
Petroleum lubricating oil	25
Scotch shale oil	6
Linseed oil	68
Thickened rape oil	58

4. This test is used chiefly for animal and vegetable oils, mineral oils being usually free from acid. Take a small amount—about as much as will stand upon a sixpenny-piece—of phenol phthalein, and dissolve it in 6oz. of methylated spirit. Add a few drops of caustic soda solution until the solution takes a red tint. Pour a little of the oil to be tested into a beaker, and add a small quantity of the test solution and shake well. If any acid be present, the red tint will be discharged. This is the only way of testing for acid, litmus paper being of no use.

5. This is an important test, but can only be carried out in a reliable manner by means of a "viscosimeter," an instrument which enables time of flow of oil at certain temperatures through an orifice of known size to be determined. The resulting figures are then compared with rape oil, which has a standard viscosity of 100 at 70deg. F. Tables of viscosities may be found in some engineering pocket-books.

6. The flash point is an important matter in mineral and mixed oils. The test is made by very slowly heating the oil to be tested in a suitable vessel in which a thermometer is suspended. As the temperature rises the oil commences to "smoke"—this is the point of vaporisation. Continue to heat the oil, and occasionally pass across the oil, but slightly above it, a small flame. An ordinary blow-pipe may be used for this purpose, being connected to the gas supply by means of rubber tubing. The flame should be a mere bead. Continue to pass this flame over the oil, and presently a blue flame will be seen to dart across the surface of the oil. The temperature at which this takes place is the *flash* point, and the higher it is the safer the oil is to use. If the heating be continued, the flame, instead of darting in and out, will shortly continue to burn. This point is the *fire* test.

7. Evaporation is tested by weighing a small quantity of oil very carefully in a glass vessel, and then placing it in an oven and heating it up to a temperature of from 212deg. F. to 350deg. F., and for from five to 24 hours, according to the nature of the oil. A good oil should not lose more than from 0·25 to 0·5 per cent., and any loss greater than this would indicate an oil of suspicious quality.

8. The iodine test is for determining the amount of (*a*) stearic, (*b*) oleic, and (*c*) linolic acids present in certain oils. There are also bromine, acetic acid, and other tests; but these, with some of the above, are better made in the special appliances manufactured for the purpose.

Animal and vegetable oils are composed of the elements carbon, hydrogen, and oxygen, and when treated with an alkali and boiled, soap is formed. Mineral oils, on the other hand, are composed of only two elements, carbon and hydrogen, and will not saponify when treated with an alkali. Thus this simple test clearly demonstrates the difference between a "fatty" and a mineral oil. To distinguish between animal and vegetable oils is considerably more difficult. With the exception of Japan wax, most oils and fats contain at least two acids as well as the common base glycerine. If, therefore, these fats are heated in contact with superheated steam, the fat is decomposed, and there are formed glycerine and fatty acids. These acids are very numerous, and it is necessary to settle by test what the constituent acids of the paticular oil may be, and then find from a table of acids what particular animal or vegetable matter produce this acid. Another test is to put 20 drops of the oil into a white china evaporating dish and add two drops of strong sulphuric acid, when a tint of characteristic colour may be noted spreading through the oil. Vegetable oils give a yellow, brown, or green colour; fish oil gives a purple or violet colour; animal oil gives a red or reddish-brown colour; whilst mineral oil gives a slight indication of blackish-brown. A keen eye and great care are necessary for this test, which should always be made under the same conditions precisely and always in broad daylight. Tests should first be made upon oils of known purity.—F. STOTT.

Answer to No. 74 (*awarded* 5*s.*).—All lubricating oils are either mineral, animal, or vegetable products, and can be tested by analysis and use. To test by analysis apparatus is required such as used in laboratories, and to test by use close observation of the practical application is necessary.

Analysis—Mineral Oils.—The tests to be made are in the order of their value, and should be for viscosity, specific gravity, evaporation, cold test, and flash test. The duty of a lubricant is to prevent wear and loss by friction between metals by interposing itself between them in a film or thin layer upon which the metals can move easily. The ideal lubricant is that which has the greatest adhesion to surface and the least cohesion among its own particles, therefore its viscosity is of first importance. Viscosity is the degree of fluidity of an oil or its internal friction, but is independent of specific gravity of the oil. Within certain limits it may be taken as a measure of the value of oil as

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a lubricant by comparing the viscosity of the oil under examination with that of other oils which have been found to yield good results in practice. For those engaged in the extensive buying or use of oils this test will be quite enough for their requirements as experts. Three searching tests, requiring special apparatus in the shape of viscosimeters, can be made by Saybolt's, Woolittle's, or Traube's method with viscosimeter. The Saybolt process determines the quality of oil by efflux; the Woolittle by retardation effect; the Traube by liquid friction. As the last-named is the simplest and cheapest of the three, it is here described. The viscosimeter consists of a vertical bulb with a long horizontal capillary jet, it being contained in a trough to keep the temperature constant. About eight cubic centimetres of oil are used for the test, and forced through the jet under a pressure of 60cm. of water. This jet is 30cm. long and of various diameters, according to the oil to be tested. The results of this method of test more closely correspond than any other with those results obtained by friction in actual use.

Specific Gravity.—This can be ascertained by the use of hydrometer. A hydrometer jar is four-fifths filled with the oil, a Beaumé hydrometer introduced into it, and the depth read off to which the instrument sinks in the oil. This may be better effected by placing a strip of white paper back of the jar, and noting the point at which the lower meniscus of the oil touches the scale. The temperature of the oil is taken at the same time, and in case it be not 60deg. F., for every increase of 10deg. F. subtract 1deg. Beaumé from the hydrometer reading. The specific gravity is found by the formula $\frac{144{\cdot}3}{134{\cdot}3 + B^{\circ}}$, B° representing the reading of hydrometer.

Evaporation.—The object of this test is to know what percentage of an oil is volatile. Take a flat watch glass for a dish, and some annular discs of filter paper 1⅝in. diameter with ⅝in. hole, which have been standing in a sulphuric acid dryer for some days; place some of the discs of paper on the dish, and weigh both together to tenths of a milligramme. Whilst these are in the scales drop 0·2 gr. of oil on to the glass dish, and then again accurately weigh. Take the dish off the scales, and place it in an air bath having a constant temperature of 60-65deg. C. When the oil is evaporated, cool the dish and reweigh, the loss being figured in per cent. No oil should be passed which gives an evaporation of more than 4 per cent.

Cold Test.—This may be defined as the temperature at which the oil will just flow. A 4oz. vial is one-fourth filled with oil to be examined and thermometer inserted in it, and the whole placed in the freezing mixture of ice. When the oil has become solid the vial is removed, the oil allowed to soften, and thoroughly stirred until it will run from end to end of the bottle. The reading of the thermometer is now taken by withdrawing it and wiping off the oil to render the mercury visible. The chilling point is the temperature at which flakes begin to form in the liquid, and is determined similarly by cooling the liquid five degrees at a time.

Flash-Point Test.—There are several forms of apparatus for testing this. The simplest is to use an open porcelain cup with a Bunsen burner. The cup is filled with oil to within ¼in. of the top (not so high if flash point such as for cylinder oil is above 500deg.), the edge of cup carefully wiped free of oil, and the thermometer inserted, but not to touch the bottom. Place the lamp underneath carrying a ¾in. flame, the bottom of the cup being about 2in. from the mouth of the burner, and the heating commences. The rate of heating should be 15deg. F. per minute, and may be regulated by the burner. The testing flame should be first applied at 250deg. F., and then every half-minute until the flash point is reached. This is shown by a slight puff of flame by the edge of the vessel. The faster the oil is heated the lower will be the flash point. Draughts should be carefully avoided.

Animal and Vegetable Oils.—The tests most commonly employed are as follows: specific gravity, Valenta test, specific temperature, and saponification.

Specific Gravity.—For the determination of this in small quantities of oil the arœopienometer of Eichhorn may be used. This consists of an ordinary hydrometer having a stoppered 10 cubic centimetre bulb between the empty and weighted bulbs. The stoppered bulb is completely filled with the oil at 15deg., wiped dry, and the instrument placed in a hydrometer jar filled with water at 15deg. C., and the depth to which it sinks shows the specific gravity of the oil.

Valenta Test.—This test determines the solubility of the oil, and is performed as follows: Enough oil is poured into a test tube to fill it to a depth of 1in., the exact height being marked by the thumb. An equal quantity of glacial acetic acid is poured in—that is, until the acid reaches the point indicated by the thumb. A light thermometer is placed in the tube, and it is heated until the oil dissolves, shown by the liquid becoming homogeneous. The tube is now allowed to cool, and the point noted at which it begins to be turbid. Castor oil is soluble at ordinary temperatures, while rapeseed and other cruciferous oils are insoluble even at the boiling point of the acid.

Specific Temperature.—Take a beaker, and weigh into this 50 grm. of the oil to within two drops, and its temperature noted. Ten cubic centimetres of sulphuric acid are now gradually run into the oil. Stir the mixture at time of running together, and do so until no further temperature is noted. The highest point at which the thermometer remains constant for any time is observed, and the difference between this and the initial temperature is the rise of temperature. This will vary with the strength of the acid employed, and to secure uniformity the results should be expressed by dividing the rise of temperature with the oil by the rise of temperature with water and multiply by 100. The rise of temperature with water is determined in the same manner as with oil, using the same vessel.

Saponification.—This is determined by the number of milligrammes of potassium hydrate necessary to saponify 1 grm. of the oil. One to two grammes of the oil are weighed into a flask and saponified by 25 cubic centimetres $\frac{N}{2}$ alcoholic potash accurately measured from a burette, by heating upon a water bath, a funnel being inserted in the flask. When the saponification is complete, shown by the homogeneity of the solution, a few drops of phenol phthalein are added, and the excess of alkali titrated with $\frac{N}{2}$ hydrochloric acid. At the same time, two blank determinations of the strength of the $\frac{N}{2}$ potassium hydrate must be made.

Friction Tests.—The lubricating power of an oil is so closely related to its viscosity that results of a practical value can be obtained by the determination of the viscosity of the oils and subsequent observation of their behaviour in actual use. All oils should be tested by comparison, giving each a fair trial under similar conditions of work, temperature, attendance, and surroundings.

The following readings should be taken for cylinder oil: (1) pounds pressure per square inch rubbing surface, (2) constant temperature in degrees F., (3) feet travelled by rubbing surfaces per minute, (4) total feet travelled by rubbing surfaces, (5) average coefficient of friction; and for heavy journals and machinery: (1) pounds pressure per square inch of rubbing surfaces, (2) rise of temperature in degrees F., (3) feet travelled by rubbing surface, (4) feet travelled per minute, (5) average coefficient of friction; and for light spindles and machinery: (1) pounds pressure per square inch of rubbing surfaces, (2) maximum temperature in degrees F., (3) feet travelled per minute, (4) coefficient of friction at 80deg. F., (5) coefficient of friction at maximum temperature.

To find out if Mineral, Animal, or Vegetable Oil.—The first thing to do is to ascertain all facts about an oil as to its source, its use, and the cost. An oil which is low in cost is not likely to be adulterated with one of higher cost. A list of oils in their order of cost is here given:

1. Almond.	5. Rape.	9. Peanut.	13. Cod.
2. Castor.	6. Olive.	10. Linseed.	14. Cotton seed.
3. Sesame.	7. Sperm.	11. Tallow.	15. Mineral.
4. Neatsfoot.	8. Whale.	12. Lard.	16. Rosin.

Physical conditions may help in the examination. The

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colour is misleading, as oils may be coloured by the use of the oleates or butyrates of iron or copper. Fluorescence will indicate the presence of mineral oil, and this can be seen by placing a few drops on a sheet of ebonite and observing the bluish tint.

Odour and taste will reveal much, as marine animal oils are, when warm, detected by their strong fishy odour; neatsfoot, tallow, lard, olive, rosin, and linseed oils each have an easily distinguishable odour. Whale oil has a nutty and rape oil a harsh taste. A specific gravity test will help to distinguish any unknown oil at constant temperature of 15deg. C.—H. J.

Answer to No. 74 (*awarded* 5*s.*).—The tests which an engineer would apply to lubricating oils for the determination of their quality, composition, etc., are as a rule only rough and empirical, but still they give him some idea of which oil is suitable for certain purposes and which the reverse. Briefly, they are specific gravity, viscosity, flashing point, acidity, tendency to gum.

The specific gravity is taken by means of an oleometer which has been carefully calibrated, care being taken to make the test at some definite temperature. The viscosity of an oil or the time required for a certain quantity to pass through an orifice of definite size, at a known temperature and pressure, is measured by means of a viscosimeter, one form of which consists of a small cylinder with closely fitting, weighted piston, and having a small nozzle or orifice, through which the oil slowly exudes. Glycerine, as a rule, is taken as the standard. The flashing point is the temperature at which the oil will fire, and, roughly, with mineral oils varies with the amount of refinement they have undergone. The instrument for determining this test consists generally of an enclosed vessel heated by some external means, such as a Bunsen burner, and having in its interior an agitator and a thermometer. In the lid of the vessel there is also a small burner through which when the oil has assumed a certain temperature vapour is given off and ignites; this temperature is then the flashing point of the oil. The amount of acidity of a lubricant is a very important factor in some instances owing to the prejudicial effect the acid would have on certain metallic surfaces. As a rule, to carry out this test successfully is more within the scope of the chemist than the engineer. A good elementary test consists of agitating the oil with warm water, separating, and then adding a solution of methylorange, when the presence of acid will be detected by a red discoloration. The tendency to gum or oxidation is another very important point; especially is this so with any light machinery, such as some spinning machines, etc. A rough test of this may be made by pouring a small quantity of the lubricant to be compared on a sheet of glass and noting which has the quickest drying surface. The above tests would be the ones which an engineer would resort to for distinguishing between animal, vegetable, and mineral oils.

In the tables below are given the specific gravity and viscosity of some of the principal of each kind of oil.

Specific Gravity.

Rape at 60deg. F.	915
Olive at 60deg. F.	916
Sperm at 60deg. F.	884
Tallow at 120deg. F.	895
Mineral oils at 60deg. F.—	
Spindle	885-895
Machine	895-910
Cylinder	910-930

Viscosity.

Rape at 60deg. F.	540
Olive at 60deg. F.	400
Sperm at 60deg. F.	177
Tallow at 200deg. F.	55
American mineral oil—	
Specific gravity 885	105
,, ,, 913	295
,, ,, 923	680
Russian mineral oil—	
Specific gravity 909	1,235
,, ,, 915	1,980

The flash point of most mineral lubricants ranges from 350deg. F. upwards, and should certainly not be below this figure. Another rough but fairly reliable method of detecting the composition of lubricating oils is by means of taste and smell. In the case of most animal oils, by slightly warming them they give off an objectionable odour, which is readily detected. Mineral oils when tested leave a most nauseous taste in the throat such as no other oils do, and vegetable oils may be distinguished by their greater tendency to gum; especially is this so with some types of olive oil.—H. B.

Question No. 75.—What periodic tests would you advise to be made on a set of accumulators, and what records kept in order to tell how the cells were being treated?

Best Answer to No. 75 (*awarded* 10*s.*).—The attention you give accumulators is directly proportional to their life, and periodic testing is essential if you wish to keep in check all those minor faults which develop rapidly and finally ruin a battery. Before giving particulars of necessary periodical tests and records, I would draw attention to some common evils that beset the life of an accumulator. A cell will be found now and then not gassing with the rest, and on inspection a pellet of paste will most probably be found wedged between two plates and causing a partial short-circuit. If this is not discovered in time, the fault develops, with the result that the cell gets completely exhausted, and if in circuit when the battery is discharging it gets charged by the main discharging current the wrong way, abnormal and uneven expansion takes place, and the cell buckles. Another fault to guard against is the loss of electrolyte by evaporation. This should be compensated for by the addition of pure water not less than once a fortnight, so that the specific gravity is not pulled down too much at a time; if left until it requires a large quantity of water adding, the electrolyte takes a long time to regain its original density, and that means increased internal resistance for the time being. The worst evil to find happening to a cell is the presence of the lead sulphate (Pb_2SO_5), which is the result of over-discharging, and is caused by the lead sulphate (Pb_2SO_4), a large proportion of which forms the positive paste when the cell is exhausted, uniting with the oxygen. The best way to get rid of it is to give the cells long charges, not necessarily heavy, but spread over a long time, and to be careful not to allow the specific gravity to get too low. On no account use sodium sulphate (Na_2SO_4), for although it answers the purpose quicker in the first instance, it ultimately causes the disintegration of the peroxide. Yet another fault to be careful of—and that is overcharging. Many authorities deny it is possible. When a battery suffers from overcharging, the peroxide paste (PbO_2) is forced off the plates by the gas that is given off, and part falls to the bottom and part is carried up in the gas globules to the surface and deposited on the edge of the plates in ridges. This can easily be found out by the predominance of the peroxide at the bottom of the cells. Instead of being in the proportion to the negative paste about 3 to 1, it will be more like 10 to 1.

Now as to periodic tests. The cells should have their specific gravity taken every other day. This should be taken when the cells are fully charged and discharging at their normal rate. The voltage of each cell should be taken once a week under the same conditions, and any cell under 2·0 volts should be attended to. It is very convenient to rule a sheet of paper in the following fashion and keep the record to refer back to, so that any falling off in a particular cell can be readily noticed, and it is also a history of the battery from start to finish:

DATE.....

No. of Cell.	Specific Gravity.	E M.F.	Remarks.

The cells should be examined by having a hand-lamp reflecting light along bottom of cell, and looking down between each plate for any obstruction. These obstructions can be removed by a thin piece of wood. The cells should be tested periodically for leakage to earth. This can readily

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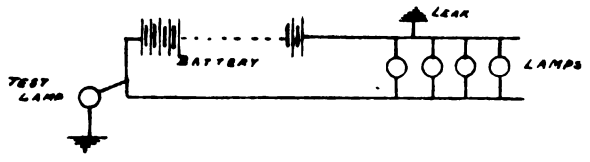
be done either by placing a lamp across one pole and earth (try both poles), or more roughly by placing the back of the hand on outside of a cell near either end of battery and making good contact to earth with your other hand or feet. If there is any leakage, you will notice a prickling sensation on back of hand. This is, of course, only a rough-and-ready test, but answers the purpose very well. Where convenient, instrument tests can be made instead.



Now as to testing the capacity of battery. Where possible, this should be done at least once a year, so that you have some idea of the life left in the battery. All makers specify ampere-hours capacity and not watt-hours; therefore, your test need only be with an ampere-hour registering meter, such as Shallenberger, Ferranti, etc. To take test, charge your cells until all are 1·2 or over specific gravity, and discharge with ampere-hour meter in circuit until specific gravity is 1·15. At this gravity the cells are exhausted as far as it is safe to go. Of course, the capacity varies with the rate of discharge, and when taking the test the ampere discharge must be in accordance with the listed discharge for a certain ampere-hour capacity.

The above tests are only rough ones, but they can be conveniently taken on any installation with very little trouble, and, if conformed to, will be all that is necessary to keep a set of accumulators in first-class working order. The state of a battery can always be judged by its colour, the positive plates being a dark plum colour when fully charged, and gradually change to a lighter brown as they get exhausted. With practice it is possible to tell the amount of charge or ampere-hours left in the battery by the colour of peroxide plates. If an accumulator is being badly treated, some of the following things will be noticed: no gassing when charging; plates buckling; white formation in patches on positive plates, which is lead sulphate; large deposit of peroxide in bottom of cell; and quick exhaustion after being charged due to leakage.—J. E. DONOGHUE.

Answer to No. 75 (*awarded* 5*s.*).—The following tests should be made in connection with all installations of secondary batteries, but especially when used as a central-station stand-by:

Tests—Daily.—(1) Specific gravity of acid in hydrometer cell taken both before and after charging.

Weekly.—(2) Voltage of each cell before and after charging; (3) specific gravity of acid in each cell before and after charging; (4) insulation test of battery; (5) quantity of ampere-hour efficiency of battery; (6) energy or watt-hour efficiency of battery.

At Intervals.—(7) Sulphuric acid test. 1, 2, and 3 should be in each case taken during the *last* hour of discharge *before* charging, and during the *first* hour of discharge *after* charging. Any of the numerous electrical pocket-books will give formulæ for 4, 5, and 6. Test 7 should be made whenever a fresh carboy of acid is opened. Its object is to preclude the possible use of acid which through impurities may be harmful to the battery plates. The chief impurities are compounds of iron and arsenic in the form of sulphate of iron and trioxide of arsenic, and these two impurities generally occur in "pyrites" acid. None but the best "brimstone" acid should be used for secondary cells, and it is necessary with this acid to be mindful to reject any acid which, through the improper or faulty management of the lead chamber used for collecting this acid during manufacture, may have become contaminated with compounds of sulphuric and nitric acids. These compounds are disastrous to the life of the plates, since they attack the active material as well as the grid and containing boxes if of lead, destroying them in a very short time. It will be apparent from this that it is necessary to test every carboy of acid opened. A simple and effective test for nitrous compounds is to put a little of the *concentrated* acid in a test tube together with a few drops of mercury. On shaking the tube, if nitrous compounds are present, a gas will be given off which, as it mixes with air, takes a brownish colour and has an odour similar to that of chlorine.

Records.—(1) Records of all above tests.

Daily.—(2) Time of commencement and finish of charge; (3) amperes passing through battery; (4) amperes discharging; (5) maximum volts whilst charging; (6) volts and number of cells discharging; (7) ampere-hours of charge and discharge; (8) number of hours charging and discharging.

Weekly.—(9) Colour of plates and their condition in each cell; (10) date when cells are filled up with water to replace evaporation.

Whenever required.—(11) Date of mixing new acid solution; (12) date of adding new solution to cells; (13) date and quantity of carbonate of soda solution added to cells; (14) date of cutting out, cleaning, straightening plates, rebuilding, and replacing in charge of "sick" cells.

In a central station many of the above records would be automatically made by means of recording instruments, whilst others would be deduced from these automatic records. Many of the records from 9 to 14 would fall under the "remarks" column in the battery maintenance book, whilst others again would naturally appear on the daily station log sheet. Some of the above tests and records may appear redundant, but perhaps nothing will be lost and much may be gained by having everything tabulated for recognition at a glance; at least irregularities and improper usage of cells will be the more easily recognised and remedied.

The weekly examination of cells and plates (record 9) is easily carried out where a good natural light is available if conducted whilst the battery is discharging at a normal rate, as then the electrolyte is perfectly clear and transparent, enabling one to distinguish clearly the lower edges of the plates and thus localise buckling, short-circuits, broken insulators, and other obstructions, etc. Where the light is not good, and especially when the cells are placed in lead containing boxes, recourse may be made to the aid of a specially manufactured battery exploring lamp, consisting of a 2-volt 3-c.p. flat-bulb lamp mounted on a long, narrow thin ebonite rod, which enables it to be inserted between the plates in search of the ubiquitous short-circuit. This lamp, besides being very fragile, is not of much use, as it stirs up the mud and obstructs the vision. The simplest and at the same time the most reliable examination of a cell in a big battery is to use a flat, narrow blade of hard wood of such a thickness as will allow of its being readily inserted between the adjacent plates of the cell. By the intelligent use of this exploring stick a more correct knowledge of the interior state of a cell may be arrived at than by any other, short of taking apart, besides which a cell may by its aid be examined at any time of the day. When a cell has been taken apart and is to be re-erected, care should be taken that the plates bear evenly and closely up to the insulating rods. Do not, however, carry this too far, as is the case in some station batteries where the plates are kept close up to the insulating rods, by the insertion at either end of the lead containing box of waxed boards and wedges, which being driven in tight prevent the plates from moving. Such practice makes the cells nice and compact, but it is apparently forgotten that the positive plates of a battery are continually growing in size so long as they are in use. Lead being an inelastic substance, it follows that if the plates are rigidly fixed and bound this increase in area must take place between the insulating rods, producing abnormal buckling and a tendency for the plate to burst at the edge, so that although the immediate effect of wedging the plates may be good, the ultimate result is more disastrous than if the plates had been allowed even growth and had been taken apart for straightening purposes several times. The former method means short life, little trouble, and excessive renewal costs; whereas

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the latter method means longer life, greater labour, and smaller renewal costs.

If a cell is "sick," or has been recently replaced in circuit and is not properly charged, if it cannot be cut out of the battery whilst the latter is discharging, instead of allowing the weak cell to discharge with the others and probably become reversed, put it in parallel with a good reserve testing or spare cell, and let the two take the place of the weakly cell. This will save the cell, and by merely removing the connecting wires of the spare cell the weak cell is ready for charging with the rest of the battery.—F. STOTT.

AN ELECTRIC SEA-GOING LAUNCH.

Somebody, after reading "The Coming Race," evidently came to the conclusion that the mysterious "vril" might be used on the surface of the globe in connection with that mysterious substance or motion which we call electricity. Hence the title "Vril Launches Company." The London offices of this company are at 19, Coleman-street, and the temporary works at St. Helen's, Isle of Wight. On Monday last, at the invitation of Messrs. Crewdson and Alexander, the directors of the company, we proceeded to Portsmouth to witness the trial of an electric launch, built to the order of Captain I. Grigorovitch, on behalf of the Russian Government. Now, electric launches are not so uncommon as to demand a long description, yet in this case a new departure has been made, in that the launch is not an ordinary river launch, but is described as a sea-going boat, intended, indeed, to be used on the large lakes in North Russia. The following is a description of the boat: "It is built of double-skin mahogany, polished and varnished, of the following dimensions: length, 32ft.; beam, 8ft.; depth, 3ft. 8in. All the fittings are of gunmetal, nickel plated; cushions covered in morocco."

The machinery consists of a 7,000-watt motor, wheel controller, and 42 E.P.S. Faure-King accumulators. The cells are placed under the seats, thus leaving a clear space down the whole length of the boat. The machinery gives a speed of about seven knots for four hours, or 4½ knots for 10 hours.

The motors are of the usual type, having no external field. The field magnets are of cast steel and series wound in two equal circuits. The armature is wound in two distinct circuits, and has a commutator at each end. The brush gear is all made in delta metal, and carbon brushes are used. The controllers are substantially made, and have large contact surfaces. They are fitted with a patented arrangement which gives an absolutely instantaneous make-and-break without the possibility of the controller sticking in an intermediate position, and insures contact being made and broken with a minimum of sparking. The batteries are put into special ebonite boxes of the Vril Company's design, which allow of a joint at once thoroughly tight and neat being made round the lid. The joint at the opening to pass the lead lugs for connecting terminals is made tight by a special arrangement of rubber rings, insuring a good tight joint under all circumstances.

In working these launches the first movement of the controller to half-speed either ahead or astern puts the full battery on to the motor, which is connected up so as to form practically two motors in series, one field winding and armature winding in series being in series with the other field and armature in series. The next movement to full speed connects the motor up as two in parallel—viz., one field and armature in series in parallel with the other field and armature in series. This arrangement does away entirely with the usual objectional method of regulating by either varying the number of cells or by putting cells in parallel and series in groups. It is well known that batteries always give trouble sooner or later if they are run in parallel, and that the motors are not efficient at half voltage.

The tail shafts are made of hand-rolled brass, and the stern tubes are lined with lignum vitæ. Thrusts are made of steel, and are fitted either with rings running in a horse-shoe thrust block, or are of the firm's special self-oiling type, having one heavy collar solid with the shaft and a number of steel and brass washers alternating and running in an oil-bath. All bearings are made self-oiling by means of a ring tight on the shaft, which lifts the oil out of an oil-well and throws it against a dash plate, which distributes it all along the bearing.

It will be seen that this arrangement of controller practically limits to two speeds, half and full, but of course it can easily be arranged to permit of any other speed between none and full. On the trip mentioned we watched

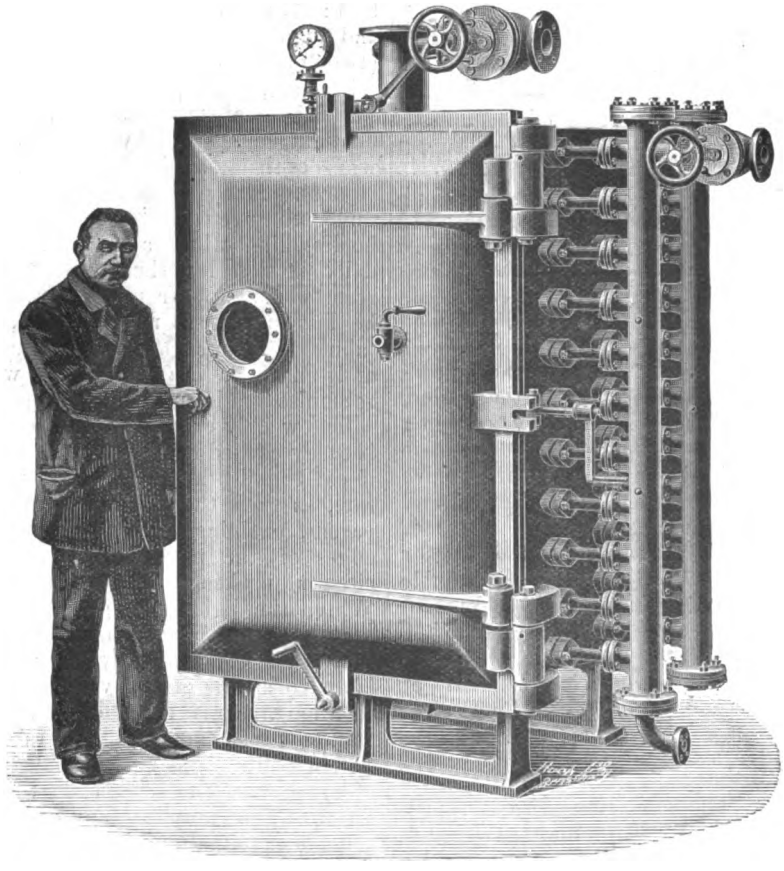

FIG. 1.—The Passburg Vacuum Drying Chamber Closed.

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the instruments very carefully, and found the ammeter showing 40 amperes at half speed and 120 amperes at full speed. At full speed the voltmeter showed about 72 volts. This gives at full speed nearly 11·5 h.p., but it must be remembered that the boat was very heavily laden. So far as we were able to examine the work everything has been excellently constructed, and much care and attention given to every detail. We hope to return to this subject again and to give some drawings, but feel that the company has deserved an earliest reference—thus these forewords.

VACUUM DRYING.

There are more faults initiated by moisture in the windings of electrical apparatus than, we think, by all other causes put together—in fact, the drying of electrical goods is most important, and the usual method of drying by heat is not really satisfactory. In many factories the field magnet coils and armatures are dried in a hot chamber, while the windings are heated up by passing current through them. The vacuum drying chamber, such as we illustrate below, is a much more satisfactory one, as by using a vacuum the vaporising temperature is reduced very much. This apparatus is designed by Mr. E. Passburg, of 33, Brücken Allee, Berlin, and has found favour with the leading electrical firms in Germany.

The apparatus (Figs. 1 and 2) consists of a cast-iron chamber, heated by steam or hot water, which is closed hermetically at one or both ends by doors. This chamber contains a number of shelves arranged one above the other. These shelves are, as a rule, made strong enough for a pressure of 75lb. On the shelves are placed iron, copper, galvanised, or earthenware trays, which contain the material that is to be dried. After the door of the apparatus, which is fitted with an indiarubber joint, has been closed, a vacuum of at least 28in. of mercury or more is created by means of an air-pump, whilst exhaust or live steam or hot water passes through the heating shelves. At a very moderate temperature in the material that is to be dried—about 95deg. F.—the water begins to evaporate briskly out of the substance, and the latter dry rapidly. Even materials which are very difficult to dry, and which by other methods it took days to dry or which could not be dried at all, are mostly dry after a few hours, without the substances being in the least impaired through being overheated. The charging of the chamber is simple and easy, the working very clean and reliable. The temperature can be easily regulated by valves in the steam-pipes. By using hot water for heating and by means of an air-pump giving a high vacuum, the evaporation of the water contained in the materials that are to be dried can be effected at as low a temperature as 63deg. F. The shelves are not required when large articles such as dynamo armatures are to be dried, but such modifications of the chamber are obvious.

In drying the insulation of electric cable the idea is not new, as we have seen similar vacuum drying plant at several English cable works, but the following figures of what can be done are of interest. In a chamber 9ft. by 10ft. by 9ft. eight lengths of 275 yards each, or a total of 2,200 yards, of 1¼in. diameter jute cable are dried in under 15 hours, telephone cables with paper insulation in eight hours. By a certain contrivance, the evaporated water extracted from the jute, paper, etc., can be measured, and the end of the drying process ascertained, as a measure of the perfect insulation resulting. Also for drying washed indiarubber these chambers are most suitable, and have been adopted by several leading manufacturers to their entire satisfaction. The rubber is dried in two hours, and as under vacuum no oxidation of its surface takes place, the yield of the material remains undiminished and the quality unimpaired, which is not the case with methods of drying in which heated air is used.

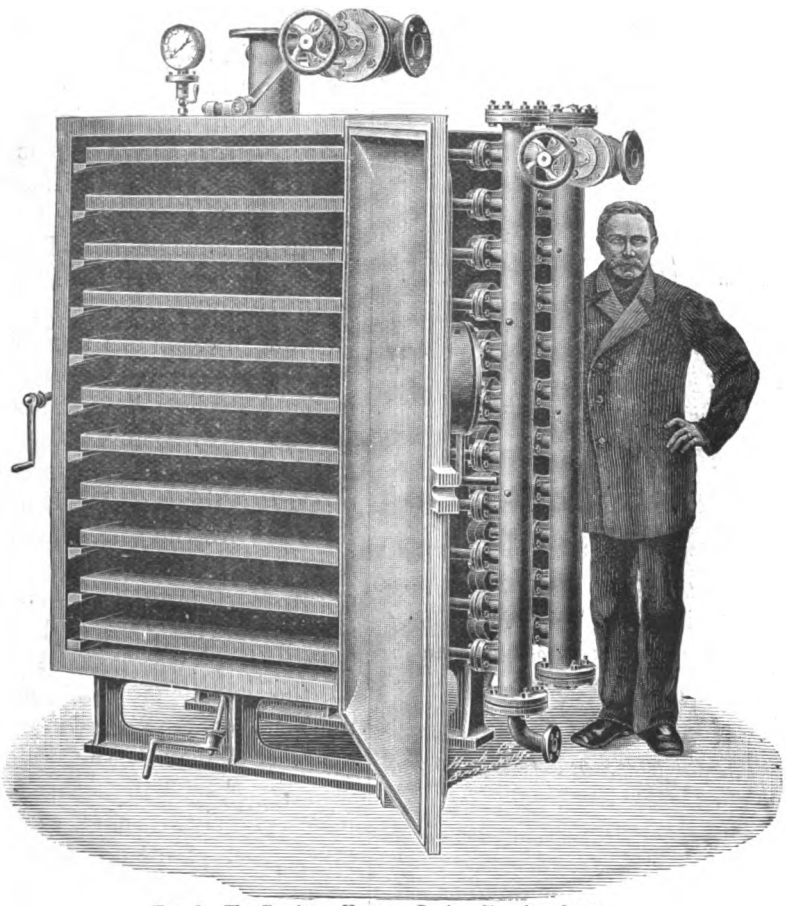

FIG. 2.—The Passburg Vacuum Drying Chamber Open.

Old Lamps for New.—The *Daily Telegraph*, referring to a recent meeting of the Brighton Town Council, said the members were much interested at finding suspended in the State corridor of the Royal Pavilion some 20 of the fantastic lamps originally used in the decoration of the palace by George IV. They were illuminated by electricity. The lamps, which are elaborately painted, form part of the decorative material kindly returned to the borough quite recently from Kensington Palace by the Queen's command.

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RAILWAY CARRIAGE COMMUNICATION.

The report given in another column is an opportune document. It is very aged, however, and ought to have been born half a century or more ago. Of course that was impossible, because the committee which has reported did not then exist. We have always admitted that Britain is a practical country—in the abstract. Its concrete practicality consists in going as you please, till you tread upon an influential man's toes, or the pawns of the body politic take to voting upon the question. It necessitated an atrocious murder to get railway carriage communication at all, and it has taken a quarter of a century, more or less, before the mildest of mild agitations has obtained a report which says some of the so-called methods at present in vogue are little better than delusions and snares. A strong, healthy, bold man may stop a train by some of the methods in use, and get fined for so doing because he is strong, healthy, and bold; but a man, and still less a woman, suddenly attacked by illness or by light-fingered gentry has as much chance of calling attention to his or her desperate plight as of sending a telegram to the moon. We say this is an opportune yet an aged document. It is also a beautiful example of the English method of locking the stable after the steed is stolen. Corridor trains are beginning to oust out of existence the old-fashioned coaches upon wheels hooked to a locomotive, and corridor trains in the first place lend themselves to more publicity, and so to a lessened value of these means of communication; and in the second place, the most recent of these trains are fitted with electric bells in connection with the refreshment department. Still, so long as the older carriages exist—splendid examples of insular prejudice—so long will the necessity of a perfect method of communication exist. The report we have referred to makes much of the excellence and non-liability of electrical methods of communication to break down. We agree so far with the report that these methods are the best in use, but we are very far from agreeing that as installed they are of much use. How not to do it, is and has been the motto of all almost railways in this respect. They set out with the idea, and the idea has become ingrained in their bodies, corporate and incorporate, that a simple and easy method of communication would be abused. That is a very plausible argument, and hence in fear of abuse, the means of communication were made almost impossible of use. We have a higher appreciation of the terrors of the law, and although in the earlier days some folks might have erred through ignorance, some when the occasion hardly warranted so drastic a step as the stopping of a train, and some wilfully, we imagine that a very few introductions to the magistrates would have made folks think twice before using the means once. When such a method of communication appeared absolutely necessary, legislation said you must provide it, but legislation never said you must make it effective for the people who ought to use it, that is, it was never made effective for the sick or the victim of attack. While in the mood for cavilling at legislative procrastination in things that

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really affect the welfare of the public generally, we would direct attention to another phase of work—the report of the Petroleum Commission. Thanks principally to the action of the *Star*, there is a report as a preliminary, perhaps—or perhaps not—to action, and some day—we know not when—a start will be made to stop the ever-increasing holocaust of victims of lamp accidents. With properly constructed lamps the present flash point might be made less dangerous, if not absolutely free from danger, while without proper lamps any flash point will be dangerous. However, we only add this reference to oil because it is another example of how not to do it. Both questions required instant action years ago, not dilatoriness, and both may get action when in the natural course of things the evils are being slowly abolished, and something safer and of a different character substituted. Really, the English people are a practical, very practical nation.

A GRACEFUL ACT.

The town of Wolverhampton is to be congratulated on the action of their General Purposes Committee with respect to their electrical engineer, Mr. F. Harman Lewis, who has been compelled to resign his position from ill-health. This report of the committee tells the bald facts of the case, and reads as follows:

"Your committee have received from the Lighting Committee a report stating that the borough electrical engineer (Mr. F. Harman Lewis) has been compelled, in consequence of ill-health, to resign his appointment. Mr. Lewis was appointed in May, 1893, at a salary of £300 per annum, and entered upon his duties on Sept. 1 in that year. The Council will remember that immediately upon his appointment he undertook the revision of the important scheme then before them for lighting the borough by electricity. In consequence of his proposals, fresh tenders were obtained, resulting in a reduction of £10,000 upon the original ones being effected, this being to a great extent due to the improved tenders and to the economical revision of the scheme by Mr. Lewis. He also superintended the construction of the works, and thus a sum equal to 5 per cent. upon the amount of the tenders, which would have been payable, as at first intended, to an expert, was saved by the Corporation. A scheme for the extension of the undertaking, involving a heavy capital expenditure, has recently been prepared by Mr. Lewis, and will at an early date be submitted to the Council. It will probably be necessary when carrying out this scheme to have recourse from time to time to him for his advice, and he has promised that if, after his recovery, any matter should arise as to which his intimate knowledge of and experience with the electric lighting undertaking can be of service to the Corporation, he will be most willing to render assistance. The demand made upon Mr. Lewis in dealing with the exceptional difficulties which arose during the first two years of the working of the undertaking, has caused his health to suffer to such an extent that he is now in a condition which renders him incapable of satisfactorily performing his duties. He requires a prolonged rest for recovery, and as at the present period the undertaking needs energetic and rapid development, he has felt compelled to submit his resignation to the Council. During his term of office he has always taken a keen personal interest in his work, and striven to promote the interests and success of the undertaking. The Lighting Committee have recommended the acceptance of his resignation by your committee with regret. They have also advised that his services should be retained as consulting engineer for 12 months from June 24 last at his present salary, having regard to their probably requiring his help in connection with the extensions above mentioned. Under these circumstances, your committee beg to recommend the Council to accept Mr. Lewis's resignation, and to retain his services as consulting engineer for 12 months from June 24 last at his present salary, so that the Lighting Committee may be able to look to him for advice in carrying out the contemplated extensions of the works which he has formulated. The necessary resolution for giving effect to this report will appear on the summons for the next meeting of the Council."

This kindly consideration shows the appreciation felt for the good work done by Mr. F. Harman Lewis, and we trust that it will help him to recoup his strength. There is no doubt that his advice from time to time will, in consequence of his intimate knowledge of the station, amply repay the Council for the fees he will receive. It must be remembered in this respect that, as stated in the report herewith, Mr. Lewis has acted both as consulting and resident electrical engineer to this Corporation since the commencement of the undertaking, and was the means of effecting a very considerable saving in the initial cost, amounting to some £10,000. As is, perhaps, generally known, the system in operation in this town is a 2,000-volt direct-current system, with motor-transformer sub-stations. Every credit is due to Mr. Lewis for his exceptionally good work in overcoming the many difficulties to be dealt with in the design, erection, and working of such a station. The financial result of this undertaking is also highly satisfactory, being as follows: first year, gross profit £1,584; second year, gross profit £2,359—net profit, £225; and third year, gross profit £2,833—net profit, £589.

SOME NOTES ON THE ELECTROLYTIC REFINING OF TIN AND THE RECOVERY OF TIN FROM ITS ORES.

BY SHERARD COWPER-COLES.

Electrolytic methods have recently been applied to the refining of tin, Claus having taken out a patent in which he describes the use of an alkaline solution or compound of solutions containing sulphide or sulphides used for dissolving tin by passing an electric current through anodes cast from the crude tin to be refined. The solution is composed preferably of one part of stannate of sodium and two parts of water. The best results have been obtained from a sulphostannate of sodium (SnS_3Na_2) of specific gravity 1·070, and heated to approximately 90deg. C., the current density being approximately 10 amperes per square foot of anode surface. The residual metals or other material, except antimony or arsenic, contained in the anode are precipitated as sulphides, together with those metals or residue which are insoluble in the electrolyte. In the case of the metallic tin containing antimony or arsenic, or both, the deposited metallic tin is made the anode in a second bath, which is composed of dilute hydrochloric acid to which hypo-sulphite of soda has been added, the arsenic and antimony being precipitated as sulphides. Claus has also patented the use of a solution of sulphide of sodium of sp. gr. 1·065. Gold, silver, zinc, lead, copper, antimony, iron, etc., remaining insoluble in the anode mud, some as sulphides and some in the metallic form. In some cases the inventor finds it preferable to use hydrate of sodium or potassium, and, instead of smelting the ore and using the alloy as the anode in the electric bath, he finds it more convenient to prepare the sulphostannate of sodium solution by fusing the ore with a proper proportion of sulphur and soda or sulphate of soda and carbon, and lixivating the mass, or by boiling the ore or other material containing tin in a solution of hypo-sulphide of sodium and in converting either a part or the whole of the sodium sulphide in the solution into sulphide of ammonium, preferably by sulphate of ammonium or other salts of ammonia, the tin being deposited by an electric current, any copper, bismuth, zinc, etc., present in the tin anodes is recovered in the anode mud. The same method is employed for the treatment of tin ores as that described in the first records of tin smelting, only small improvements having been made in minor details. Attempts have been made from time to time to try and win the tin from the ore by electrolytic treatment. Processes hitherto devised have not been successful on account of the difficulty of finding a suitable solvent for the tin oxide. Dr. Burghardt has proposed treating tin ores electrolytically as follows: the tin ore is first crushed to a powder, to which a sufficient quantity of carbonaceous matter, such as coal or charcoal, is added, varying from 3 to 7 per cent. by weight. A quantity of caustic soda or potash is heated in the vessel without the addition of water, and the mixture of ore and carbon is added to the fused caustic soda, the proportion of caustic alkali being about twice

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the weight of the ore to be treated. The contents of the vessel are thoroughly stirred until the ores become dissolved and enter into chemical combination with the caustic alkali. The gases driven off by this process are chiefly carbon monoxide and carbon dioxide. The heat is increased until the carbon monoxide ignites. In the process of smelting, the oxide of tin is reduced momentarily to the metallic state; the metal thus formed is at once dissolved in the melted caustic soda or potash forming stannate of sodium. The combination of the ore and caustic alkali having taken place, the contents of the vessel are poured out to cool, and the resulting mass is broken up and dissolved in a suitable proportion of water; the solution is used as a bath in which the tin is obtained by electro-deposition. Vortmann and Spitzer proposed

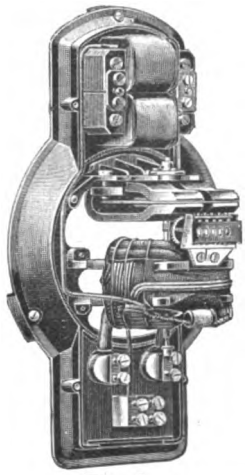

Fig. 1.

melting finely-pulverised ore mixed with from two to three times its weight of a mixture of one equivalent of sulphur and two equivalents of silver. Air is excluded through the fusion, which results in the formation of a triostannate. This salt is then washed out, and the solution is allowed to settle. After the addition of ammonia and ammonium sulphate the clear liquid is electrolysed with insoluble lead anodes. Classen has also proposed a somewhat similar process for the electro-deposition of tin. The electro-deposition of tin has always been a matter of some difficulty, as the tin has a great tendency to come out in the form of trees instead of in an adherent mass. The electrolyte devised by Roseleur has been used to some extent. The bath is composed of 5,000 parts of distilled

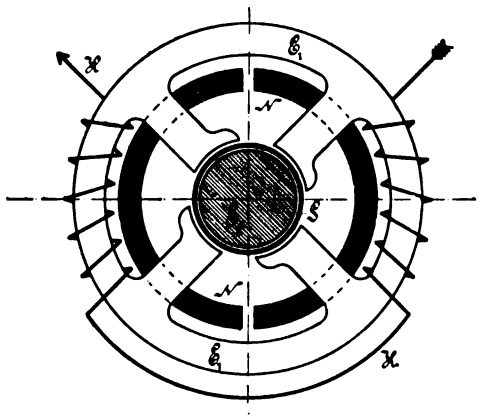

Fig. 2.

water, 50 parts of pyrophosphate of sodium or potassium, and six parts of protochloride of tin, and is made by placing the pyrophosphate and water in a tin-lined wooden tank, the lining serving as an anode, the stannous chloride being suspended in the liquid in a copper sieve. The first result is to produce a cloudiness in the liquid, which, however, subsequently becomes clear. After the complete solution of the tin in the salt the solution is ready for use. The tin anodes are incapable of keeping the solution up to its original strength in spite of the large anode surface, and small quantities of pyrophosphate tin salt has to be added from time to time. Tin bioxide dissolved in caustic soda has been used to some extent. Maitresse ensures the complete continuity of the tin covering obtained by electro-deposition by heating the coated object to the melting point of tin. All the solutions required for the deposition of tin require to be worked with a moderate current, the voltage being from three to five. The deposits have a dull, frosted appearance, similar to that obtained from silver cyanide solutions, but the tin deposited can readily be brightened either by scratch brushing or by friction of bran or by mopping with lime.

A NEW ALTERNATE-CURRENT METER.

The sketches below illustrate the new meter for alternate currents now being put on the market by the Electrical Company, Limited, of 122, Charing Cross-road. The meter is a most ingenious one, and from tests shown to us seem very accurate. In fact, one curve of calibration is almost too straight for credence. The meter corresponding to this curve was a 10-ampere one, and with that current the motor

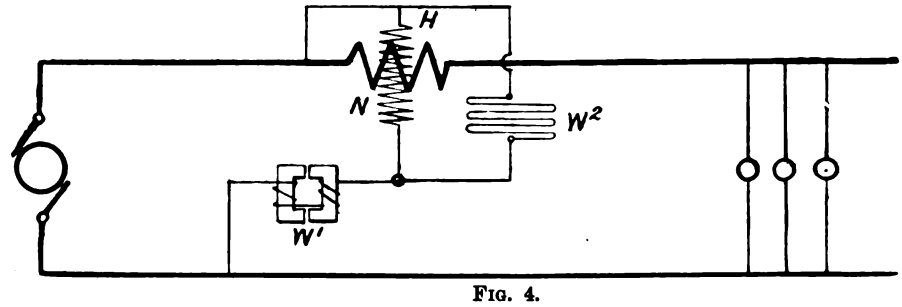

Fig. 4.

ran at 40 revolutions per minute. The errors at different parts of the range were as follows:

Current.		Error per cent.
·19 amperes	.....	+0·25
·99 ,,	.....	−0·6
4·01 ,,	.....	−0·31
6·01 ,,	.....	−0·25
9·97 ,,	.....	+0·3

The general view of the meter with the case off is shown in Fig. 1. The construction of the meter is seen in Fig. 2 and in the section, Fig. 3.

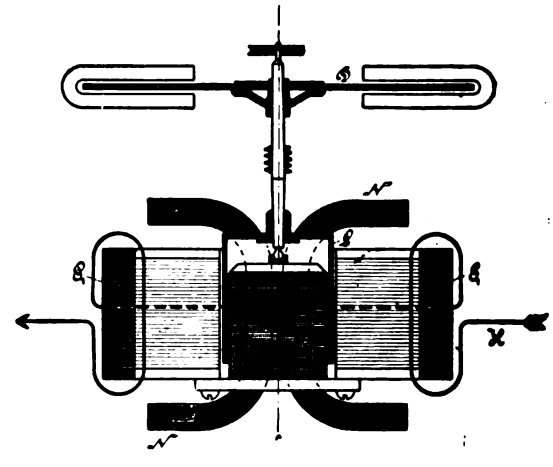

Fig. 3.

The motor is constructed on Ferraris's principle for working with single-phase alternating current. The field, E_1, possesses four poles with four corresponding pole-pieces, each having an extension on one side, all of which point in the same direction. The series winding, H, is of the Gramme type; the shunt winding, N, is laid in frames inside the poles. The amount of current in the shunt circuit is controlled by an inductive resistance, W_1 (Fig. 4), which can be regulated. Thus the speed of the motor can be arranged so as to admit of the consumption being read off direct in hektowatt-hours or kilowatt-hours, and the necessity for a constant is obviated. The armature core,

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E_2, is fixed, while the armature, formed of a bell-shaped piece of copper, G, weighing about 50 grm., revolves. The relative arrangement is such that part of the weight of the copper armature is counteracted by the Thomson effect, so that the actual weight of the revolving portion on the bearings is less than 50 grm. The motor works against a Foucault brake, shown by D (Fig. 3), which rotates between permanent magnets.

In order to make the meter as sensitive as possible under a very light load, the armature is so arranged that its torque, by reason of the above-mentioned extension of the pole-pieces, is somewhat greater than the mechanical friction, so that the armature under the influence of this force tends just to rotate continuously by the action of the shunt. To prevent the meter from running idle in this manner, a small piece of iron wire is attached to the damper, so as to be attracted by the permanent magnets; it is so bent that the meter remains motionless so long as no main current passes through, however violently it may be shaken. Nevertheless, the slightest action of the main current suffices to cause the meter to start. After being switched out of circuit the rotating portion completes one more revolution, until arrested by the action of the permanent magnets upon the above-mentioned piece of iron. The meter can be relied upon with absolute certainty to register under even ½ per cent. of the maximum load. There being neither collector nor brushes on this apparatus, the only mechanical resistance worth consideration is the friction in the lower bearing, for as the spindle is vertical, that in the top bearing is of no importance.

The current taken by the shunt circuit is kept by careful design so low that only about one watt is wasted in the circuit. Meters hitherto constructed upon the Ferraris principle do not take into account the lag of phase in inductive circuits, but only that occurring in the shunt circuit within the meter itself; to measure inductive circuits with accuracy it is necessary that the artificial difference of phase in the shunt shall amount to exactly 90deg. In the present construction, this lag of phase of 90deg. is attained by adding to that of the separate choking coil the lag in the motor itself, arising from the non-inductive resistance, W_2 (Fig. 4), which is connected in parallel with the shunt winding of the motor. The readings of the meter depend upon the number of alternations; it is, therefore, necessary to calibrate the meter in accordance with the periodicity adopted by each individual central station.

ALUMINIUM AS AN ELECTRODE IN CELLS FOR DIRECT AND ALTERNATE CURRENTS.*

BY E. WILSON.

This paper deals with the apparent great resistance which aluminium offers to the passage of an electric current when used as an anode in cells containing, for instance, such an electrolyte as alum in water. The following are references to papers which deal in whole or in part with this or other properties of aluminium when employed as an electrode in electric cells:

Wheatstone. "Roy. Soc. Proc." Read April 26, 1855. This is the earliest paper I have found dealing with the metal aluminium in voltaic cells, but Wheatstone does not appear to have noticed the apparent great resistance mentioned above.

Heeren. "Mittheil. des Gewerbevereins für Hannover," Jahrg., 1855, p. 342. Reference is made in this paper to Wheatstone's experiments.

Buff. "Liebig's Annalen," 1857, vol. 102, p. 269. The author of this paper points out that nine Bunsen elements were not able to pass a current through a cell having aluminium as an electrode. This is the first mention of this property I can find

Ducretet. "Comptes Rendus," 1875, vol. 80, p. 280; also "Journ. de Phys.," 1875, vol. 4, p. 84. Observed great resistance in dilute sulphuric acid due to aluminium plate.

* Paper read before the Royal Society, May 26. Communicated by Dr. J. Hopkinson, F.R.S.

Beetz. "Wied. Ann.," 1877, vol. 2, p. 94. Supposes oxygen to be the cause of this apparent high resistance.

Winkelmann. "Wied. Ann.," 1883, vol. 20, p. 91.

Wright and C. Thompson. "Phil. Mag.," 1885, Part 9, Series 5, vol. 19, pp. 27, 116, 203. Call attention to the non-compliance of aluminium with thermo-chemical data. Reference is made to the work of Julius Thomsen.

Laurie. "Phil. Mag.," 1886, series 5, vol. 22, p. 213. Investigates the effect of amalgamating aluminium, and points out the important part played by the oxide or sub-oxide of aluminium.

Streintz. "Wied. Ann.," 1887, vol. 32, p. 116; also *ibid.*, 1888, vol. 34, p. 751. Suggests a kind of dielectric polarisation distinct from ordinary electrolytic polarisation as cause of the apparent high resistance of aluminium.

Herroun. "Phil. Mag.," March, 1889. Refers to the disconformity of aluminium in voltaic cells with ordinary theory.

Hutin and Leblanc. "Etude sur les Courants Alternatifs et leurs Applications Industrielles," part 2, chap. 10, p. 135.

Graetz. "Wied. Ann.," 1897, vol. 62, No. 10, pp. 323-327; also "Journ de Phys.," series 13, vol. 7. This paper specially deals with alternate currents, and will be referred to again. With regard to direct currents, Graetz gives 22 volts as the E.M.F. which aluminium as anode is able to oppose.

Pollak. "Comptes Rendus," 1897, vol. 124, p. 1,443. With alkaline solutions, Pollak says he can overcome 140 volts continuous pressure. Proposes to use aluminium as one pole of a cell for the purpose of producing a unidirectional current from alternate currents.

Lang. "Ann. Phys. Chem.," 1897, vol. 66, pp. 191-194. Uses an electric arc with aluminium and carbon poles for the purpose of rectifying an alternate current.

PART I.

Direct Currents.

Two sizes of cells have been used in these experiments, each having aluminium and carbon electrodes. The large size consists of one aluminium plate, $\frac{1}{16}$in. thick, and one carbon plate, ¼in. thick, separated by ebonite bolts and nuts, the distance between the plates being ¼in. The surfaces thus opposed to one another in an electrolyte of saturated potash alum in water have each an area of 36 square inches. The aluminium plate was not brought as being specially pure, and may have 2 per cent. impurities. After making preliminary experiments with alternate and direct currents over a lapse of four days, the following experiment was made with this cell and was repeated.

An exploring electrode was inserted midway between the plates, and consisted of a platinum wire sealed into a glass tube. The wire beyond the tube had a length of about 2in., and was coiled into a small spiral, the plane of the spiral being parallel with the surfaces of the plates. A Kelvin quadrant electrometer was arranged with a two-way switch, so that the potential between this electrode and either the carbon or aluminium plate could be observed. The cell was placed in series circuit with another similar in all respects, except that the distance between the plates was ⅛in. instead of ¼in., an adjustable resistance, and an ammeter. By means of a reversing switch this circuit could be reversed across the poles of 22 storage cells having a potential difference of 44 poles. The temperature of the cell was about 12deg. C. The negative pole of the storage cell was connected to the aluminium plate and the current adjusted to 3·6 amperes, the potential difference between the aluminium and carbon plates being 4·4 volts, and gas evolved freely. On reversing the connections—that is, placing the positive pole of the charging battery to the aluminium plate—the current, so far as this ammeter could show, was zero, the potential between carbon and aluminium being about 22 volts. The surface of the fluid was maintained in a state of agitation, but no gas was evolved, except in very small quantity, if any.

The figures in Table I. show how the potentials between the exploring electrode and the carbon and aluminium plates

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respectively, as also the current, varied in terms of time after reversal took place. The time between the two reversals in Table I. was 27 minutes. There is no doubt but that the current, when reversal took place from 3·6 amperes, first crossed the zero and acquired an opposite sign, finally coming to zero of the instrument.

TABLE I.

Time in minutes after reversal.	Reversal from Al anode to Al cathode. Volts between Al plate and exploring electrode.	Volts between C plate and exploring electrode.	Amp.	Reversal from Al cathode to Al anode. Volts between Al plate and exploring electrode	Volts between C plate and exploring electrode.	Amp.
0	+16·6	+1·63	0	-1·74	-2·73	-3·56
About ½	-3·81	-2·04	-3·35	+14·3	+0·30	+1·20
1	-2·48	-2·40	-3·42	+18·2	+1·57	+0·64
2	-2·23	-2·79	-3·47	+19·1	+1·64	0
3	-1·9	-2·84	-3·49	+19·6	+1·67	0
4	-1·9	-2·84	-3·50	+20·0	+1·68	0
5	—	—	—	+20·5	+1·67	0
7	-1·65	-2·84	-3·55	—	—	—
13	-1·74	-2·73	-3·56	—	—	—
190	—	—	—	+17·9	+1·76	0

This is an important point, and was fully established during another set of experiments undertaken to find the resistance of the electrolyte. For this purpose the plates were separated to the extent of $1\frac{3}{16}$in., and two platinum exploring electrodes used, the distance between them in the electrolyte being $\frac{15}{16}$in. along a straight line perpendicular to the parallel surfaces of the plates. Each time reversal took place from negative to aluminium, to positive to aluminium, the potential between these electrodes changed sign, and gradually returned to near zero. The results of the experiments on resistance show that at this temperature the resistance of a layer of electrolyte of area equal to the area of the plates submerged, and of length equal to the distance between the electrode and the plate—that is, $\frac{1}{8}$in. in the experiment of Table I.—is 0·063 ohm. The correction is, therefore, small with current 3·6 amperes, and is negligible when the positive pole is connected to the aluminium.

The next set of experiments were carried out with aluminium $\frac{1}{16}$in. thick of 99·5 per cent. purity, the electrolytes being specially pure and only distilled water used. The cells used are of a smaller size, and each consists of one aluminium plate $1\frac{1}{2}$in. wide, having a carbon plate on each side of it, the distance between the aluminium and carbon being $\frac{5}{32}$in., the carbon plates being $2\frac{1}{2}$in. wide and $\frac{1}{4}$in. thick. The aluminium plate was submerged $2\frac{3}{4}$in. in the electrolyte, so that the total area for current is $8\frac{1}{4}$ square inches.

Two such cells were prepared, one with a 10 per cent. by volume solution of H_2SO_4 in water, the other with a saturated solution of potash alum, and left for 47 hours with a current of $\frac{1}{24}$ ampere passing through each in series, the positive of charging cells being connected to aluminium. At the end of this time, and with this current, the potentials across the cells were 2·4 volts for the H_2SO_4 solution, and nine volts for the alum solution. On breaking the circuit, the potential of the H_2SO_4 solution cell fell to about 0·38 volt in one minute, and rose fairly gradually to 2·4 volts on making circuit. The alum solution cell lost its potential immediately on breaking circuit—that is, the electrometer needle appeared to return to zero as though there were no opposing E.M.F. When the current was reversed—that is, negative to aluminium, and still of the value $\frac{1}{24}$ ampere—the H_2SO_4 solution cell gave 0·24 and the alum solution 1·29 volts.

The aluminium plate which was formed in the H_2SO_4 solution, together with its carbon plates, were next washed in distilled water and placed in a saturated solution of alum. Eleven storage cells were connected without extra resistance in circuit to each of these cells positive to aluminium, and the resulting current noted. The plate which had been formed in H_2SO_4 allowed about 0·2 ampere to pass, and in 4 hours 10 minutes this current had risen to about one ampere, the temperature of the cell having risen. The plate formed in alum solution only allowed 0·083 ampere to pass. The two cells were then placed in series and left for 13 hours, with $\frac{1}{24}$ ampere passing from the aluminium to carbon plates in each.

(To be continued.)

RAILWAY PASSENGER COMMUNICATION.

The following is the report of the committee appointed by the Board of Trade to consider (*a*) whether the means of communication between the passengers in railway trains and the servants of the company in charge of the train at present adopted are efficient; (*b*) whether any particular system of communication in use, or available, is so efficient as to make its general adoption by the railway companies desirable; also to consider and report whether any extension or amendment of the law on the subject is desirable. The report is addressed to the Right Honourable Charles Thomson Ritchie, M.P., the President of the Board of Trade, and reads as follows:

SIR,—We have the honour to report that in accordance with the instructions contained in the minute of the Board of Trade of May 3, 1897, we have carefully considered whether the means of communication between the passengers in railway trains and the servants of the company in charge of the train at present adopted are efficient, whether any particular system of communication in use, or available, is so efficient as to make its general adoption by the railway companies desirable, and also whether any amendment or extension of the law on the subject is desirable. The only legislative enactment bearing upon the subject is Section 22 of the Regulation of Railways Act, 1868, which enacts that "after the first day of April, 1869, every company shall provide, and maintain in good working order, in every train worked by it which carries passengers, and travels more than 20 miles without stopping, such efficient means of communication between the passengers and the servants of the company in charge of the train as the Board of Trade may approve. If any company makes default in complying with this section it shall be liable to a penalty not exceeding £10 for each case of default. Any passenger who makes use of the said means of communication without reasonable and sufficient cause shall be liable for each offence to a penalty not exceeding £5." In order to ascertain the present practice of the railway companies, the committee addressed a circular letter to 36 of the leading companies, asking for information as to the systems of communication in use on their lines, and inviting them to nominate representatives to give evidence before the committee. The replies to this circular showed that the systems adopted may be divided into three classes: (1) systems where communication is made by pulling a cord or wire, placed either inside or outside the carriages; (2) systems in which the communication is made by means of electricity; (3) a system by which a passenger can attract the attention of the servants in charge of the train by a partial application of the brake. Some companies provide no means of communication, as none of their trains exceed the above-mentioned limit of distance without a stop.

Cord Systems.—The method of communication by means of a cord outside the carriage, which is well known and needs no description, is still used by the majority of the companies. This system was approved by the Board of Trade in 1869, but the approval was withdrawn in 1873. Two companies use a modification of this system, in which a cord or wire passes through the inside of the carriages. On the London, Tilbury, and Southend Railway this is placed under the roof, and on the London, Chatham, and Dover Railway along the floor of the carriages. In both cases, the cord or wire when pulled should cause a bell to ring on the engine and in the guards' vans. The cord system used by the latter company was approved by the Board of Trade in 1869.

Electrical Systems.—Various forms of electrical communication are adopted by the following companies: The London, Brighton, and South Coast Railway use a system invented by Messrs. Stroudley and Rusbridge, and approved by the Board of Trade in July, 1887. This is applied to all the company's trains, and it is stated in evidence that no case of its failure to act is recorded. The South-Eastern Railway Company have fitted to almost all their trains an apparatus invented by Mr. Walker, and approved by the Board of Trade in February, 1869. The London, Chatham, and Dover Railway Company use a system, known as Varley's, on some of their express trains. The same arrangement is also used by the Hull and Barnsley Railway Company. It has not been submitted for the approval of the Board of Trade, but both companies state that it works in a satisfactory manner. In each case the communication is made by means of a handle within the carriage, and a bell is rung on the engine and in the guards' vans, but the systems vary somewhat in their details. In Varley's system two wires are used, necessitating two couplings between each

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carriage, while in the other systems one coupling only is required. On the South-Eastern Railway an indication of the compartment in which the apparatus has been used is afforded by means of a disc outside the carriage. Some of the companies who use the cord have fitted electrical communication on particular trains—*e.g.*, the London and North-Western and Caledonian Companies on the Royal train, the Great Western Railway on their corridor trains, and the Great Northern Railway (Ireland) on their limited mail trains.

Brake System.—A means of calling the attention of the servants in charge of a train by a partial application of the automatic vacuum brake is adopted on the Great Central and Furness Railways, and partially on the Cambrian Railway. The passenger wishing to use the apparatus moves a handle inside the carriage, and thereby opens a valve admitting a certain amount of air into the brake pipe, thus partially applying the brake. At the same time an indication is given, by means of a disc outside the carriage, of the compartment from which the signal has been given. When the brake is thus applied, the driver can either stop the train at once, or, if the alarm is given from one carriage only, he can overcome the resistance for a time and allow the train to proceed for a certain distance until it reaches a suitable stopping place. If, however, the alarm is given from more than one carriage, the train is speedily brought to a standstill. No direct indication is given to the driver or guards that the apparatus has been used beyond that furnished by the brake gauge, but the effect upon the train should call their attention to the fact that the brake has been applied. This system was provisionally approved by the Board of Trade in 1890, and the approval was confirmed in 1893.

Systems in Use on Railways in other Countries.—The committee thought it desirable to ascertain the means of communication used on railways in other countries, and they therefore requested the Board of Trade to obtain for them through the Foreign, Colonial, and India Offices, information as to the means adopted on the principal railways in Austria-Hungary, Belgium, France, Germany, Italy, Russia, Switzerland, the United States of America, Canada, New South Wales, and India. The replies received show that in Austria all fast and express trains are fitted with an electrical communication (system Rayl). In Hungary the use of corridor carriages is said to be nearly universal, and when these are fitted with an automatic brake means are provided to enable the passengers to apply it, and thus call the attention of the servants in charge of the train, and no further means of communication is thought necessary. A system of electrical communication was formerly employed, but it has gone out of use since automatic brakes were generally adopted on main lines. In Belgium a means of communication by the application of the Westinghouse brake, similar in principle to that used in connection with the vacuum brake by the Great Central and other railways in this country, is in force on the State railways, and it is instructive to note that it was thought desirable to increase the size of the valve through which the air escapes from the brake pipe when the brake is applied by a passenger, so as to ensure the speedy stoppage of the train. The same arrangement is used on the principal Italian railways. In France, the system to be adopted is left to the discretion of the individual companies, some of which employ electrical means, generally Prudhomme's system, while others prefer the Westinghouse brake system. In Germany, almost all passenger trains are fitted with automatic brakes, and means are provided to enable passengers to apply the brake in case of emergency. In Russia and Switzerland corridor carriages are generally used, and when automatic brakes are provided, passengers can apply them. In Canada there is direct means of access from one part of a train to another, each carriage being connected to the next by a gangway, but a cord runs through the train by which a signal to stop can be conveyed to the driver. In India various means of communication have been tried, but the Indian Government state that the only one that has given satisfaction is an electrical method invented by the late Mr. G. K. Winter. This system, in which the electric connection between the carriages is made by means of the side or safety chains, has been in use on the Madras Railway since 1880, and is being introduced on the South Indian Railway. No information as to the methods of communication in the United States and New South Wales has been received.

Witnesses.—The first witness who gave evidence before us was Mr. F. J. S. Hopwood, C.B., C.M.G. The committee are indebted to him for an account, both of the causes that led up to the inclusion in the Regulation of Railways Act, 1868, of the section requiring the provision of means of communication, and also of the action subsequently taken by the Board of Trade and the different railway companies under the section. The committee then proceeded to examine the following representatives nominated in response to the circular issued by the committee: Mr. H. Pollitt, locomotive engineer, Great Central Railway; Mr. R. J. Billinton, locomotive and carriage superintendent, London, Brighton, and South Coast Railway; Mr. T. I. Allen, superintendent of line, Great Western Railway; Mr. C. Spencer and Mr. W. R. Sykes, works manager and telegraph inspector, London, Chatham, and Dover Railway; Sir C. Scotter, general manager, London and South-Western Railway; Mr. W. L. Mugliston, superintendent of line, Midland Railway; Mr. J. Alexander, superintendent of line, Great Northern Railway; Mr. W. Leonard, telegraph superintendent, South-Eastern Railway; Mr. I. Kempt, general superintendent, Caledonian Railway; Mr. R. Turnbull, chief passenger superintendent, London and North-Western Railway; Mr. B. Bullock, traffic manager, London, Tilbury, and Southend Railway; Mr. F. T. Hollins, telegraph engineer, Great Eastern Railway. The committee also had the benefit of learning the views held by Lieut.-Colonel H. A. Yorke, R.E., one of the inspecting officers of railways to the Board of Trade; by Mr. G. P. Neele, who for 35 years was superintendent of the line on the London and North-Western Railway; and by Mr. C. E. Spagnoletti, consulting electrical engineer to the Great Western Railway Company, and formerly their electrician-in-chief.

Conclusions as to Existing Systems.—Most of the witnesses examined by the committee agreed that the ordinary means of communication by means of a cord outside the carriage is unsatisfactory, and with these opinions your committee entirely concur. Owing to the difficulty of obtaining access to the cord in cases of emergency, and to the uncertainty of its action when pulled, this system cannot be regarded as affording a reliable means of communication, and the committee have no hesitation in condemning it. Some advantages over this system are no doubt possessed by those in which a cord or wire passes inside the carriages, but the committee cannot hold that they are satisfactory. As regards the electrical systems of communication referred to above, the committee had the advantage of making trial of that in use by the London, Brighton, and South Coast Railway Company, on a train placed at their disposal by the company. They found it to work efficiently, whilst the company, as previously mentioned, have no record of its having ever failed. Evidence was received by the committee indicating that the electrical methods in use on the South-Eastern and London, Chatham, and Dover Railways had given satisfactory results. The committee also had an opportunity of inspecting an electrical system fitted by the Great Eastern Railway Company to one of their trains, in which the wires are carried along the brake pipes, and the coupling of the pipes between two carriages automatically gives the necessary connection between the wires. This system worked satisfactorily when tested, and it has the advantage of obviating the necessity for any additional coupling, a point which the committee think will be found of considerable importance to railway companies in working their traffic. The committee are of opinion that all these electrical systems, though some of them may be capable of improvement, may be considered as providing efficient means of communication. The London and South-Western Railway Company have been good enough, at the request of the committee, to fit up a train with a somewhat similar system, in which the electrical connection between the carriages is made by coupling the side chains. The system was invented by the late Mr. G. K. Winter, and, as has already been stated, is largely used in India. As the train has only recently been fitted with the apparatus, there has not been time for a prolonged trial of the system, but, so far as the tests have gone, they have, we understand, been satisfactory. The conducting surfaces, however, being open to the atmosphere and to dust or snow, are not likely in the opinion of the committee, to be as efficient as those which are placed within the brake coupling. A system of communication by means of the automatic brake has been applied in this country only on trains using the vacuum brake. Through the kindness of the Great Central Railway Company, the committee have had an opportunity of practically testing this method of communication. It worked satisfactorily, and companies by whom it has been adopted speak of it in the highest terms. One of its great advantages is that each carriage is complete in itself, and the coupling of the brake pipes between two carriages of necessity connects the means of communication. It has also been pointed out to the committee that, in the case of interchange rolling-stock fitted with both the vacuum and Westinghouse brakes, the same apparatus within the compartment can be made to actuate valves connected to either brake pipe, so that whichever brake is in use the means of communication is available. As already stated, the system is largely applied on Continental railways to the Westinghouse brake, and appears to have given satisfaction, but in the opinion of the committee it would be improved by an additional arrangement by which the attention of the driver and guards might be audibly called to the signal, and by which drivers and guards could communicate with each other. It has been suggested that the increasing use of corridor or other similar carriages will do away with the necessity for means of communication, but the committee cannot agree with this view, as they are of opinion that some method of communicating with the driver and guards is as necessary upon corridor as upon other trains. Your committee have carefully considered the second point referred to them—viz., whether any system in use or available is so efficient as to make its general adoption desirable. The

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committee do not think that any one of the electrical systems of communication in use at the present time possesses such advantages over the others or over the brake system as to justify them in recommending it for general adoption. On the other hand, many railway companies entertain a strong objection to granting to a passenger even a limited control over the brake, and the committee do not think that a system which involves the grant of such a control, however efficient it may be, should be pressed upon a company against the advice of its responsible officers. Of systems not in use, but available, the committee have had a number brought before their notice. Many of these are very ingenious and do credit to their inventors, but they have in most cases been anticipated by other inventions, and either closely resemble or possess no great advantage over means now in use.

Conditions which a Method of Communication should Fulfil.—The following are the conditions which it appears to the committee a method of communication should fulfil to be entirely satisfactory: (1) it should be one which would lend itself readily to the interchange of carriages between different railways; (2) it should be easily applicable, and should communicate directly with the driver as well as with the guards, whilst the means by which it is actuated by the passenger should be in a conspicuous position, either in the centre or at both ends of the compartment without affording too great a temptation to passengers to tamper with it; (3) it should be reasonably cheap, as to both initial cost and maintenance; (4) it should afford an indication outside the carriage of the compartment from which the communication has been made, and a passenger should not be able to replace the means by which the alarm is given; (5) it should not entail the use of additional couplings to those already existing—viz., the screw coupling, the side chains, the automatic brake, and the heating apparatus (where in use); (6) it should be capable of being used as a means of communication between the driver and guards of a train, as well as between the passengers and the driver and guards.

Extension of the Existing Law.—The committee were also directed to consider whether any extension or amendment of the law on the subject is desirable, and to this point they have given careful attention. Under the present law means of communication need only be provided on trains running 20 miles without stopping. It is obvious, however, that serious harm can be done, either by accident or design, in a journey of much less duration. Experience has unfortunately shown that a very short journey affords sufficient time to enable murder and outrage to be committed. Several railway companies have already fitted, or are fitting, means of communication to all their trains, irrespective of the distance to be run without a stop, and representatives of other companies agreed in evidence that such an extension was reasonable. The committee are of opinion that the law should be so amended as to require efficient means of communication to be provided on all passenger trains.

Conclusions.

On the three points to which the enquiry of the committee was directed, their conclusions may therefore be summarised as follows:

1. That of the methods of communication at present adopted, the outside cord system should be condemned as inefficient, while the systems in which the cord or wire is inside the carriages cannot be regarded as satisfactory. The principal electrical systems and the communication by means of the brake may, however, be held to be efficient.

2. That no one of the electrical systems so far excels the others as to enable the committee to recommend it for general adoption, although they prefer the system of communication described above as experimentally used on the Great Eastern Railway.

3. That the law should be extended so as to require the provision on all trains of an efficient means of communication between passengers and the servants in charge of the train, which could also be used as a means of communication between the guards and driver.

Reference has been made above to certain trials conducted by the committee, who desire to express their obligations to the Great Eastern, Great Central, and London Brighton and South Coast Railway Companies, for having placed trains at their disposal, whilst the first of these companies, in addition, afforded the use of their line for the trials. The committee are also indebted to the London and South-Western Railway Company who, at their request, fitted up a train with an electrical system. They also desire to thank those gentlemen who appeared to give evidence for the assistance which they rendered. In conclusion, the committee wish to express their appreciation of the services of their secretary, Mr. Marwood, who has been of the greatest assistance to them throughout their enquiry.—We have the honour to be, Sir, your obedient servants,

(Signed) T. W. P. Blomefield. C. S. Hutchinson.
William Birt. G. W. E. Loder.
Douglas Fox.

W. F. Marwood, Secretary, June, 1898.

KINGSTON-UPON-HULL.

The electric lighting accounts of the borough of Kingston-upon-Hull show a total expenditure on the electric light undertaking up to March 31, 1898, of £61,738. 11s. 6d. Herewith we give the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., for the 12 months ending March 31, 1898:

Revenue Account.

Dr. Expenditure.		£	s.	d.
To Generation of Electricity.				
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£1,096 0 0			
Oil, waste, water, and engine-room stores	169 15 3			
Wages at generating station	816 0 2			
Repairs and maintenance—buildings, £146. 9s. 10d.; engines and boilers, £175. 5s. 8d.; dynamos, exciters, transformers, motors, etc., £140. 14s. 9d.; *other machinery, instruments, and tools, £1,201. 18s. 11d.; *accumulators and accessories, £94. 19s. 10d., £1,759. 9s; *less sale of old boiler, £375	1,384 9 0			
		3,466	4	5
Distribution of Electricity.				
Wages and other remuneration to linesmen, fitters, and labourers	70 14 2			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	80 8 5			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold	4 13 5			
		155	16	0
Rents, Rates, and Taxes.				
Rents payable	140 13 9			
Rates and taxes	615 5 9			
		755	19	6
Management Expenses.				
Salaries (engineer's department)	737 11 2			
Printing and stationery	107 19 8			
General establishment charges	145 15 10			
		991	6	8
Law and parliamentary charges		10	10	11
Special charges—insurance, etc.		70	12	10
		5,450	10	4
Amount carried to net revenue account		5,002	15	5
		£10,453	5	9

Cr. Receipts.	£	s.	d.
Sale of current per meter, 3d., 4d., 5½d., and 6d. per B.T.U.	9,967	8	7
Rental of meters and other apparatus on consumers' premises	329	6	7
Other items, miscellaneous	92	5	9
Premium	30	0	0
	10,419	0	11
Stores on hand, March 31, 1898	34	4	10
	£10,453	5	9

* Temporary auxiliary installation at North-street to deal with the continually and rapidly increasing demand during the winter months.

General Balance-Sheet.

Dr. Liabilities.		£	s.	d.
Capital account—loans raised by stock		53,474	3	7
Treasurer		6,479	1	8
		59,953	5	3
Net revenue		1,785	6	3
		61,738	11	6
Sundry depositors' deposits on supply of current		10	10	0
Revenue account—sundry creditors		51	13	7
Balance at credit of net revenue:				
Dec. 31 1893	£13 2 4			
Dec. 31, 1894	996 2 2			
Dec. 31, 1895	1,263 0 4			
March 31, 1897	1,981 9 10			
	4,253 14 8			
Less applied to capital	1,785 6 3			
	2,468 8 5			
Balance	2,039 18 6			
		4,508	6	11
		£66,309	2	0

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Cr. Assets.	£	s.	d.
Capital account—expended on works	61,518	7	11
Stores on hand	220	3	7
	61,738	11	6
Revenue account—stores on hand: coal, £15. 4s. 3d.; oil, waste, etc., £19. 0s. 7d.; sundry debtors for current supplied, £4,057. 9s. 7d.; other debtors, £228. 17s. 3d.; treasurer, £249. 18s. 10d.	4,570	10	6
	£66,309	2	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units	553,389
Quantity sold to private consumers by meter	467,352
Quantity used on works	46,455
Total quantity accounted for	513,807
Quantity not accounted for	39,582
Total maximum supply demanded—kilowatts	687

SUNDERLAND ELECTRICITY WORKS.

The accounts of the Sunderland Corporation electricity works for the year ended March 31, 1898, have just been issued. The total expenditure on capital account up to date has been upwards of £45,000. We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

ELECTRIC LIGHTING REVENUE ACCOUNT.

Dr. Expenditure.				£	s.	d.
Generation of Electricity.						
Coal	£463	0	9			
Oil, waste, water, and engine-room stores	127	15	2			
Wages	665	17	6			
Repairs and maintenance: buildings, £3. 2s. 5d.; engines and boilers, £118. 9s.; dynamos, transformers, etc., £14. 15s. 5d.; other machinery, instruments, and tools, £20. 15s. 11d.; accumulators and accessories, £148. 4s. 8d.	305	7	5			
				1,562	0	10
Distribution of Electricity.						
Wages of linesmen, etc.	33	19	7			
Repairs of mains and services	1	4	10			
Repairs of meters, switches, fuses, etc.	2	18	5			
				38	2	10
Attending and repairs to public lamps				36	10	7
Rents, Rates, and Taxes.						
Rents payable	128	17	2			
Rates and taxes	149	18	0			
				278	15	2
Management expenses—salaries: engineers, £304. 11s. 8d.; clerical staff, £62. 17s. 3d.	367	8	11			
Collector	82	15	0			
Stationery and printing	52	4	0			
General establishment charges	88	9	9			
				590	17	8
Insurances				91	14	7
				2,598	1	8
Amount carried to net revenue account				1,653	6	6
				£4,251	8	2

Cr. Income.	£	s.	d.
Sale of current per meter at 5d., 3d., and 2½d. per B.T.U.	3,951	13	10
Public lighting	99	0	0
Rental of meters and other apparatus on consumers' premises	131	3	7
Sale and repairs of lamps, £8. 4s.; other apparatus, £19. 4s. 3d.	27	8	3
Rents receivable	39	2	0
Charging batteries	1	19	6
Deposit fee forfeited	1	1	0
	£4,251	8	2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received as per account	46,124	2	2
Sinking fund account	38	0	2
Balance due treasurer	779	12	8
	£46,941	15	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	45,083	15	7
Stores on hand: coal, £2. 12s. 5d.; oils, waste, etc., £29. 5s. 6d.; general, £292. 4s. 3d.	324	2	2
Sundry debtors for current supplied to March 31	1,533	17	3
	£46,941	15	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		361,420
Quantity sold { Public lamps	11,253	270,352
Quantity sold { Private consumers by meters	259,099	
Quantity used on works		59,521
Total quantity accounted for		329,873
Quantity not accounted for		31,547
Number of public lamps		50
Total maximum supply demanded (kilowatts)		361

MANCHESTER ELECTRICITY WORKS.

The following is the report of the Electricity Committee for the year ended March 31, 1898, together with the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

The number of consumers at the close of the year was 1,981, being an increase of 400 as compared with the previous year. The total number of lamps connected was: incandescent, 149,176 (of 8 c.p.); arc, 1,399; as compared with 120,142 and 1,172 respectively. There were also 214 motors in use, representing 496 h.p., being an increase on the previous year of 92 motors, equivalent to 279 h.p. The total length of mains now laid is 80,102 yards, or 45 miles 902 yards of mains. The amount of energy measured and accounted for was 3,641,599, being 93·11 per cent. of the total generated at the works. It will be observed on referring to the accounts that the financial results of the year have been satisfactory. The net profit, after defraying all charges for cost of production, etc., providing for renewals, sinking fund, and interest on loans, amounts to £13,522. 17s. 4d.

REVENUE ACCOUNT (ABSTRACTS 3 AND 4).

The amount derived from sales of current, which works out at 3·67d. per unit accounted for, was				£55,657	12	7
The receipts for meter rents amount to				1,751	1	10
Producing a total income of				£57,408	14	4
The expenditure was	£24,425	10	9			
To which is added the amount transferred to renewal suspense account	3,434	12	1			
				27,860	2	10
Showing a gross profit of				£29,548	11	7
Out of this sum the following requirements had to be met—viz.:						
Interest on mortgage debt, etc.	£8,039	5	9			
Sinking fund	7,986	8	6			
				16,025	14	3
Leaving a surplus, or net profit for the year of				£13,522	17	4
This surplus has been appropriated in the following manner:						
Placed to city fund in aid of rates				£10,000	0	0
Placed to reserve fund				3,522	17	4
				£13,522	17	4

The following statement exhibits the financial position of the undertaking at March 31, 1898:

Total capital expenditure	£357,616	14	10
Mortgage debt	£325,694	16	6
Amount of mortgages redeemed to date by action of sinking fund	£24,305	3	6
Balance at credit of renewals suspense account	14,233	7	2
Ditto reserve fund	20,009	9	4
	£34,242	16	6

On Sept. 30 last the price of electric energy was reduced from 6d. to 5d. per unit consumed, and the fixed charge to long-hour consumers was reduced from £9 to £7 per annum per unit of demand. The long-continued dispute in the engineering trade during the later months of 1897 impeded the construction of a large combined engine and dynamo (of 2,500 h.p.) which had been ordered from the Electric Construction Company, Limited, for delivery at Dickinson-street station in October last, and the committee were reluctantly compelled to issue a notice to the effect that no new applications for a supply of electric energy could be connected to the mains until the spring of this year. This action, although under the circumstances unavoidable, resulted in a serious loss of revenue to the department, and caused much disappointment to a large number of firms who had wired their premises in readiness for the electric energy. In order to cope with the increasing demand for the supply of electric energy for lighting and motive power the following extensions of plant have been ordered, and are in course of construction, for the Dickinson-street station—viz., six Lancashire boilers and four tubular boilers, all with mechanical stokers; two economisers; two direct-driven electric generators, of 2,500 h.p. each. Progress is also being made with the extension of mains, and the work will proceed along the following thoroughfares—viz., City-road, Chester-road, Liverpool-road, Great Bridgewater-street, Hyde road; Clowes-street, Gorton; Thomas-street, Gorton;

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Wilmslow-road, Oldham-road. Preparations are being made to supply electric energy in the districts of Moss Side, Withington, and Levenshulme during the coming winter. Your committee have recently acquired an eligible plot of land alongside the canal in Stuart-street, Bradford, containing 41,955 square yards, which will be equipped as a generating station in due course; the ultimate capacity of this station will be about 100,000 h.p. In addition to the above, a plot of land in the Polygon, Ardwick, has been purchased, on which it is intended to erect buildings for the storage of cables and various instruments, also for workshops and transformer station. For the purposes of the foregoing and other extensions which are contemplated, further borrowing powers will be necessary, and, in accordance with a resolution of the City Council, application has been made to the Local Government Board for sanction to raise an additional sum of £200,000. May 20, 1897, marked the commencement of arc lighting in the streets, on which date the electric energy was switched on to the arc lamps in Albert-square, St. Ann's-square, and Piccadilly. In compliance with instructions from the City Council, a considerable number of arc lamps will shortly be erected in many of the principal thoroughfares of the city.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal (including cost of unloading, etc.)	£6,449	18	8			
Oil, waste, water, and engine-room stores	2,316	9	3			
Wages at generating station	2,738	6	11			
Repairs, maintenance, and renewals: buildings, £437. 19s. 6d.; machinery, etc., £1,980. 12s. 11d.	2 418	12	5			
Current used on works, etc., £1,243. 8s. 4d.; and maintenance of lamps, etc. (lighting of station), £65. 6s. 4d.	1,308	14	8			
				15,232	1	11
Distribution of Electricity.						
Wages	641	2	9			
Sundries	155	16	9			
Repairs, maintenance, and renewals at distributing stations: Hunt's Bank, £18. 9s. 5d.; Piccadilly, £12. 8s. 5d.; Royal Exchange, £12. 5s.; All Saints', £67. 8s. 7d.; Ardwick Green, £3. 2s. 8d.; mains, fuses etc., £642. 15s. 2d.; meters, £41. 4s. 7d.; tools, £349. 1s. 8d.	1,146	15	6			
				1,923	15	0
Rents, Rates, and Taxes.						
Chief rents	180	6	6			
Rents of sub-stations and offices in town hall	330	16	0			
Rent of telephones	26	0	0			
Rates	1,066	7	10			
Income tax	870	10	0			
				2,474	0	4
Management Expenses.						
Salaries—viz.: Engineer's department	1,361	1	4			
Secretary's department and clerical staff	1,290	19	11			
Stationery, printing, and advertising	387	10	7			
General establishment charges	1,072	12	1			
				4,112	3	11
Law and Parliamentary Charges and Expenses.						
Law charges	146	17	7			
Stamp duty	123	7	9			
				270	5	4
Special Charges.						
Insurances	14	14	8			
Bank commission (including £2. 9s. 11d. transferred from sinking fund account)	35	8	8			
Contributions to Manchester Corporation Thrift Fund	60	3	2			
Commission on loans	68	16	7			
Repairs and maintenance of office furniture	171	4	3			
Official clothing	46	3	5			
				396	10	9
Amount written off for bad debts				16	13	6
				24,425	10	9
Amount transferred to renewal suspense account, being difference between the estimated wear and tear of buildings, machinery, mains, etc., during the year and the repairs and maintenance actually charged				3,434	12	1
Balance carried to net revenue account				29,548	11	7
				£57,408	14	5

Cr.	£	s.	d.
Current (including £237. 17s. 10d. for current supplied to public street lamps)	55,657	12	7
Rental of meters	1,751	1	10
	£57,408	14	5

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgage debt—loans as per capital account	325,694	16	6
Sundry creditors—deposits held as security for current supplied, £1,487. 12s. 2d.; interest accrued on ditto, £78. 18s. 8d.; trade accounts owing, £9,908. 0s. 3d.	11 474	11	1
Amount at credit of renewals suspense account	14,233	7	2
Amount at credit of reserve fund	20,009	9	4
Balance, being surplus—mortgages redeemed by sinking fund, £24,305. 3s. 6d.; cash in sinking fund account, £1,615	25,920	3	6
	£397,332	7	7

Cr. Assets.	£	s.	d.
Land, buildings, plant, etc.—amount expended	357,616	14	10
Stocks on hand	2,723	9	4
Sundry debtors—accounts due for current supplied, £17,337. 18s. 2d.; other accounts due, £461. 12s. 4d.; cash in hand, £241. 2s. 10d.	18 040	13	4
Amount at bankers	2,464	18	1
Reserve fund investment—India 3 per cent. stock	16,486	12	0
	£397,332	7	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated		3,911,279
Quantity sold { Private consumers	3,406,762	3,434,850
Quantity sold { Public lamps	28,088	
Quantity used on works		206,749
Total quantity accounted for		3,641,599
Quantity not accounted for (6·89 per cent.)		269,680
Number of public lamps		20
Total maximum supply demanded (watts)		3,776,000

COMPANIES' MEETINGS AND REPORTS.

THOMAS PARKER, LIMITED.

The annual meeting of the shareholders of the above Company was held last week at the works, Wolverhampton. Mr. C. T. Mander, J.P., chairman of the Company, presided.

The **Chairman** moved the adoption of the report (which has already appeared in our columns), which was adopted.

Subsequently a resolution was passed formally ordering a dividend of 8 per cent. to be paid.

Mr. W. Thomas was re-elected a director, and Messrs. Allen Edwards and Smith were reappointed auditors.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

Directors: Sir Daniel Cooper, Bart., G.C.M.G. (chairman); James William Barclay (deputy chairman); Philip Edward Beachcroft; John Irving Courtenay; Sir Henry C. Mance, C.I.E.; Sir James Pender, Bart., M.P. Manager: A. B. Blackburn, M.I.C.E. Secretary: James Gray.

Report of the directors, to be submitted to the shareholders at the fifth annual meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Thursday, July 21, 1898, at 2.30 p.m.:

The net profits of the year are £18,854. 7s., and adding the balance brought from last year, £16,499. 0s. 9d., the amount available for dividend is £35,353. 7s. 9d. Your directors recommend payment on July 30 of a dividend of 7 per cent. on the preference shares, and of 6 per cent. on the ordinary shares, one-half on July 30, and the other on Jan 31 next. These dividends will absorb £16,274. 7s. 3d., and your directors further recommend that £17,000 of the surplus, together with the £23,000 now at credit of depreciation account, be transferred to a general reserve and depreciation account, which would thus amount to £40,000, the balance of £2,079. 0s. 6d. remaining at credit of profit and loss account to be carried forward. The buildings and plant have been fully maintained, and adequate depreciation provided as formerly out of revenue. Only such additions as tend to increase of output or to economy in production are charged to capital account. The business continues to make satisfactory development, both in respect of quantity and novelty of machines manufactured, and its growth has necessitated further additions to buildings and plant. During the year several installations of central-station plant have been successfully completed, including the Halifax electric tramways. An important contract has recently been concluded with the City and South London Railway Company for the electrical equipment of its extension to Moorgate-street. It is not expected that the Workmen's Compensation Act, 1897, will affect the Company to any important extent, as there has been no serious accident in the works during the last five years. The financial arrangements mentioned in last report have been successfully carried out. Eight thousand six hundred and fifty-seven preference shares were issued to shareholders at a premium of 15s. per share, and a 4 per cent. debenture stock has been created to redeem the 6 per cent. first mortgage debentures. Holders of £112,800 of the debentures exchanged them in January

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for an equal amount of stock and a premium of 3 per cent., and the balance of £37,209 will be dealt with on the 15th current. The 6 per cent. second mortgage debentures are repayable by half-yearly drawings. The directors who retire by rotation at the general meeting (and are eligible for re-election) are Messrs. Barclay and Courtenay. Messrs. James Meston and Co., the auditors for the past year, offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDED MAY 31, 1898.

Expenditure.				£	s.	d
Interest on loans and debentures, paid and accrued				10,922	3	4
General charges—salaries to staff in head office and works	£11,965	3	5			
Rent, rates, and taxes, and income tax	1,206	5	3			
Insurances	212	4	5			
Advertising	652	14	2			
Travelling expenses	518	14	1			
Patent fees and royalties	1,275	17	3			
Law charges	202	10	6			
Printing and stationery, postages and telegrams	830	1	6			
Commissions and foreign agency charges	790	1	8			
General expenses, bank charges, stamps, etc.	932	18	1			
Fees and expenses of trustees under first and second mortgages	222	16	6			
Auditors' fee	120	0	0			
Directors' fees	1,500	0	0			
				20,429	6	10
Maintenance of plant and buildings	1,735	1	6			
Depreciation account—amount set aside	5,000	0	0			
				6,735	1	6
				38,086	11	8
Net profit				35,353	7	9
				£73,439	19	5

Income.				£	s.	d.
Amount brought forward from last year				16,499	0	9
Gross profit on manufacturing, contracting, etc	£45,845	6	9			
Rents, pupils' premiums, and sundry profits	3,638	11	1			
Interest and dividends on debentures and shares of other companies	4,829	17	7			
Premium on issue of 8,657 7 per cent. preference shares, £6,492. 15s.; less cost of redeeming £150,000 6 per cent. first mortgage debentures and issuing £150,000 4 per cent. debenture stock, £3,967. 16s. 9d.	2,524	18	3			
Transfer and registration fees	102	5	0			
				56,940	18	8
				£73,439	19	5

BALANCE-SHEET, MAY 31, 1898.

Capital and Liabilities.				£	s.	d.
Capital authorised—						
150,000 ordinary shares of £2 each				300,000	0	0
50,000 cumulative 7 per cent. preference shares of £2 each				100,000	0	0
				£400,000	0	0
Capital issued—						
110,000 ordinary shares of £2 each, fully paid				220,000	0	0
25,000 cumulative 7 per cent. preference shares of £2 each, fully paid				50,000	0	0
				270,000	0	0
Debentures issued—First mortgage 6 per cent. debenture bonds	£37,200	0	0			
4 per cent. perpetual first mortgage debenture stock	112,800	0	0			
Second mortgage 6 per cent. debenture bonds, authorised issue, £140,000: current at June 1, 1897, £41,040; less drawn and paid off during year, £26,660	38,380	0	0			
				188,380	0	0
Loans (secured by deposit of shares and debentures in other companies)				95,000	0	0
Sundry creditors	£37,799	4	4			
Debenture interest accrued	3,488	10	0			
				41,287	14	4
Bills payable				505	7	2
Provision for balance of expenses of debenture issue				1,000	0	0
Depreciation account—Amount at credit per last account	£18,000	0	0			
Credited from profits for year ending May 31, 1898	5,000	0	0			
				23,000	0	0
Profit and loss account—Net profit				35,353	7	9
				£654,526	9	3

Assets.	£	s.	d.
Properties, patents, and goodwill—			
Freehold and leasehold land and buildings at Bushbury (Wolverhampton) and Millwall; plant, machinery, tools, and patterns at works; furniture; patents and goodwill, as per last account	318,339	14	1
Additions to plant and furniture during the year	4,751	9	3
Ditto to buildings ditto	2,674	7	11
	325,765	11	3
*Shares and debentures of other companies	124,494	3	0
Sundry debtors (after providing for bad and doubtful debts)	95,716	18	0
Trustees of first mortgage debentures—price of property sold	2,500	0	0
Bills receivable	1,249	18	6
Work and contracts in progress—cost	52,266	0	5
Stock—finished goods and materials on hand—cost or under	40,056	8	8
Cash at bankers and in hand	12,477	9	5
	£654,526	9	3

* Note.—There is a contingent liability in respect of amounts uncalled on certain of these shares.

EDMUNDSONS' ELECTRICITY CORPORATION, LIMITED.

The first ordinary general meeting of Edmundsons' Electricity Corporation, Limited, was held last week at the offices, Broad Sanctuary-chambers, Westminster, S.W., under the presidency of Mr. John R. Wigham, J.P., chairman of the Company.

The **Chairman**, in moving the adoption of the report, said the profit and loss account gave the result of 21 months' working, the Company having taken over the business as a going concern from July 1, 1896, and showed a profit of £7,645; but out of that profit the sum of £2,500 had been paid to the shareholders in the old company as interest on the purchase-money for nine months, according to the arrangement made with that company. Under the head of assets, goodwill, leases, etc., £45,000, that amount ought to be greater by the sum of £9,000. The £9,000 received from the Government as compensation for taking Edmundsons' premises, 19, Great George-street, was taken off the amount standing in the books for goodwill, thus reducing that amount to the figure at which it now stood. The directors, in recommending that a dividend at the rate of 5 per cent. be paid upon the ordinary shares, reminded the shareholders that those shares were entitled to a cumulative 6 per cent. dividend before anything was paid on the deferred shares, and, as only 5 per cent. was being paid this year, a further 1 per cent. was due on these shares before any dividend could be paid on the deferred shares. The business of the Company was increasing rapidly, and the directors proposed to give a preference to the existing shareholders for any new shares which might be issued. The directors regretted to have to record that one of their collegues, Mr. Henry Wigham, had been removed by death.

Mr. W. R. Davies seconded the motion for the adoption of the report and statement of accounts, and it was unanimously agreed to.

The auditor, Mr. W. H. May, was reappointed.

CROMPTON AND CO., LIMITED.

Directors: John Trotter, Esq. (chairman); Rookes Evelyn Bell Crompton, Esq. (managing director); Bernard Gibson, Esq.; Carleton F. Tufnell, Esq.

Tenth report of the directors, to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Thursday, July 21, 1898, at 3 p.m.:

The net profits for the year amount to £13,568. 14s. 4d. Seeing that during nearly six months of the year the engineering trade was disorganised by the disastrous strike of the workmen, and, secondly, that the removal of the machinery from the old works to the new was effected during the past 12 months, the result of the year's working may be considered reasonably satisfactory. After providing for debenture interest and the other payments set out in the net revenue account, there remains a balance of £4,606. 17s. 11d., which the directors propose to carry forward. The new freehold works of the Company are now equipped and in going order, and the anticipations of the directors as to economies and speed of manufacture at these works have been fully realised. The manufacture of arc lamps, electrical measuring instruments, and switchboards is still being carried on at the old works; probably it will be to the advantage of the Company in the near future to conduct the whole of its manufactures in one place. Since Jan. 1 the Chelmsford Electric Lighting Company has been in possession of the generating station and has been supplying current to the old works. The lighting company is making satisfactory progress, and has declared a dividend of 4 per cent. upon its share capital for 1897. The business of manufacturing electrical machinery is in a satisfactory state, and, although better prices are being charged, the order book of the Company is very full. Negotiations are also in a forward state for several important contracts at good prices. The directors believe that the prospects of the Company have decidedly improved during the year. The resolutions for reduction of the capital of the Company, passed by the shareholders last autumn, have been confirmed by

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the Court, and in the opinion of the directors the statement now presented represents the actual financial position of the Company. The whole of the assets have been thoroughly examined and written down to what is considered their proper values, and the Board take this opportunity of congratulating the shareholders on their having taken the necessary steps to place their business on a sound footing. Mr. J. F. Albright has retired from the position of a director of the Company, and it is not proposed to fill the vacancy at present. In accordance with the articles of association, Mr. Bernard Gibson retires from the board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offers themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS AT MARCH 31, 1898.

Capital and Liabilities.	£	s.	d.
Authorised issue 54,000 shares at £3	162,000	0	0
Issued—32,098 shares at £3	96,294	0	0
Less calls in arrears	1,660	0	0
	94,634	0	0
Debentures, 5 per cent.	86,600	0	0
Loans from bankers, secured by deposit of debentures	49,330	16	4
Sundry creditors	51,058	18	5
Three months' debenture interest accrued	1,051	9	1
Doubtful debts and contingencies account	2,183	8	3
Unclaimed dividends	65	11	1
Revenue account balance	4,606	17	11
	£289,531	0	11

Property and Assets.	£	s.	d.
Freehold property	35,473	7	1
Plant, tools, furniture, fixtures, etc.	62,377	0	7
Stock-in-trade and work in progress	80 362	4	11
Trade debtors	61,921	16	8
Investments in shares of other companies	2,269	15	8
Chelmsford electric lighting and other subsidiary companies	14,673	3	8
Cash at bankers and in office	2,313	16	10
Patents account	12,139	15	6
Electric cooking and heating department, cost of establishing	3,000	0	0
Goodwill	15,000	0	0
	£289,531	0	11

PROFIT AND LOSS ACCOUNT, YEAR ENDED MARCH 31, 1898.

Dr.	£	s.	d.
Trading expenses—steam and electric power, labour in stores, works, salaries, and expenses	16,853	16	10
Administration and office expenses, rents, rates and taxes, salaries, advertisements, etc.	6,758	9	6
Repairs to buildings and plant	381	5	11
Depreciation of plant and machinery, patents and fixtures	3,856	11	0
Balance carried to revenue account	13,568	14	11
	41,418	18	2

Cr.	£	s.	d.
Gross profit from trading account, pupils' premiums, and dividends on investments	41,418	18	2
	£41,418	18	2

Dr. REVENUE ACCOUNT.	£	s.	d.
Interest on debentures	4,081	19	1
Interest on bankers' advances	2,209	6	3
Directors', managing directors', trustees', and auditors' fees	2,531	5	0
Income tax, £139. 6s. 8d.; balance, £4,606. 17s. 11d.	4,746	4	7
	£13,568	14	11

Cr.	£	s.	d.
Net profit from profit and loss account	13,568	14	11
	£13,568	14	11

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

The half-yearly general meeting was held last week at the Cannon-street Hotel. **Mr. H. Marsham**, who presided, stated that they had been called together to approve the declaration of an interim dividend. As usual at their meetings at that time of the year, there were no accounts or balance-sheet to submit. During the six months ended the 30th ult. their general business had been well maintained, and the turnover showed an advance on the results for the same period of 1897. On the other hand, they had had an enhanced price of raw materials to contend with, and great difficulty in getting the people who purchased their manufactures to recognise the fact. As mentioned at the last general meeting, they and other manufacturers of indiarubber goods were unwillingly driven to raise their selling price 10 per cent., and within the last week they had been obliged to notify a further increase. In their general electrical business they had been busy. In submarine cable work they had had little to do. He then proposed the payment, tax free, of a dividend of 2½ per cent., or 5s. per share, for the half-year ended the 30th ult.

Mr. S. W. Silver seconded the motion, which was carried unanimously.

LEGAL INTELLIGENCE.

THE CITY AND THE ELECTRIC LIGHT.

The appeal in the case of H. H. Crawford (the City Solicitor) *v.* the City of London Electric Lighting Company was heard in the High Courts recently. The *City Press* reports as follows: It was a case stated by an alderman (Sir James T. Ritchie) on an application made by the appellant, the City Solicitor acting on behalf of the City, "to ascertain the amount of fees and reasonable expenses of an electrical inspector," under the provisions of the Electric Lighting Orders Confirmation Act, 1890.

Mr. P. Rose Innes appeared for the appellant and Mr. Roskill for the respondents.

In this trial was involved the question as to whether the electric lighting company should be charged with the expenses attached to the office of electrical inspector under the Corporation. It was stated that Mr. Voysey was appointed to the position at a salary of £250 per annum, the agreement being that two-thirds of his time should be given to the work of inspection and the remaining one-third to other duties connected with the Corporation. Certain accounts, amounting to £1,226. 2s. 7d., were put in when the case came before the alderman. From this sum was deducted £84, representing fees received by the inspector, and there remained a balance of £1,142. 2s. 7d. The alderman decided that there were no "reasonable expenses" within the meaning of the Act, and that the company was not liable to pay the Corporation anything beyond the £84 admitted. He, however, found alternatively, in case he should be wrong in law, that the accounts set before him were reasonable and accurate if the Court was of opinion that the company ought to repay the same to the Corporation.

Counsel for the appellant now argued that the sum of £1,142. 2s. 7d. comprised the fees and reasonable expenses of an inspector.

Mr. Rose Innes contended that the alderman had acted wrongly on the interpretation of Section 47. He should have said that the £900 odd, after deducting one-third of the salary, was the proper amount payable by the electric company. The expenses of a reasonable office and laboratory were the reasonable expenses to be paid by the company.

Mr. Roskill urged that the expenses set out before the alderman did not come within the meaning of the words "reasonable expenses" in Section 47 of the Act.

Mr. Justice Day and **Mr. Justice Ridley** agreed that there was no reason for disturbing the decision of the alderman.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Melbourne (Victoria).—The Town Council invite tenders for a supply of arc lamp carbons. Particulars may be obtained of, and tenders addressed to, the Town Clerk by Aug. 16.

Belgrade.—Tenders are invited for the electric lighting of the town. Specifications, etc., may be obtained from the Department of Public Works in Belgrade. Tenders by 21st inst.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns. Tenders by Aug. 10.

Exeter.—Tenders are invited by the Corporation for about four miles of high and low tension concentric mains, four transformers, about 50 meters, and a feed-water heater of about 1,000 gallons capacity. Tenders by 25th inst.

Stavelot (Belgium).—The Municipal Authorities invite tenders for the installation and working of an electric plant for light and power for 30 years. Conditions, etc., may be obtained for 2s. 8d. from the Town Clerk, at Stavelot. The deposit is £120. Open until Aug. 2.

Banbridge (Ireland).—Tenders are invited by the Town Commissioners for lighting the public lamps in the town by electric light or gas for one, two, or three years. Specification to be seen in Town Surveyor's Office. Tenders to be sent to Mr. Wm. MacCormac, town clerk, to-morrow.

London.—Messrs. Twining and Co. invite tenders for the supply and erection of two 6-h p. motors, with all wires and accessories, at their premises at 216, Strand. Specification and all details from Mr. J. G. Lorrain, consulting engineer, of Norfolk House, Norfolk-street. Tenders to be returned by July 23.

Hapton (Padiham, Lancs.).—Tenders are invited for lighting the Hapton township with electricity from Sept. 1, 1898, to April 30, 1899. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, St. Anne's-terrace, Padiham, by Aug. 1. Full particulars on application.

West Hartlepool.—The Town Council of West Hartlepool invite competitive plans, designs, and tenders for the erection of refuse

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destructor, boilers, etc., adjoining the electric light station, Burn-road. Conditions, etc., can be obtained upon application to Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on July 27.

Manchester.—Tenders are invited by the Electricity Committee for the supply during 11 months ending June 30, 1899, of brass and iron castings, cables, carbons, incandescent lamps, meters, etc. Particulars and forms of tender may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by 26th inst.

South Shields.—Tenders are invited by the Tramways Committee for the constructional work and paving thereto of 185 lineal yards double line of steel girder tramway, including points and crossings, with electrical bonding. Specification may be obtained at the office of Mr. S. E. Burgess, A.M.I.C.E., borough engineer, Chapter-row. Tenders by 12 noon on 23rd inst.

Glasgow.—Tenders are invited by the Corporation for providing and erecting the following plant required for their new generating station at Port Dundas—viz.: (1) cast-iron and mild-steel tanks; and (2) cast-iron hoppers, chutes, bolts, etc. Particulars, etc., may be obtained on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by July 28.

Hull.—The Technical Instruction Committee invite tenders for wiring the municipal technical school, Park-street. The specification and plans may be seen at the office of Mr. J. T. Riley, D.Sc., 7, Albion-street. Tenders, endorsed "Tender for Wiring Technical School," are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office, Town Hall, Hull, before noon on July 18.

Newington.—Tenders are invited by the Vestry for the supply and laying of insulated electric mains, conduits, junction boxes, etc., in connection with the Vestry's electric lighting generating station, Penrose-street, Walworth. Specifications, etc., can be obtained from the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, upon payment of £5. 5s., which will be returned on receipt of a bona fide tender. Tenders by 22nd inst.

Shoreditch.—Tenders are invited by the Vestry for the supply and erection of additional continuous-current motor-transformers, with switch gear, and extension to switchboard at the electric generating station, Coronet-street, Shoreditch. Specifications, etc., can be obtained from Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders before 4 p.m. on 18th inst.

West Ham.—Tenders are invited by the Town Council for the following machines, tools, and apparatus required for the equipment of the institute: (1) battery of 55 cells and switchboard; (2) two electromotors; (3) experimental dynamos and transformers; (4) machine tools for the engineers' and carpenters' shops; (5) experimental steam-engine. Specifications, etc., may be obtained from Mr. A. E. Briscoe, principal, Municipal Technical Institute, Romford-road, E., upon payment of £1, which will be returned upon receipt of a bona fide tender. Tenders by noon on 18th inst.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of one 150-kw. high-speed engine and alternator coupled direct, and sundry additional steam and exhaust pipes. Copies of the specification, with general conditions and forms of tender, may be obtained at the office of Mr. A. H. Miller, town clerk, Town Hall, Yarmouth, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Copies of drawings and any further information may be obtained at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster, S.W. Sealed tenders, endorsed "Electric Light Plant," must be delivered at the Town Hall by 10 a.m. on 19th inst.

Achnasheen.—Tenders are invited for the erection of a line of wire, 10¾ miles long or thereby, on the estate of Arthur Bignold, Esq., of Loch Rosque, Achnasheen. The line to have two terminal instruments and four intermediate ones complete. The first four miles of line to be on poles, followed by 2¾ miles underground cable, the remaining four miles to be submerged in Loch Fannich. Intending contractors must satisfy themselves as to the nature of the ground and the means of access thereto. On receipt of a post-card two days previous, Mr. J. Patterson, Loch Rosque, Achnasheen, will show contractors over the grounds, and conditions and specifications may be had from him on application, and sealed tenders, marked outside "Telephone Tender," are to be lodged with Mr. J. Patterson by July 22.

RESULTS OF TENDERS.

Exeter.—The Electric Lighting Committee have accepted the tender of the Brush Electrical Engineering Company, Limited, of supplying a 100-kw. steam alternator for the sum of £1,447. 10s.

Southport.—The Electricity Committee have accepted the tender of S. Z. de Ferranti, Limited, for one 600-k.w. disc alternator, direct-coupled to one 1,000-h.p. Musgrave engine, 214 revolutions, for the sum of £6,882.

Shoreditch.—The Vestry have accepted the tender of Messrs. Pritchetts and Gold for supplying a new battery to discharge at 400 amperes for six hours, under conditions to be guaranteed, including allowance for and removal of the existing battery, at a price of £1,062.

Newington.—The Vestry have accepted the tender of Messrs. Babcock and Wilcox, Limited, for the construction, supply, and erection of boilers, pumps, steam and water mains, water tank, surface condenser, fuel economiser, ironwork, mechanical stokers, conveyor, and elevator, for the sum of £9,348.

Burnley.—The Council have accepted the tenders of the undermentioned firms for the supply of condensers fitted with all necessary appliances, at the following amounts: Messrs. Korting Bros., two Korting ejector condensers, £188, and two pumps and motors combined, £347; and the Burnley Ironworks Company, Limited, piping and valves, £348.

Leeds.—The following tenders have been accepted by the Leeds City Council, for supply of engines and dynamos in connection with the extension of the electric tramway system to Headingley, Chapeltown, and Hunslet: Greenwood and Batley, Leeds, £15,586. For supply of tramcars for the same: Dick, Kerr, and Co., Glasgow and London, £468. 10s. each. For all builders' work in connection with the extension of the generating station at Crown Point: I. Gould, Leeds, £4,082. 15s.; Clayton, Son, and Co., Limited, Hunslet, smith and founder's work for the same, £830. 3s. 10d.

Edinburgh.—The following tenders have been accepted by the Corporation:—For the supply, delivery, and erection at Henderson-row power station of steam-engines and other machinery for the cable tramway: Dick, Kerr, and Co., Limited, Kilmarnock, £4,833. 16s. 6d. For the supply, delivery, and erection at Shrubhill and Tollcross power stations of rope drives and tension machinery, etc., for the work required in connection with the conversion of the tramways to the cable system of traction: Dick, Kerr, and Co., Limited, Kilmarnock, £10,016. 17s. 10d.

BUSINESS NOTES.

Barton.—The Workhouse Building Committee are considering the question of electric lighting.

Glenshee.—The telephone was inaugurated on Wednesday last at Blacklunans and Glenshee post offices.

Ossett.—The Town Council are considering the advisability of combining the electric lighting plant and refuse destructor.

Fleetwood.—Major Marindin, C.M.G., R.A., inspected the Blackpool and Fleetwood Electric Tramroad on the 13th inst.

Towyn and Abordovey.—The electric lighting question has been deferred for further consideration by the Urban District Council.

Clacton-on-Sea.—We are informed that a company has given notice of intention to apply for a provisional order for the electric lighting of the town.

Burnley.—The town clerk has been directed to make application to the Local Government Board for sanction to borrow £10,000 for electric lighting purposes.

Barrow.—The Electric Light Committee have made a contract for the lighting of the Furness Abbey Hotel. The cost of laying the main is estimated at £2 500.

Whitby.—At last week's meeting of the Urban District Council the Chairman said he had been approached with regard to the establishment of a trunk telephone line to Whitby.

Keswick.—It is stated that, in view of the feeling of the Urban District Council expressed at the last meeting, the electric light company have decided not to do any work until the end of the season.

Camberwell.—The Vestry have received statutory notice from the Crystal Palace District Electric Supply Company of its intention to open and break up Crystal Palace-parade for the purpose of laying pipes and mains.

Ryde.—A provisional electric lighting order will probably be applied for by the Council. The Council is still divided upon the question whether they should undertake the lighting themselves or allow a company to do so.

Horsham.—The Electric Lighting Committee's report, which recommended that application should be made to the Board of Trade for a license authorising the Council to obtain a supply of electricity in the urban district, has been adopted.

London and Brush Provincial Electric Lighting Company, Limited.—The directors of this Company have declared an interim dividend on the preference shares for the half-year ended June 30 at the rate of 6 per cent. per annum, less income tax.

Brentford.—Application is to be made by the Electrical Power Company for the purpose of lighting the Brentford district or supplying electrical energy. No action was taken by the District Council when the matter came before the Board last week.

Telegraph Construction and Maintenance Company, Limited. The transfer books of this Company will be closed up to the 19th inst., inclusive, preparatory to the payment of an *ad interim* dividend of 12s. per share to all shareholders on the register on the 11th inst.

Incandescent Electric Lamp Company.—We are informed that this company have now entered into the large extension of their factory, the building of which has become necessary owing to the enormous increase in the demand for the "Robertson" high-voltage lamps.

Telegraph Construction and Maintenance Company, Limited. The transfer-books of this Company will be closed from 11th to 19th inst. inclusive, preparatory to the payment of an *ad interim* dividend of 12s. per share to all shareholders on the register on first-named date.

Huddersfield.—At the recent telephone enquiry, Mr. Lloyd, the town clerk, told the Select Committee that the success of a private service which the Corporation of that town had instituted

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was such that he believed a municipal service would bring the tariff down to £3. 4s.

Colchester.—A committee's report adopted by the Town Council embodies a letter from the British Electric Traction Company, in which the latter state that they will probably apply under the Light Railways Act for power to construct a small line of tramway in the town.

Globe Telegraph and Trust Company, Limited.—The directors have resolved to recommend a distribution of 3s. on the preferred and 4s. 3d. on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent. on the preference and 5⅛ per cent. on the ordinary capital.

Maybole.—At a public meeting the proposed light railway to be promoted by the Glasgow and South-Western Railway Company from Ayr to Girvan, *viâ* Danure and Maidens, was considered, and a resolution passed to the effect that the directors be memorialised to form a branch from Maybole to Maidens.

Aberdeen.—The following candidates for the office of electrical engineer, vacant by the resignation of Mr. Blackman, have been selected: Messrs. J. A. Bell. John R. Dick, London; Charles M. Johnston, and H. Turner. These gentlemen have been asked to have a personal interview with the committee.

Trowbridge.—A notice from Edmundsons' Electricity Corporation, Limited, on behalf of the Urban Electric Supply Company, Limited, that they intended to apply to the Board of Trade for a provisional order for electric lighting in the district, has been referred to the Lighting and Paving and Finance Committee.

Limehouse.—At the last meeting of the District Board, a letter was received from the Metropolitan Electric Supply Company, Limited, giving notice of their intention to apply to the Board of Trade for a provisional order authorising the company to supply electricity within the district. This was referred to the Works Committee.

Norwich Electric Tramways Company.—An extraordinary general meeting of this Company will be held at 4, Bank-buildings, London, E.C., on Friday, July 29, 1898, at 3.30 p.m., for the purpose of authorising the borrowing by the Company on mortgage of the sum of £60,000 at interest after the rate of £4 per centum per annum.

Southport.—A letter has been forwarded to the Southport Tramways Company informing them that the Electricity Committee has under its consideration the provision of generating plant for tramway purposes, and requesting the company to state whether they are willing to take a supply of energy on terms to be agreed upon between the Corporation and the company.

Eccles.—Numerous applications for electric lighting were reported to the Town Council at the last meeting, and it was stated that the provisional order covered the whole of the borough, and extensions could be made as required, but the Electric Lighting Committee hoped to get as many applications as possible, so as not to have to take up a number of loans where one would do.

Cost Rica Electric Light Company.—The first (statutory) meeting of the shareholders of the Costa Rica Electric Light and Traction Company, Limited, has been held at Dashwood House, E.C. Mr. W. Leese, the chairman of the directors, presided. A slight alteration in the articles of association was decided upon, so as to allow the Company's shares to be quoted on the exchanges.

Farnham.—The Urban District Council having received letters, stating that Mr. Preston (of Tokenhouse Yard) and Mr. A. J. Nash (of Farnham) each proposed applying for a provisional order to serve the town with electric light, decided that the question of application for the provisional order being made by the Council should be discussed at a committee meeting of the whole Council.

Appointment Vacant.—The council of the Durham College of Science, Newcastle-upon-Tyne, are inviting applications for the lectureship in electrical engineering. The stipend is £200 per annum and a share of fees. Further particulars may be obtained from the secretary, to whom applications and testimonials must be sent not later than Aug. 10. The duties will commence on Oct. 1.

Eastern Telegraph Company, Limited.—Last year's accounts, made up to March 31 last, show that, after placing £60,000 to the reserve and providing for the debenture and preference charges a balance remains allowing the payment of a final dividend of 2s. 6d. per share on the ordinary shares together with a bonus of 4s. per share, making a total dividend for the year on these shares of 7 per cent.

Lewisham.—At the last meeting of the District Board letters were received from the Great Western Electric Light and Power Company, Limited, and the County of London and Brush Provincial Electric Light Company, Limited, giving notice of their intention to apply in the next session of Parliament to the Board of Trade for a provisional order to supply electricity within the district.

Sheffield.—Progress is being made with the tramway works. The foundations for the power station at Kelham Island are laid, the work having been done by the staff of the highway department. The foundations are of concrete. Mr. John Eshelby, the contractor, has commenced the brickwork, and is rapidly pushing on. The city surveyor is now engaged on the plans for the extension of the power-sheds at Tinsley.

Derry.—A letter from Dr. R. H. Todd, addressed to the citizens, appeared in a recent issue of the *Derry Journal*, in which he recapitulates the main features of his proposal for a company to take over the electric lighting from the Corporation. Dr. Todd urges the case with further reasoning on the facts already submitted, and contends that in the interests of the city the scheme should be adopted.

Irish Calcium Carbide Company, Limited.—This Company has been registered, with a capital of £60,000, to acquire and take over the Campbell mills and water powers at Collooney, co Sligo, and to carry on the business of manufacturers of and dealers in calcium carbide and other materials for the manufacture or supply of acetylene or other gases.

Hammersmith.—At the usual meeting of the Vestry a letter was read from the Vestry's parliamentary agents stating that the result of the recent tramway contest was very satisfactory, and well justified the trouble and expense, and that the decision of such a strong committee would prevent the company in a future session from attempting electricity in Hammersmith unless they first obtained the consent of the Vestry.

Croydon.—The Local Government Board have refused their sanction to a loan for £1,000, the sum payable to the British Thomson-Houston Company upon the Corporation taking over the works. The workmen in the employ of the electric light department are to be insured under the Workmen's Compensation Act, 1897, with the Ocean Accident and Guarantee Corporation, Limited, to insure at the rate of 10s. per cent.

Boston.—The Town Council have received from Edmundsons' Electricity Corporation, Limited, statutory notice on behalf of the Urban Electric Supply Company, Limited, that they intend to apply to the Board of Trade for a provisional order for electric supply in Boston, for confirmation by Parliament in the session of 1899. The town clerk has been instructed to write that the Corporation intend to supply electricity themselves.

West Bromwich.—At the last meeting of the Town Council the question of municipalising the tramways in the borough was discussed, and it was decided that the matter be considered by the General Purposes Committee, and that they have authority to inform the conference of local authorities of the attitude the Corporation proposed to assume. A sub committee reported in favour of overhead electric tramways worked by the Corporation.

Direct United States Cable Company, Limited.—The directors have resolved to recommend a final dividend of 3s. per share and a bonus of 1s. per share (both free of income tax), such dividend and bonus to be payable on and after 30th inst., making with the three interim dividends already paid a total distribution of 3¼ per cent for the year ended June 30 last, and, after placing £10,000 to reserve fund account, carrying forward a balance of about £3,388.

Bournemouth.—The Light Railway Commissioners held an enquiry last week into the proposals for the construction of tramways through the borough and into the districts of Christchurch and Poole. They rejected the proposals so far as the borough of Bournemouth is concerned, and after a long hearing granted the application of the British Electric Traction Company to run a tramway to the borough boundary from Poole and Parkstone.

Brighton.—Two hundred and fifty reflectors and lamp supports are to be made immediately to replace the glass projectors at present in use in the centre of the town and important thoroughfares, and also to supply those lanterns which are at present unprovided with any kind of reflector. An electricity main is to be laid to the arch opposite Paston-place groyne, at an estimated cost of £86, for the purpose of supplying the seashore electric railway with electricity.

Northwich.—The Urban District Council have decided to go in for lighting the streets by electricity. Experiments made with "Blahnik" lamps in the market hall have induced them to consider public lighting, four "Blahnik" lamps used in the market hall coming out at 10 per cent. less than gas. Over 500 16-c.p. lamps have been applied for within the last month, and 275 have been coupled to the mains. The supply company are about to put down a third engine and dynamo. Extensive main extensions are also in progress.

Felixstowe and Walton.—At the last meeting of the Urban District Council it was proposed: "That it be referred to the General Purposes Committee to consider and report upon the desirability or otherwise of the Council undertaking the supply of electricity for public and private purposes, with power to incur the necessary expense for an expert opinion and estimate." The motion was carried, it being understood that the committee would not go to the expense of employing an expert, but get what information they could in a less expensive manner.

Hereford.—The Electric Lighting Committee's report was adopted at the monthly meeting of the Town Council. The report embodies a recommendation to empower the committee to obtain a site. It also states that if steam is adopted as the power to create the current, the committee think that the town refuse should be used as the fuel. The committee incline, however, to recommend the Council to adopt gas as the power, though they have not as yet completed their investigations so as to enable them to report confidently and unanimously as to this.

Plumstead.—At the last meeting of the Vestry, the Works Committee reported that they had received notice from Mr. George Whale, solicitor, on behalf of the Woolwich District Electric Light Company, of the company's intention to apply to the Board of Trade for a provisional order to supply electricity to Plumstead. The committee recommended, and it was agreed, that a reply be sent that the Vestry will oppose the granting of the order. The question of applying for a provisional order for an electric supply by the Vestry is already under the consideration of the committee.

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Blackheath and Greenwich District Electric Light Company. This Company, which has a capital of £150,000 in £1 shares, of which 148,800 are now being issued, was formed in 1896 to obtain a provisional order for the supply of electric energy in the parish of Greenwich and parts of the parishes of Charlton, Eltham, Kidbrook, Lee, and Lewisham. This order was obtained from the Board of Trade and confirmed by Act of Parliament in 1897. A plot of freehold land has been secured for a generating station, and the capital outlay is estimated at £121,895, which would leave £28,105 for working capital and contingencies.

Camborne. — The Camborne Electricity Supply Company, Limited, having given notice to the Council of their intention to apply for a provisional order for the supply of electricity for private and public purposes in and for the Council's district, the matter has been referred to the Town Improvement and Lighting Committee with instructions to report as early as possible. The feeling expressed is that they ought not to prevent other people supplying electricity if the Council were not willing to do it, but that the Council should go into the matter first and decide whether they themselves would not have an installation.

Gorleston.—On Tuesday the Yarmouth Town Council had a lengthy debate on the question of whether the Yarmouth and Gorleston Tramway Company should take the place of the Corporation under the provisional order to supply Gorleston and Southtown with electric light and traction. The Electric Lighting Committee recommended the Council to grant the company such concession, but ultimately a committee was appointed to confer with experts as to whether it were expedient for the Corporation to part with their powers to supply electricity to Gorleston and Southtown, and, if so, at what price and on what terms.

Brierley Hill.—At the monthly meeting of the Urban District Council the Lighting Committee reported that notice had been served by the Midland Electric Corporation of their intention to apply to the Board of Trade for a provisional order empowering them to supply electricity to the district. The committee's recommendation that the Council do not assent to the granting of such provisional order was adopted. The Tramways Committee recommended that the application of the Dudley and Stourbridge Electric Traction and Tramway Company for power to be able to take up the road in High street opposite the Post Office for more than 100 yards should be granted.

Glasgow.—The Tramway Committee have fixed the stopping places on the new electric route between Glasgow and Springburn. The distance between each station measures about a furlong. The names of the stations will be attached to the electric lamp-posts, and no person will be taken off or on the cars except at the stations named. At a meeting of the Finance Committee on the 12th inst., it was reported that the gross income, including receipts from private and public lighting, for the year just ended was £36,360, against £30,474 last year, an increase of £5,886. After meeting the cost of production the balance is carried to depreciation and sinking funds. The committee are considering the advisability of making a change in the rates charged.

Whitechapel.—At the last meeting of the District Board, the letter from the County of London and Brush Provincial Electric Lighting Company, Limited, which, as reported in our last issue, referred to the latter's intention to apply to the Board of Trade, before Dec. 21, for a provisional order to supply electrical energy within the district, was referred to the Electric Lighting Committee. A communication was also received from Messrs. Barlow and Barlow, solicitors to the Metropolitan Electric Supply Company, to the effect that the company intended to apply to the Board of Trade for a provisional order to authorise the company to supply the Whitechapel district with electric light. The reading of the letter provoked considerable laughter, and it was referred to the same committee.

Banbury.—The Electric Lighting Committee have received a notice from Edmundsons' Electricity Corporation, Limited, on behalf of the Urban Electric Supply Company, that they intend to apply to the Board of Trade for a provisional order for electric lighting in the borough of Banbury, and for confirmation by Parliament in the session of 1899. To obtain the Town Council's approval of that application, the company would be prepared to insert clauses in the provisional order providing that the Council might purchase the undertaking, if they wished to do so, at an early period, and the giving of special terms for the supply of the electric current for public purposes. The matter was considered in committee, but no decision was come to in regard to the communication, the further consideration of which was deferred.

Russian Contracts.—A report has been received at the Foreign Office from H.M. Acting Consul-General at Odessa, stating that in view of the recent abrogation of import duty on ships built abroad entering Russia, and also of the decision of the Government to reserve exclusively to vessels under the Russian flag the rapidly increasing carrying trade between the Baltic, Black, and other seas, and with Russian ports in the Far East, the attention of shipbuilding firms in Great Britain should be directed to the possibility of securing orders for the new ships which will become indispensable to the Russian mercantile fleet, if it is to cope with the increasing demands made upon it. Such orders should be secured as promptly as possible, in order that English firms may not be forestalled by foreign rivals.

Parliament.—In the House of Lords the Charing Cross, Euston, and Hampstead Railway Bill has been read a second time. Several amendments were made which were afterwards agreed to in the House of Commons. In the latter House the Plymouth and Stoke Tramways Bill, the General Power Distributing Company Bill, the Metropolitan Electric Supply Bill, and the Dundee Corporation Tramways Bill have been read a third time. The Select Committee of the House of Lords, presided over by the Earl of Northbrook, have decided "that it is not expedient to proceed further" with the Bill promoted by the Central Electric Supply Company, Limited, for powers to construct a generating station at St. John's Wood in proximity to the terminus of the Great Central Railway. Although the Bill was opposed by four opponents, the rejection of the Bill was due to the Great Central Railway Company, who have this session revived some lapsed powers to acquire the same area required by the electric company.

Limerick.—At the meeting of the Fishery Board on Thursday week the Shannon Electrical Syndicate scheme again come under discussion. The *Dublin Mail* reports: "Mr. Vansittart complained that the Conservators were not getting satisfactory information, and proposed that the secretary be directed to write to the Board of Works asking what rights they have given the syndicate in connection with the contemplated works at Doonass, and for a copy of any agreement entered into for the guidance of the Fishery Conservators. Mr. Blood Smith said the fishery owners would oppose the scheme in every way possible, and he believed some of them intended to take out an injunction as a last resort to prevent the syndicate proceeding with the scheme. Mr. Mackay did not agree that all the fishery owners were opposed to the scheme, which might tend to improve the Shannon and South of Ireland, but the Conservators would protect the interests of fisheries. Mr. Fitt said he understood at least a quarter of a million would be spent a few months after the scheme was put into operation, but still he agreed with Mr. Vansittart's view. The resolution was passed unanimously."

British Thomson-Houston Company, Limited.—We are informed that this Company has secured the following contracts: Two complete electrical power plants for Messrs. Vickers, Sons, and Maxim, Limited, one of 600 h.p., being for their Barrow works and the other, of 400 h.p., for their Erith works; a 600 h.p. factory installation for Messrs. Lever Bros., Limited, of "Sunlight soap" fame; two large motor-alternator plants for the Newcastle-upon-Tyne Electric Supply Company, Limited; electric brake equipments for motorcar and trailer, and a special water-tank motorcar, for the Leeds City Tramways; two completete motorcar equipments for the Portrush electric tramway; 50 new car bodies for the Dublin United Tramways Company, Limited; and 20 additional complete motorcars for the Bristol Tramways and Carriage Company, Limited. The Company have also secured a contract for the supply of a considerable quantity of steel rails, fishplates, and accessories, and electrical rail bonds, for the Brisbane Tramways Company, Limited.

Morecambe.—From the minutes of the Electric Light Committee it appears that a plan showing an arrangement for preventing rain or snow from penetrating into the engine-room, and a plan for weighbridge-house showing a proposed room over the weighbridge-room to be used as a testing-room, has been approved, and that the work is to be proceeded with at once. It has been resolved to purchase from Messrs. Callenders one mile of service cable, and also to effect an insurance with the Fine Art and General Fire Insurance Company, Limited, at the electric generating station as follows: on buildings, £2,000; on machinery and plant, £2,000; on dynamos and armature therein, £1,250—total, £5,250. Mr. Parkinson has submitted a report of tests of steam dynamo taken after erection, in which he stated that the insulation was only 2·4 megohms instead of 50 megohms, and that he could not advise the Council to accept the armature, and that he would complain to Messrs. Parker. The following contracts have been accepted: Messrs. J. Nicholl and Sons for the weighbridge, house, etc., Mr. J. Edmondson for the louvre arrangement, and Messrs. Milne and Son, Edinburgh, for the second-hand meter (£6).

London County Council.—At Tuesday's weekly meeting of the Council it was agreed to lend the Hammersmith Vestry £15,500 and the Hampstead Vestry £16,700 for electric lighting. The report adopted at the last meeting of the London County Council, referring to the purchase of the whole of the London Tramways Company's system, which will after Aug. 10 next come under the operation of the purchase clauses in certain of the company's Acts of Parliament, recommends that the Council should take over the entire system and work it themselves. The Highways Committee has offered £800,000. The company has asked £900,000. The difference consists of the value of the lines and the amount to be allowed for the surrender of the unexpired term of the portions which are not yet purchasable by compulsion, and the County Council is recommended to refer these questions to the friendly arbitration of Sir F. J. Bramwell. The committee also proposed that they should be authorised to continue the negotiations for the acquisition by the Council of the whole of the undertaking of the London Tramways Company and its transference to the Council on Dec. 31 next, which was agreed after an amendment to the effect that the matter should be suspended until a report had been received from the Finance Committee had been defeated.

Edinburgh.—The results of the year's operations of electric lighting from May 15, 1897, to May 15, 1898, which have just been made up, show that the total output for private lighting and power has been 2,059,763 units, an increase over the previous year of nearly 90 per cent. The total units for public lighting have been 834 660, making a grand total of 2,894,423 Board of Trade units. The income from private lighting and power has been £30,024. 4s. 5d., and from public lighting £7,993. 5s.—making in all £38,017. 9s. 2d. The expenditure has been—for generation of electricity, distribution, management, rates and taxes, upkeep of public lamps, and all expenditure in connection with the under-

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taking, except interest and sinking fund, £16,744. 15s. 4d.; interest and sinking fund, £13,623. 6s. 7d.—making a total expenditure of £30,368. 1s. 11d., and leaving a net profit on the year's working of £7,649. 7s. 3d. Of this sum, £4,000 is to be put to reserve, leaving £3,649. 7s. 3d. available as a contribution to the rates, or £1,649. 7s. 3d. more that was estimated. The burgh assessments on the undertaking amount to £763. 18s. 5d., and the poor and school rates to £617. 6s. 8d. The rates benefit in all from the undertaking for the year just closed by £5,030. 12s. 4d., in addition to a charge of over £1,000 for the town clerk, collector, and chamberlain's departments.

Electrically-Driven Engineering Works.—Messrs. Kendall and Gent, machine-tool makers, of Manchester, have just erected new works adjoining the Belle Vue Station of the Great Central and the Midland Railway Companies, which present interesting special features, in that they are being electrically driven and lighted throughout. The main building is a large erecting shop divided into four bays, 280ft. long, and each about 40ft. in width, traversed from end to end by electric travelling cranes. In laying out the electric power for driving the whole of this shop, what is known as the group system has been adopted. The central generating station, which is outside the shop, consists of an installation of two independent dynamos, developing 200 h.p., which can be used separately for lighting and driving, or for both, and in combination, according as necessity may arise. The motors for driving the different groups of machines are mainly 20 h.p., but for lighter work they run as low as 10 h.p. and 5 h.p., whilst the cranes are on the three-motor system throughout. As it is a matter of great importance in engineering work that the power required to drive each of the machine tools should be carefully ascertained, in the introduction of electrical driving, the firm have attached to each motor an ammeter from which records are being carefully taken, so that very interesting data is being obtained in every department.—*Leeds Mercury.*

Watford.—At the last meeting of the Urban District Council the Electric Lighting Committee submitted the following report: "Mr. Hawtayne, accompanied by Mr. Gordon, one of the architects retained by him to prepare the plans, specification, etc., for the electric lighting station, attended the meeting. The committee discussed various points with Mr. Hawtayne and Mr. Gordon, and the latter stated that he considered three months would be a sufficient period for the completion of the buildings if the contractors were not hindered by the engineer; that he had expressly omitted from the tender the setting of the boilers, the expense of which he estimated at £150, as he did not quite understand the instructions given to him by Mr. Hawtayne, and there would be no appreciable addition to the amount of the contract by reason of the alteration of the size of the boilers. The committee recommend the Council to accept the tender of Messrs. Wilkinson, amounting to £3,155, subject (1) to their entering into a proper contract and furnishing satisfactory security to the amount of £500 for the performance thereof, and (2) to their agreeing to complete the works within three months. The committee instructed Mr. Hawtayne to obtain a price from the Brush Company for setting the boilers, and the committee considered Mr. Hawtayne's letter of July 2, and instructed him to report in detail in writing upon the points raised therein." The report was carried.

Shoreditch.—At the last meeting the Vestry had before them a letter from Messrs. Barlow and Barlow, 165, Fenchurch-street, solicitors to the Metropolitan Electric Supply Company, Limited, who wrote as follows: "In compliance with Section 4 (I.) of the Electric Lighting Act, 1882, notice is hereby given that the Metropolitan Electric Supply Company, Limited, whose registered office is at 29, Baker-street, in the county of Middlesex, intend to apply to the Board of Trade for a provisional order to authorise the supply of electricity by them within the district of the Vestry of the parish of St. Leonard, Shoreditch." The County of London and Brush Provincial Electric Lighting Company also wrote intimating that they intend to make application before Dec. 31 next to the Board of Trade for a provisional order, whereby it is proposed to authorise the said company to supply electrical energy for public or private purposes within the area of the local authority for the parish of Shoreditch. Dr. Robinson explained that the latter company was renewing their endeavour to get a way-leave through Shoreditch so as to supply Hackney. Mr. Kershaw moved that the vestry clerk be empowered to take immediate steps to prevent any such thing happening in Shoreditch. There was not the slightest doubt that if the House of Commons were consistent they could give these companies permission to run in opposition to the Vestry's show, but what the chances of the company were was another matter. This was a most important question to all undertakings under municipalities. The motion was agreed to.

Blackpool.—The proceedings of the Electric Lighting and Tramways Committee were confirmed by the Town Council at its last meeting. They showed that the electric lighting accounts, amounting to the sum of £7,370. 17s. 2d., were approved and placed before the Finance Committee. Also accounts amounting to £666 for tramways. A letter had been received from Mr. J. Parkinson, secretary of the Blackpool Company House Proprietors, forwarding the following resolution: "That in the opinion of this meeting it is not advisable to spend any more money on electricity in the borough until the promenade is widened." Letters had been received from the Board of Trade consenting to the adoption of the overhead trolley system of electric traction on the Corporation tramways, and as to the Board's sanction to the borrowing by the Corporation at interest of £9,400 in connection therewith. In referring to the consent of the Board of Trade to the overhead tramway, the Chairman said they had also sanctioned the loan of £9,400, which was applied for at the same time. He might say that £4,000 had already been spent on motors and other things. So that whatever system was adopted, this money had been spent. Mr. Quin had tenders which amounted to £8,800, but the Council might rest content that the committee would not take upon themselves to do anything until the whole scheme was brought before them and fully explained by the engineer. Mr. Quin was going to erect a section on the promenade, so that the ratepayers would have the opportunity of seeing what it was proposed to do before the work was entered upon.

Tees-Side Tramways.—This extensive system was officially inspected on the 12th inst. by Sir Francis Marindin and Major Cardew; the former inspected the lines and the latter the power stations. During the inspection the whole of the available cars, numbering about 30, were run to scheduled time. Although the inspection was conducted in private, we learn from the *Middlesbrough and Stockton Evening Telegraph* that all the local authorities through whose jurisdiction the electric tramways pass, including the Middlesbrough owners, expressed themselves as thoroughly pleased with the work and the system. Mr. Sockett, the deputy town clerk of Middlesbrough, produced the agreement with Mr. Clifton Robinson relative to the paving of the tracks, under which he undertook to make the paving level with the tops of the rails at the end of three months if requested to do so. Sir Francis Marindin advised the Corporation not to enforce the provisions of the agreement at the end of three months, as, if the paving blocks sank to the level of the rails in three months as was anticipated, he was afraid they would sink still lower during the next nine months, and it would be much more dangerous to have the rails above the paving blocks than in their present condition. It would appear from this that the Middlesbrough Corporation have been labouring under a misapprehension as to the facts, and altogether too hastily concluded that the company were in any way desirous of doing anything in connection with their system that was not in accordance with the most thorough, efficient, and up-to-date electric tramway practice. They will now, doubtless, having had the advantage of learning from the official head of the Railway Department of the Board of Trade that the company had consistently pursued the proper course in making proper provision for contingency, which they in their experience were well aware must arise, be more ready in the future to give the company and its officials credit for understanding their own business. The speeds vary from 8 to 12 miles an hour, according to the different localities. Both inspectors expressed their great satisfaction at what they had seen, and in consequence the lines will be opened to the public from to-morrow.

Islington.—At a meeting of the Vestry to-day the following report from the Electric Lighting Committee will be submitted: "Your committee begs to report that the demand for electrical energy has been increasing since the opening of the works at the rate of about 1,000 h.p. per annum. The works were opened on March 4, 1896, with machinery equivalent to 1,000 h.p. This became loaded almost immediately, and further plant to the extent of 1,000 h.p. was, with the Vestry's sanction, placed on order, and was started last winter. Another 500-h.p. engine and dynamo is now being fixed, and it was expected that this would meet all immediate requirements. The demand, however, is increasing so rapidly that there is little doubt that it will be insufficient to do more than meet the requirements of private consumers after providing for the necessary reserve, and that a great portion of the additional street-lighting already authorised by the Vestry will have to stand over until new plant is fixed. Much inconvenience has been caused in the past by the delay in building operations, which has prevented the engineering work being carried out with necessary expedition, and your committee has with your sanction instructed the architect to draw up plans, etc., for a considerable extension. The electrical engineer estimates that the increased boiler and engine house accommodation will be sufficient to contain the whole of the additional machinery required for about seven years, and he advises that plant to the extent of 3,000 h.p. be placed on order forthwith, two engines and dynamos of 1,000 h.p. each to be erected within 12 months, and the third to be erected within two years. The estimated cost is as follows:

Six boilers, fittings, etc., complete	£8,400
Three 1,000-h.p. engines	16,500
Three 600-kw. alternators	15,000
Steam and exhaust pipes, pumps, heaters, injectors, switch-gear, regulators, connections, and contingencies, say	9,000
	48,900
Architect's estimate for building extensions	22,500
Total	£71,400

and your committee recommends that this work be carried out accordingly, and that the sum of £72,000 be raised by loan as required."

Hackney.—The Vestry have received a notice from Messrs. Barlow and Barlow, of 165, Fenchurch-street, E.C., of the intention of the Metropolitan Electric Supply Company, Limited, dated June 30, 1898, to apply to the Board of Trade for a provisional order to supply electricity in Hackney. The report of the Electric Lighting Committee states that a letter has been received from the Board of Trade, in reply to a letter from the vestry clerk on the subject of the electric lighting order, stating that they will defer considering the question of the revocation of the order for a further period of 12 months from the 9th inst., having regard to the circumstances which have prevented the order being put into operation. That they have had 500 copies of the electric lighting

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order printed at a cost of £23, all the copies of the last print having been used, and it was thought that now the matter was under consideration a large number would be required from time to time, and recommend that their action be approved. That they have had under consideration the following matters, referred to the Joint Public Health and Electric Lighting Committee, on the subject of the Vestry's electric lighting order: letter from Mr. G. Mansbridge and others, dated April 18, 1898; memorial and resolutions from the public meeting held at the town hall, Hackney, on April 18, 1898, presented by Mr. B. Dent, of Cromwell House, Clifden-road, N.E.; letter from the Millfields Radical Club, of 127, Chatsworth-road, N.E, and dated April 16, 1898; letter from the West Hackney Ratepayers' Association, dated April 25, 1898; letter from the Electric Extension Company, dated June 2, 1898, making a further proposal to carry out the work of the electric lighting and dust destruction undertaking—and recommend that the same be received. That they have had under consideration the report of the Highways Committee of the London County Council with reference to the conference of London local authorities *re* generating stations for the supply of electrical energy, and as a further report on this subject is to be submitted to the Council, they have adjourned the further consideration of the matter for the present. Notice of motion has been given to the effect "That in consideration of the large and continually increasing amounts paid by this Vestry for horse hire and cartage, and with a view to facilitate the work of 'slopping and dusting' being undertaken entirely by the Vestry without the intervention of a contractor, that it be referred to the General Purposes Committee, and to the Sanitary Committee jointly, to report as early as may be (*a*) as to the practicability and possible economy of employing, for the purposes of the Vestry, carts and vans driven by electrical or other automatic motors; (*b*) as to the advisability of fitting suitable motors to the water-carts and other vehicles, all or any, at present the property of the Vestry; (*c*) as to the advisability of the purchase by the Vestry, for experimental purposes, of a motor van or vans of the most approved pattern designed, for the collection of refuse and scavenging, either or both. And further, that the said joint committee be, and is hereby, authorised to obtain all such necessary estimates, plans, drawing, and specifications, as will enable the fullest possible information (specially as to probable capital outlay and cost of maintenance) being embodied in the report for the guidance of the Vestry. (Consideration adjourned for six months, Jan. 12, 1898.)"

Kensington.—At the meeting of the Vestry on Wednesday, the 13th inst., the Special Electric Lighting Committee reported: "(1) That they have had under consideration the report of the Joint Select Committee of the House of Lords and the House of Commons on Electrical Energy (Generating Stations and Supply), and the General Power Distributing Company Bill, and the Metropolitan Electric Supply Bill now pending in Parliament, and referred to therein. In their consideration of the joint report of the Select Committee of the House of Lords and the House of Commons the committee have been struck with one conclusion embodied therein, the opinion being expressed that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended, and that the local authority should be deprived of the provisional veto which they at present possess. The committee are of opinion that exception should be taken by the Vestry to this decision of the Joint Committee on the ground that it would unduly weaken the hands of the local authority, and looking to the fact that the principle involved will no doubt be discussed in the House of Commons in connection with the electric lighting schemes now before Parliament, they consider that the members of Parliament for the borough should be informed of the views of the Vestry on this point, and they recommend accordingly. (2) That the committee have had before them, pursuant to the reference by the Vestry of June 15, the notices received from the three electric lighting companies already having areas in the parish, and the Metropolitan Electric Supply Company and the County of London and Brush Provincial Electric Lighting Company of their intention to apply to the Board of Trade for provisional orders empowering them to supply electricity in the parish of Kensington. The committee recommends (*a*) that the several companies be notified that the Vestry will withhold their consent to their applications for provisional orders, and will themselves in due course apply for a provisional order for the supply of electricity within the parish of Kensington; (*b*) that the vestry clerk do take the necessary steps to convene a special meeting of the Vestry at the proper date for the passing of the formal resolution as regards the application for a provisional order. (3) That the committee have considered, pursuant to the reference of the Vestry of June 15, so much of the surveyor's report to the Wharves and Plant Committee which dealt with the question of generating electricity for parochial purposes at the land recently acquired by the Vestry at Wood-lane. The committee have also had before them a further important report, prepared by the surveyor at their instance, dealing with the capabilities of the Wood-lane land as a site for the erection of a generating station in its bearing upon the wider question now before the committee. The committee are not in a position to deal with this portion of the reference in their present preliminary report, as before doing so they desire to obtain the advice of an expert electrical engineer on various points of importance that have to be considered, and they feel that there will be no hesitancy on the part of the Vestry in granting them this assistance. The committee accordingly recommend that they be empowered to consult an electrical engineer upon certain points involved in the reference to them."

PROVISIONAL PATENTS, 1898.

JULY 4.

14661. Draw and joint or intersection boxes for electric wiring on the tubular system and the like. Robert Alexander Douglas, 85, George-street, Edinburgh.

14666. Improvements in electrical fusible cut-outs. Archibald John Howard, Euston Villa, Cheddon-road, Taunton.

14682. An improved winding for polyphase motors. W. R. Pidgeon and E. F. Bradley, 42, Porchester-square, London.

14694. Improvements in and connected with electric arc lamps. Ernst Buchholtz and John Taylor, 49, Percy-road, Shepherd's Bush, London.

14714. Improvements in vacuum dielectrics, electrodes, and apparatus for the production of ozone. Dan Martini, Ivy Lodge, Tilford, near Farnham, Surrey.

14715. Improvements in tubular conduits for electric wiring. Thomas Taylor, 12, Cherry-street, Birmingham.

14726. Improvements in primary batteries. Walter Rowbotham, 18, Southampton-buildings, Chancery-lane, London.

14732. Method for obtaining combined alternating and continuous currents, and distributing the same for the electrical transmission of power, particularly for electrical traction. Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 5.

14761. Improvements in electrical safety fuses or "cut-outs." William Edward Langdon, Midland Railway Company, Derby.

14785. An improved method of facilitating the coupling and uncoupling of alternating-current dynamos. Georg Dettmar, 75, Chancery-lane, London.

14793. Improvements in insulators. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Ben Willard, United States.) (Complete specification.)

14800. Improvements in and relating to electrical heaters, rheostats, and the like, having comminuted resistance for the electric current. Richard Van Rensselaer Sill, 77, Chancery-lane, London. (Complete specification.)

14809. Improvements relating to electric accumulators or storage batteries, and to the manufacture of plates or electrodes therefor. William Henry Smith and William Willis, 11, Southampton-buildings, Chancery-lane, London.

14810. Improvements in electric couplings. William James Davy, 40, Chancery-lane, London.

14826. Improvements relating to electric railways. Reginald Belfield, 322, High Holborn, London. (The Westinghouse Electric and Manufacturing Company, United States).

JULY 6.

14833. Improvements in and connected with junction boxes for electric cables, inspection chambers, and the like. Frederick Franklin, 28, Church-street, Chelsea, London.

14835. Improvements in electrical curative appliances. José Gallegos, 20, Bucklersbury, London.

14837. Watertight covers and frames for boxes, street boxes, manholes, and other openings for electric mains and the like. Robert Alexander Douglas, 85, George-street, Edinburgh.

14839. Electro-deposition of metals by high-tension currents. Emile Andreoli, 147, Coldharbour-lane, Camberwell, London.

14868. Improvements in primary batteries. Peter Stiens, 139, Queen Victoria-street, London.

14896. Improvements in or applicable to vacuum brake apparatus for vehicles or trains propelled by steam, electricity, or other motive power. James Gresham and Harry Edward Gresham, 5, Market-street, Manchester.

14902. An improvement in telephone cables. Llewellyn Traherne Bassett Saunderson, 53, Chancery-lane, London.

14907. An improved arc lamp with magnetic carbon movement. Frederick Klostermann, 171, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 31, 1898, being date of application in France.) (Complete specification.)

14909. Improvements in electric conduits. Julius Peschek, 42, Wellington-road, Old Charlton, Kent.

JULY 7.

14934. Improvements in junction boxes and like fittings for electrical wiring. George Alexander Clark, William McAulay, and John Alexander McLaren, 62, St. Vincent-street, Glasgow.

14947. Improvements in apparatus for telegraphing without wires. William John Brooks, 5, Compton-street, Regent-square, London.

14953. Electric sounding apparatus. Henry Edmond Walter, 53, Victoria-street, London.

14958. Improvements in electric motors and dynamo-electric generators. Frederick Henry Varley, 82, Newington-green-road, Islington, London.

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14959. Switch and contact apparatus for the cars of electrical railways and tramways. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

14983. Improved means of making connection with electric cables. Robert James Hatton and W. T. Henley's Telegraph Works Company, Limited, 53, Chancery-lane, London.

JULY 8.

15003. An improved electric switch. George Hill, 17, St. Ann's-square, Manchester.

15028. Improvements in the manufacture of electrodes. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Carl Francke, Germany.) (Complete specification.)

15032. Improvements relating to the fixing of electric wires or cables. Sydney Weiss Mitchell, 18, Southampton-buildings, Chancery-lane, London.

15040. Improvements in automatic circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

15041. Improvements in circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

15054. An improved shade or reflector for gas, oil, candle, and electric lights. Alfred Maurice Day and Henry William Cole, 60, Queen Victoria-street, London.

JULY 9.

15082. Improvements in electric telegraphs for ships and for other purposes. Evershed and Vignoles, Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

15100. Electrical influence machines. W. R. Pidgeon, 42, Porchester-square, London.

15118. Protective device for incandescent electric lamps. Richard Käs, 62, St. Vincent-street, Glasgow.

15126. Improvements in the manufacture and production of insulated electrical cables or conductors, and apparatus to be employed in the said manufacture. Albert Harris Howard, 47, Lincoln's-inn-fields, London.

15134. A new or improved shade, reflector, or screen for electric and other lamps, and the like, and for facilitating the application of advertisements thereto. Ernest Böhm, 306, High Holborn, London.

15144. An improved system of electric traction. Nicholas Flechtenmacher, 4, South-street, Finsbury, London. (Complete specification.)

15149. Improvements in electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Stralsunder Bogen-lampenfabrik Gesellschaft mit Beschrankter Haftung, Germany.)

SPECIFICATIONS PUBLISHED.

1897.

14910. Electric motors for driving motor carriages, winches, and stationary machinery, also as a portable motor for rotary hair and cleaning brushes for drilling, milling, and other purposes. Headland.

16065. Incandescent electric lamps. Gabriel and Agenault.

16405. Electric telegraphy. Lodge and Muirhead.

17143. Automatic braking mechanism for electric cars and the like. Dulait.

17266. Starting switches of electromotors. Robinson.

17307. Multiple telegraph apparatus. Daumarie and Doignon.

18029. Process for the manufacture of electrode plates for storage batteries. Marschner.

18657. Hand electrical firing apparatus applicable for firing ordnance, grenades, mining charges, and the like. McEvoy.

20486. Electro-deposition of copper and other metals on rotary cathodes. Heys. (The Electrical Copper Company, Limited.)

21851. Electromotors for driving centrifugal pumps. Spooner. (Société Emil Salmson et Cie.)

22251. Safety fuses for electric devices. Thompson. (Goodhue and Hart.)

1898.

8539. Electric heaters. Porter.

9436. Means for electrically heating second-class electric conductors, serving as incandescence bodies, for imparting to them the requisite conducting power. Déri.

9778. Plates for electric accumulators. Bernstein.

9881. Means and devices for electrically lighting coin-freed apparatus for displaying pictures. Witt and Strikeman.

10094. Art of making plates for electric battery purposes. Croftan.

10557. Electric furnaces. Jackson.

10647. Electric incandescent lamps. Phelps.

11360. Globeholders for enclosed electric arc lamps. Weinert.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended July 10 were £1,589, as compared with £1,483 in same week of 1897, being an increase of £106.

Birmingham Tramways.—The traffic receipts for the week ending July 9 were £3,926. 6s. 7d., as compared with £4.437. 7s. 1d. for same week in 1897 (Royal visit) being a decrease of £511.

Dover Tramways.—The traffic receipts for the week ending July 9 were £201. 2s. 11d. The total receipts for the year 1898 are £3,404. 17s. 11d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending July 8 were £3,131. 14s. 2d., compared with £2,608. 19s. 9d. for same period of last year, being an increase of £522. 14s. 5d.

South Staffordshire Tramways.—The traffic returns for the week ending June 24 were £620. 1s. 10d., as compared with £767. 0s. 0d. in same week of 1897. The aggregate receipts for the year are £15,101. 2s. 9d., as against £15,452. 19s. 7d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended July 10 were £913, compared with £902 for same week of 1897, being an increase of £11. The total receipts for the half-year amount to £1,901, compared with £1,933 for the same period last year, being a decrease of £32.

Dublin S.D. Tramways.—The traffic receipts for the week ending July 8 were £853. 4s. 9d., as compared with £733. 14s. 4d. in the corresponding week in the previous year, being an increase of £119. 10s. 5d. The number of passengers carried was 123,326 in 1898 and 105,535 in 1897. The aggregate returns for the half-year are £919. 16s. 7d., as compared with £817. 3s. 2d. last year, being an increase of £102. 13s. 5d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	£	10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2-2½
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	100-106
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11½
Central London Railway, Ordinary	10	9½-10¼
——	6	5½-6½
—— Pref. Half-Shares	1	1½-1¾
—— " "	5	4½-4¾
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5¾-6¼
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	25-26
—— Prov. Cert. 90,001-100,000	5	25-26
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-71
—— Ordinary	8	2¾-3¼
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	15-16
—— " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	12½-13½
—— " " "	6	8-9
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	80-86
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	5	2¼-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-106
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	2	3¼-4¼
Electric Construction, Limited	2	2¼-2¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	107-109
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	8 9
—— 7 per cent. Preference	5	9½-10½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	12-14
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5¾-6¼
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Notting Hill Company	10	14½-15½
Oriental, Limited, £1 shares	1	1-1¼
—— £5 Shares	5	7-7½
—— £4½ shares	4	6½-6¾
Oriental Telephone and Electric Company	1½	1-1¼
Royal Electrical Company of Montreal	—	141-144
—— 4½ per cent. First Shares Mortgage Debentures	100	102-105
South London Electric Supply, Ordinary	2	1¾-2¼
St. James's and Pall Mall, Limited, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	5-15
—— 4 per cent. Deb. Stock, Red.	100	103-108
Telegraph Construction and Maintenance	12	28-30
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	100	119-121
Westminster Electric Supply, Ordinary	5	13-14
Yorkshire House-to-House	5	3½-4½

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NOTES.

Editorial Visit.—We hear that Mr. W. J. Johnston, the energetic editor of the *Electrical World* of New York, is expected to be in London this next week.

Institution of Junior Engineers.—The summer meeting of the Institution of Junior Engineers, of which Mr. John A. F. Aspinall is president, is to be held at Liverpool from Aug. 8 to 13. The president-elect is Sir William H. White, of the Admiralty.

Faraday House.—As a result of the examinations recently held at the Electrical Standardising, Testing, and Training Institution, Faraday House, Mr. F. M. Denton, of Hymer's College, Hull, has been awarded an exhibition of the value of 40 guineas, tenable for two years.

Anæsthesia Electrical.—While making experiments on the sensations derived from sinusoidal currents, Prof. Scripture, of Yale, is said to have discovered that anæsthesia of the tissues resulted from currents of high frequency, and that the condition even persisted for some time after removal of the electrodes.

The Punkah Problem in Ceylon.—The American ceiling fan driven by multipolar electric motors has, says *Indian Engineering*, already superseded punkahs in a good many offices in Colombo. The new punkah appears to find even more favour than the new illuminant. However that may be, the number of offices and business premises lately connected with the Colombo Fort electricity supply station mains is mainly ascribed to the introduction of the two-blade electric fan.

Photo-Printing.—In the *Elektrotechnischer Anzeiger* we find a description of an apparatus made at the arc lamp factory of A. Schwarz, Frankfurt-on-Maine, and destined for the printing of photographs, plans, etc., by artificial light. For a space of one square yard four arc lamps are necessary. They are arranged in pairs on iron frames, and can be moved upwards or downwards according to the degree of light necessitated by the size or density of the plate. For larger sizes more lamps are required—*i.e.*, nine lamps to light a space of 7ft. 6in. by 6ft. Each lamp has an automatic as well as a hand feeding appliance, and above the arc is an angular reflector, consisting of two sides and top formed of white enamelled metal.

Flash Advertisements. — The London County Council is circularising the various vestries as to whether they consider there is need of any regulations to control or prevent the use of flash-light advertisements. Our opinion of the signs is not overruled by the fact that they are electric, and also very ingenious. They are a nuisance to the traffic and a source of danger to pedestrians. The variation in the lighting in our principal circuses is very great, due to these signs, and hence we think the method of advertising should be discontinued as far as public streets are concerned. Without doubt, however, each of these signs draws more attention than half a dozen other signs, but still they do not conduce to the ultimate good of the public.

Telephonic Communication. — The Postmaster-General, writing to Mr. E. W. Fithian, the secretary of the Association of Chambers of Commerce, states that this year the Treasury have sanctioned the erection of a large number of additional circuits between important centres; and that a Bill for raising a further sum of £1,000,000 as telephone capital is now under the consideration of Parliament. Regarding the suggestion of the association that "with a view to relieving the wires during business hours a lower rate should be charged for trunk calls after a certain hour, and an extension of time to six minutes be then allowed," the Duke of Norfolk observes that he scarcely thinks he could "entertain this suggestion with a due regard to the spirit of the Telegraph Acts."

Quick Repairs.—The true value of the staff of any electricity works is best shown when breakdowns or accidents occur. The great fire at Sunderland last Monday was an occasion in point, and Mr. J. F. C. Snell and his assistant improved on the occasion. Due to the burning out of some heavy cable, the supply was interrupted at 10.40 p.m., as the fall of a heavy building in the centre of the town exposed these mains. The alternate-current supply was resumed within five minutes, and the whole of the supply, except the part affected by the fire, was on again within the hour. The great crowds in the streets much hampered the men when getting at the disconnecting boxes, otherwise even part of this delay would have been avoided. This promptitude speaks well for the knowledge and skill of all concerned.

Gas v. Electricity.—There was a lively explosion in Frankfort-on-the-Maine recently. A squad of 60 workmen were laying down the electric tramway across a bridge, when one of them, at work with a pickaxe, appears to have produced a spark. Instantly there was a terrific explosion, and a 12in. gas-pipe tore up into the air in small pieces, accompanied by sand, cement, and bits of everything that came handy. The row was prodigious, but, fortunately and miraculously, no one was seriously hurt, though four of the men were so dusted and blackened that they had to be taken off to the hospital. A crowded tramway car had passed over the spot an instant before. It is supposed there must have been an accumulation of gas from a small leak somewhere, and that a spark from the pickaxe ignited the explosive mixture.

Electrical Work in Peru.—The following extract from a recent letter by Frank G. Carpenter in the Washington *Star* may lead to business: "Lima is a city of 100,000 people, and it has a tramway upon which the cars are drawn by horses. The line of tracks reaches all parts of the city, and the cars, although they are irregularly run and poorly managed, are almost always full. The correspondent was told that the roads were paying, although he could see that the conductors were cheating the company right along, and that they do nothing to increase their custom. If this system could be replaced by an electric line it would probably pay well, and might be as big a bonanza as the Mexico city street railways. At present there are two or three American firms trying to buy the horse car lines and extending the system to Callao and Chorillos, the seaside resort of Lima."

Gold from the Sea.—A "Yankee" writing to the *Financial Times* claims that the recovery of gold and silver from the sea can be effected commercially. He says that the Electrolytic Marine Salts Company, which has its plant on the coast of Maine, started operations on Feb. 4 with five machines, which were increased to 114 on March 15, and on May 8 a further increase to 239 was made. Some five million tons of water were manipulated during the period named, and the product for the four months is said to be 940oz. of gold and 1,814oz. of silver (worth about £5,000), at a cost of less than £1,000. The second plant of 5,000 machines is now being constructed, and the "Yankee" says "the mine being on the mother lode, there is no danger of losing the vein." A 3 per cent. dividend has been declared by the company, and yet we prefer to wait another year before believing that the "mother lode" has been commercially attacked.

Cheeseparing at Wolverhampton.—The pleasing report of the General Purposes Committee, published in our last issue, with respect to Mr. F. Harman Lewis's retire-

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ment, has been marred by the Council. The socialistic party managed by 23 votes to 17 to reduce the fee to be paid to Mr. Lewis for his advice during the next year from £300 to £150. The usual humbug about giving one treatment to the working-men and another to the staff was well aired. After saving the town by means of a long and undignified debate a sum of which they may well be ashamed, we do not doubt but that these members proceeded to pass votes for thousands of pounds without as much as reading the agenda about them. We are sure that Mr. Harman Lewis desires no charity, so that these socialistic members will, in using his advice for the next year, have the satisfaction that they are underpaying a good man—a thing they dare not do their independent working-men and voters, especially voters.

Electrical Resistance of Crystallised Silicon.—Mr. Fernand Le Roy suggests in an article in *Comptes Rendus* the substitution of resistances of crystallised silicon in place of metallic resistances when electrical heating is required. Its resistance, specific heat, and emissive power are all high. It is easy to prepare sticks of pure agglomerated silicon 10cm. long and 40 square millimetres in sectional area, with a resistance which varies with the physical condition of the silicon, but may be as much as 200 ohms, whilst the resistance of similar rods of carbon is only 0·15 ohm, and of German silver only 0·00085 ohm. It follows that, for a given resistance, the rods of carbon must be much smaller than those of silicon, and the rods of German silver very much smaller still. The resistance of silicon diminishes as the temperature rises, and at 800deg. is only about 0·6 of its value at the ordinary temperature. The above is taken from the abstracts of the *Journal* of the Chemical Society.

Connections for Electrolytic Work.—Where small voltages and large currents are used, as in electrolytic work, the question of what terminals or connections to use becomes a most vital consideration. Dirty contacts mean the great loss of power, and it is difficult to keep the contacts clean in the atmosphere surrounding most electrolytic vats. We understand from the *Journal* of the Chemical and Metallurgical Society of South Africa that on the goldfields this trouble has been felt. This journal reproduces a paper read by Mr. A. von Dessauer on the "Carlin" tube method of connection. This consists of an iron tube filled with mercury, which is accessible for contact by having a series of holes drilled through the upper part of the tube. Into these holes the contacts with the plates are inserted, and the result is shown by figures to be most satisfactory. The mercury does not spill, and the construction also keeps down evaporation. The volts loss with screw contacts in a certain case was found to be 0·71 out of 3·82 volts employed, while with the Carlin tube the loss was reduced to 0·015 volt.

Madrid—*Electron* has an article from the *Gaceta di la Banca*, which says the general opinion that the price of electricity in Spain is exorbitantly high is quite an erroneous one, as, in fact, current is sold there cheaper than in other countries. After treating with the question that by the use of water power the current could be sold at one-fifth of its present price, the writer dwells upon the fact that engines, cables, etc., have to be purchased abroad for gold, which is at a very high premium compared with the currency of the country, while, probably for the same reason, coal and other supplies are much dearer in Madrid than elsewhere. The price in Madrid is 1·10 pesetas (currency) per kilowatt-hour. This means about 60 centimos de pesetas in gold, or about 5¾d. If the latter charge did exceed that made in Paris and Berlin, it would be justified by the increased first cost and by the higher running expenses owing to the higher prices paid for the material required for the production of the current. But in Berlin, with a net of 300 km. and 300,000 lamps, the price is 9d., and in Paris, with 400 km. of line and 418,000 lamps, it is 10½d. for the same unit, or about double that charged in Madrid.

The Durham College of Science, Newcastle-upon-Tyne.—The council of the above college at Newcastle-on-Tyne invite applications for the lectureship in electrical engineering, which has recently been created. The remuneration attached to the post is a fixed stipend of £200 and one-third of the fees of the classes taught by the lecturer, a minimum income of £250 from both sources being guaranteed. All candidates must be thoroughly qualified mechanical engineers. The lecturer will be directly responsible to the council, but he will be represented by the professor of engineering in the meetings of the council and House Committee. The appointment will date from Oct. 1, and applications and testimonials must be sent to the secretary not later than Aug. 10. The classes in technical electricity, hitherto conducted by the professor of physics, and certain of the instruments and apparatus used in demonstrating to those classes, will be transferred to the new department, but the council are of opinion that, considering the large electrical works in the district, the department is capable of great development, and those classes must not be held to limit the scope of the lecturer's duties.

Society of Chemical Industry.—The annual assembly of the Society of Chemical Industry was opened last week at the University College, Nottingham. Mr. Frank Clowes, D.Sc., the president, occupied the chair. The annual report was read, stating that the membership was 3,196 against 3,037 last year. The excess of revenue over expenditure was £737. 12s. 5d., as against £1,071. 3s. 11d. last year. The following chairmen of sections retired this year: Prof. C. F. Chandler (New York), Mr. George E. Davis (Manchester), Mr. Thomas Fairley (Yorkshire), Dr. Charles A. Kohn (Liverpool), and Dr. Rudolph Messer (London). They were succeeded by Messrs. Thomas J. Parker, David Watson, D.Sc., Christopher Rawson, A. Smelham, and B. Redwood. Mr. John Heron retired, and was succeeded by Mr. A. R. Ling as hon. secretary of the London section. Prof. H. R. Proctor has been induced to retain his post for another year. Dr. Clowes delivered his presidential address, reviewing the history of the society, and touching on the achievements in the world of science and commerce. He referred to the life work of Dr. W. H. Perkin, upon whom the society's gold medal was subsequently conferred. To Dr. Perkin he attributed in a large measure the development of the production of artificial colouring matters from coal-tar products.

Birmingham Association of Mechanical Engineers.—A smoking concert was held by this association last week to welcome Sir Salter Pyne, C.S.I., engineer-in-chief to the Ameer of Afghanistan, who has been elected a life honorary member of the association. Mr. J. Cox, the president, was in the chair. Sir Salter Pyne, in reply to the toast of his health, said he had a reverential respect for the city of Birmingham, because he was trained there. To the firm of Tangyes and the employés of the firm he was indebted for the alphabet of engineering, and in Afghanistan he had really only been the representative of English engineers, for had it not been for the lavish way in which they had supplied him with material to introduce to the country with which he was associated he would have come far short of accomplishing good. When they wanted a missionary of civilisation in the shape of a steam-engine they had to come to the Birmingham district for it,

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and after being in work for 11 years the engine stood as a monument of downright honest integrity, and there was no more potent moral influence in the country than it was. Thanks to Birmingham, Afghanistan was now able to produce a coinage which would not be a disgrace to any civilised nation. They were in their ammunition and arms factories turning out 10,000 Martini and 10,000 Snider cartridges each day, 25 Martini rifles per day, and 120 field guns per annum.

The Dangers of Acetylene.—The National Board of Fire Underwriters of America have approved of a set of rules for reducing the fire risks from the use of acetylene gas. These rules are, we understand, to be rigidly enforced. Of these rules the following are worthy of special notice. The generating and gasholding apparatus for acetylene, when installed for lighting buildings in the closely built-up portions of towns and cities, must be situated in an outside, fireproof, and well-ventilated building. No artificial light should be used inside of the building in which the gas is generated, and no heat except steam. The storage of liquid acetylene in any building, or the use of liquid acetylene gas, should be absolutely prohibited. In regard to the construction of the generator and gasholder, it is recommended that only wrought iron or steel, capable of resisting an internal pressure of 20lb. to the square inch, should be used, and under no circumstances should copper or any alloy containing copper, such as brass or bronze, be employed, since acetylene sometimes forms a compound with copper with great violence when heated or struck. It is also recommended, says the *Scientific American*, that the generator be so designed that it can be supplied with calcium carbide, and the residuum withdrawn without the escape of gas or the admission of air, in order to ensure the prevention of dangerous explosive admixtures of air with the gas in the generator.

A Little Knowledge.—The following absurdities were communicated, amongst others, to the *American Electrician* by Mr. C. R. Fontain, who obtained them from students' note-books and answers to papers. They amply illustrate the adage that "A little knowledge is a dangerous thing": "A coulomb is the one-thousandth part of an ohm." "A short-circuit is a wire of great resistance connecting the main terminals." "Hysteresis is the loss of magnetism when the wire has a static charge." "The internal resistance of a secondary cell is determined by the primary." "All resistances are regarded in their working as Wheatstone bridges." "A farad is one-billionth of the earth's quadrant." "The difference between voltage and E.M.F. is that the voltage is the amount used, and E.M.F. is the time it took to use it." "Electrolysis is the process of obtaining an unlimited number of sparks by the use of a pan filled with melted resin on a dish with an insulated handle." "Electrolysis is the condition of a battery, the elements being consumed so fast the chemicals have not had time to produce the amount called for." "Electrolysis is when the currents tend to act in unison." The following may be of interest to central-station managers: "A compound dynamo is to keep the load uniform." But perhaps the most trying to the teacher, who has carefully explained the principle of the dynamo, is to read in an examination paper "that current is generated by the friction of the brushes on the commutator."

The Telephone and the Fire Brigade.—An innovation has been inaugurated in Berlin upon which the *Elektrotechnischer Anzeiger* comments favourably. It appears that the city is divided into 15 sections with about 700 fire-alarms. The latter are connected by underground cables with the central fire stations. Up to the introduction of the new system, communication with the station from the alarm box necessitated the use of the telegraph key, which is fixed in each alarm box, and the observation of the needle of the galvanometer. Consequently a telegraph clerk had to be employed. Now each fire captain carries a small leather box, containing a microphone with switch, a second telephone, an induction coil, an automatic switch, and a condenser and battery. He can now switch on to the alarm box and communicate with the superintendent, who sits at his desk at the central station. While the captain wrangles with the intricacies of the telephone, poking his head into the box around the corner, and the superintendent at his office a mile or two away uses bad language at him, we should think the fire will have all the chance it wants. Finally, the captain and superintendent may shake hands at having achieved a scientific success in having established perfect communication with each other. The house may probably be burnt down in the meantime; but that is mere detail. Yet it is a factor to be considered, and will probably lead to a reversion to the more old-fashioned plan of having captain and superintendent at the place where they ought to be—*i.e.*, where they can see the fire.

Motive Power in London.—We are informed by the City of London Electric Lighting Company that they are about to introduce a continuous-current system of supply for motive power in the City. This entails new mains, but we understand that these will be ready in about three months. The maximum rate of charge will be 3d. per Board of Trade unit, which is equivalent to 2¼d. per electrical horse-power per hour, but by the word maximum we hope a reduction for quantities is to be inferred. Such a reduction will, we think, offer an inducement for the adoption of such means of driving machinery in place of other mechanical power, such as steam and gas, as are objectionable in the heart of a city. The company is asking for promises to take power in order that the demand may be gauged, and the details of probable demand in brake horse-power and lengths of running will not be held to commit the consumer to take the power eventually. Motors may be hired from the company if desired. It seems wonderful that the company should have passed over the multiphase system in favour of continuous currents when putting down new mains for power purposes. The difficulties of supply are less and the speed regulation obtained much less dependent on the voltage of supply when the three-phase currents are used. We do not doubt but that the engineers of the company have considered the point, but wonder what finally induced them to put down a direct-current plant. That in some areas the lights may also be supplied at times from the plant is the only suggestion we can make, but surely the pressure of the power mains will be too high to allow of this being done.

A Non-British Pacific Cable.—The passage by an overwhelming majority in the House of Representatives of the United States of the joint resolution for the annexation of Hawaii to the United States and the like action in the Senate, have caused a revival of interest in the Bill to provide for telegraphic communication between San Francisco and Honolulu. Interest in the project has also been stimulated anew by the intelligence that the Hawaiian Legislature has granted a franchise to the Pacific Cable Company to lay and maintain telegraphic communication between that country and Japan and China, the operation of the franchise being conditioned on favourable action by the Congress of the United States within the next 18 months on the Bill now pending before it. This Bill authorises the Postmaster-General to contract with the Pacific Cable Company for the payment to that company of not more than 100,000dol. a year, payable quarterly for 20 years, for the construction and operation of a submarine

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cable for the transmission of messages of the United States from San Francisco to Honolulu, and thence to such points on the coasts of Japan and China as the company, with the approval of the Postmaster-General, may select. From the details given in the *Western Electrician* we gather that the friends of the measure are not hopeful of action by the House before next winter, although they are strongly of the opinion that the work of establishing telegraphic communication between San Francisco and Honolulu should be begun as soon as annexation takes places, and vigorously prosecuted to a speedy conclusion.

The Victoria Institute.—The annual general meeting of this institute was held on Monday last, when Sir George Stokes, the president, took the chair. After the report and accounts had been passed Sir George Stokes delivered his presidential address on "The Perception of Colour." He called attention to our imperfect knowledge of new colours and perceived by the mind. Of all the theories advanced he considered the Young-Helmholtz theory the most tenable. Dr. Young believed there were three primary sensations of colour, and that they were called up simultaneously when any colour was presented, but in different proportions according to the nature of the colour. Those primary sensations were red, green, and violet. Those might be taken as the three standards of colour, because by their mixtures the other colours could be most closely reproduced. That theory was taken up by Helmholtz, and was now known as the "Young-Helmholtz" theory. Under this theory three classes of nerves were brought into play, and what scientific men had now to explain was how it was that the stimulation of these nerves produced the three different sensations which he had spoken of as primary. Helmholtz had advanced the theory that it was due to some photo-chemical action, and possibly there might be something in that suggestion. But at any rate the subject was a very difficult and speculative one, but it led to some interesting contemplations. One thing they could not fail to be strongly impressed with was the wonderful complexity of that marvellous organ, the eye and its retina, and the proof which, to his mind, it gave of design in its construction.

The Calcutta Tramways.—The committee of the Bengal Chamber of Commerce has addressed a letter to the Corporation on the Calcutta tramways question. After a reference to the length of time the negotiations have been proceeding, and nothing as yet having been determined, the letter concludes: "It is quite impossible for the present state of things to go on much longer. The system of horse traction is absolutely unsuitable for the climate of Calcutta. The state of the permanent way is in many places deplorable, and setting aside the constant delays and inconveniences to which passengers are subjected, it is intolerable that year after year a vast amount of suffering should continue to be inflicted on the horses employed. The directors of the tramways company fully recognise this fact. They state that it is impossible with horse traction to increase the service to meet the growing demands for accommodation, and the public convenience will continue to suffer if the system of horse traction is maintained. At the stage the matter has at present reached, it appears to the committee perfectly clear that a remedy is in the hands of the Corporation, and they desire to express a hope that the present difficulties be vigorously grappled with in the interest, not only of the public, but of the Corporation itself. It should be added that the final reply of the Corporation to the company's offer of electric traction must be submitted to the directors by June 30, or the offer will be withdrawn." We hope this letter, which we extract from *Indian Engineering*, has had the moving effect desired, and that an electric system of traction will be quickly installed.

Electrical Sport.—Under the above heading the *American Electrician* has published at times different pranks, all more or less dangerous to the electrical machinery used, by which an ingenious youth can waste his time and alarm his associates. The following is an account of how a carpenter furnished electrical sport without meaning to do so. It occurred soon after the Pulitzer Building, in New York City, had been completed. It was decided to cut a door through one of the partitions between two of the offices, and a carpenter was at work at the job. While engaged in stripping out the terra-cotta bricks, of which the partition was composed, he came across the three heavy insulated wires which formed the electric light network to that group of offices. The carpenter poked the three wires out of his way several times, but they kept falling back again. Finally, the man got mad, gathered up the three wires in his left hand, and struck them with his hatchet. The man stood on the staging, 5ft. from the ground, when he struck at the wires. He hit the wires fair—all three of them. There was a flash and a bang up there by the carpenter, and another firework display in the corridor at the fuse box. The wires came off and down upon the floor and most of the carpenter with them, but his moustache, eyebrows, and a good bit of his hair did not come with him. They went off into space, with a good chunk out of the edge of his hatchet and the fuse in the corridor. It is safe to say that the carpenter will never again try wire-cutting with a hatchet when the "juice" is on. As for the sport, it was sport for the observers, if not for the carpenter.

The Telephone Committee.—The evidence given by Mr. James Staats Forbes before this committee is not of a pleasing character. It concerned the verbal promise said to have been given by Mr. Goschen, in 1892, that the Post Office authorities would not compete or allow competition in districts which were well served by the National Telephone Company. Mr. Forbes said that Sir James Ferguson had also definitely promised that competition should not be allowed in those areas in which the company provided a reasonably efficient service. He did not see how it would have been possible to include such a proviso in the written agreement, and failed to see that there was any breach of faith in entering into such a verbal arrangement. He admitted, however, when pressed, that the alleged promise was not quite so definite as might have been inferred. As the alleged promise was directly controverted by the agreement signed at the same time, we cannot understand how any such promise or understanding can have been given by an English Minister. Later in the day Mr. Arnold Morley, the late Postmaster-General, stated that neither Mr. Goschen nor Sir James Ferguson had ever suggested to him that the 1892 agreement was not to be interpreted in its literal sense. But there seemed to be a tacit understanding in the Post Office that the agreement should be so carried out as to make it as valuable as possible to the public. He also declared that Mr. Forbes had never claimed, during the period that he was Postmaster-General, that it should be interpreted in any other sense.

Power Distribution over Large Areas.—A correspondent to the *Sheffield Independent* criticises most fairly certain clauses in the Bill of the General Power Distribution Company which he considers will be unfair to the general public. Thus whilst the company may serve a local authority with notices which will compel it to take in bulk from the company or face competition, there is no corresponding clause in the Bill enabling a local authority to

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give notice to the company to supply in bulk, or on failure to forfeit its right to supply in the district at all. Where is the equity in such a clause? But, further, the proviso at the end enabling the company to supply direct consumers of 10,000 units per annum is, says the correspondent, a monstrous proposition. Such a consumer as is here contemplated is by no means a very large consumer, and the proviso would enable the company to supply direct all cases which give the least trouble and are consequently the most profitable part of the business, and leave the local authority that part which is most costly, on account of the distribution and losses in collection. Again, a local authority has by its provisional order a time limit of two years to carry out its power. If it fails in this, it may forfeit its provisional order. The promoters under this Bill have five years within which to expend £50,000 on works, and having done this, it enjoys a right in perpetuity over the whole area. Thus the company may spend the £50,000 at the central generating station and in such other part of its 2,000 square miles as it may choose. It may never approach nearer to certain parts of the area than the centre, 26 miles away—it may never intend to do so—but still it will possess in perpetuity the right to do so whenever it thinks proper. This is evidently not equitable.

Water Powers in Northern Latitudes.—It may be recalled, says the *Electrical World*, that when the great power plant at the Lachine Rapids, near Montreal, was opened about a year ago there was some feeling of uncertainty as to the continuous working of water powers in latitudes where the winter temperatures are so low as in that part of Canada. It is fairly demonstrated from the past winter's operation of the Lachine plant that this fear was without adequate foundation, as no trouble from anchor ice was encountered, and the service of the installation was not hampered in any way by ice during the winter season. A large part of the available water power in the eastern part of America is in northern latitudes where the winters are of great severity, and it is as important as it is pleasant to know that there seems to be no reason to anticipate stoppage of the power from ice. The industrial development of Canada will probably keep pace with the utilisation of the magnificent water powers with which it is so abundantly endowed, the climatic and other conditions apparently marking Canada as a region in which manufacturing will one day be the principal industry. The projected railway to the Hudson Bay region will open a country full of water power awaiting development and utilisation, and this region is not so far from the centres of population and the points of transhipment for exports as some others now enjoying a large manufacturing trade. With the continual growth of electrolytic methods for the extraction of metals and the manufacture of mineral products the importance of water powers, even in comparatively inaccessible regions, is vastly enhanced. This is especially the case in a region of high-priced coal such as Canada, and it is to be hoped that the encouraging success of some recent great installations for the electrical development of water power there may be followed by a general attention to the development of the vast resources of the country through the agency of its fine natural falls.

The London County Council and Tramways.—The Highways Committee, in their report to the London County Council, state that "in view of the probable development of the Council's policy as regards the working itself of the tramways which it may in future acquire, we are of opinion that it is expedient that a tramways department should be established for the purpose of dealing with all matters relative to tramways acquired or to be acquired by the Council. There is no doubt that in the near future many important questions will arise as regards the management of the tramways when acquired, the systems of traction to be adopted in preference to the present system of horse traction, and many other matters connected with the working of tramways, and these will have to be dealt with. We think, therefore, that it is desirable in the public interest that the best advice obtainable should be at our command in order that we may be in a position to indicate to the Council what would be the most efficacious way of utilising these tramways systems to the utmost extent for the benefit of the Council as representing the ratepayers; the interests of the employés as regards hours of labour, and the question of further facilities being given for the accommodation of the public using the tramways, also receiving due consideration. In accordance with the resolution of the Council, we are endeavouring to arrange for the transfer to the Council by agreement on Jan. 1 next of the whole of the system of the London Tramways Company beyond the 2⅓ miles already purchased by the Council, so that it is clearly necessary that proper arrangements should at once be made in view of the probability of the management of the whole system of the company being taken over by the Council on that date." The committee accordingly recommend that a tramways department be formed for the administration of the Council's tramways. Perhaps we shall, after all, see the trolley system introduced, on the principle that what is wrong when done by outsiders is right if carried out by the Council.

Electric Furnaces.—Messrs. Gin and Leleux's valuable paper in *Comptes Rendus* is abstracted as follows from the *Journal* of the Chemical Society: The characteristic fall of potential of an arc striking across a given medium is due simply to the resistance of the mass of gas which lies between the electrodes resulting from the volatilisation of the material of the electrodes or of the substances subjected to the action of the arc. If this mass of gas is regarded as a cylinder with a sectional area equal to that of the electrodes, and if this cylinder is assumed to be surrounded by a perfect thermal screen, it can be shown that the temperature of the arc would increase as the square of the density of the current and the ratio of the resistivity to the specific heat per unit volume of the atmosphere of the arc, the two latter factors being themselves variable with the temperature. When the arc is allowed to pass through a mixture such as that used in the preparation of calcium carbide, the arc forms round itself a sort of pocket, at the upper pole of which is a small crater through which carbonic oxide and the vapours of calcium oxide, calcium, and carbon escape. The volume of this cavity increases up to the point at which the heat liberated by the arc is in equilibrium with the loss of heat to the surrounding medium. After cooling, it is found that the interior of the pocket is lined with a brilliant layer of vesicular graphite, behind which is a concentric layer of crystallised calcium carbide, and behind this a layer of unaltered material. This result can be explained by assuming either that at the temperature of the arc the calcium carbide dissociated, or that part of the calcium oxide volatilised so rapidly that it escaped reduction, and an excess of carbon was left. Direct experiment shows, however, that with a sufficiently intense arc, calcium carbide is dissociated at a temperature below that at which carbon volatilises. The tension of the arc varies with the surrounding atmosphere; for example, with calcium carbide mixture when the stationary temperature is reached the tension is from 18 to 20 volts, the electrodes being 10cm. apart, whilst with a mixture of carbon and manganese oxide, the tension is only 10 volts, and the pocket formed is much larger.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXX.

The cell referred to in the preceding section is in many respects a new departure; and it will be of interest to consider it, as far as possible, from the analytical, synthetical, and comparative points of view. I say "as far as possible" because, for reasons which will be understood, I am not free to make public all the details of its manufacture, more especially those relating to the methods adopted to secure the adherence and coherence of the active material and to obviate "shedding." Sufficient details, however, are available for the purpose in view: The number of plates is $n = 11$; the area of each plate is 9in. × 9in. = 81 square inches—thus the total surface of each plate is 162 square inches; the weight per square inch of the perforated supports is $w = \cdot188$oz.; the thickness of the perforated supports is $t = \cdot05$in.

We have first to notice that the supports for the peroxide active material are of the same weight and thickness as those for the spongy lead. This is a very usual condition, but it is one that is very open to adverse criticism; it is indeed, I think, permissible only when the thickness (t) is already very low, and when, moreover, the corrosion of the support, in the case of the peroxide element, is obviated to a great extent either by special means or, as in the present case, by embedding the peroxide support in the active material. By this device, more especially if the peroxide be of a dense character, local action between the peroxide and its metallic support is greatly diminished (*vide* Section V.), irrespectively of any sulphate of lead which may have been produced. With a non-embedded support or grid, it may reasonably be held that, if it be of sufficient weight to give the requisite conductivity and resistance to the effects of corrosion in the case of the peroxide element, it is unnecessarily heavy for the spongy-lead support. Under the existing conditions it would not, perhaps, be justifiable to condemn the peroxide supports as being too light, considering that lightness is a point specially aimed at in the design of the cell. We may notice in the second place that, according to the data given in the preceding section, the total weight of the spongy-lead plates is considerably greater than that of the peroxide plates. This, of course, is not as it should be (CXV.), even when, as in the case of the cell under consideration, the weight of the spongy-lead active material is equal to that of the peroxide—*i.e.*, when it is a maximum, perhaps justifiable only on the grounds that the weight of the latter tends to augment by local action, whilst that of the spongy lead may become reduced by sulphatation. But, from a practical point of view, it would be hypercritical to condemn the design of the cell because the total weight of the latter was not diminished to the extent of about 3 per cent. by the adoption of two different models for the terminal and the intermediate spongy-lead elements.

CXXI.

Now, in regard to the weight of electrolyte, although the cell was designed to give 250 ampere-hours at the normal rate of discharge, its real capacity is quite 260 ampere-hours. The initial specific gravity of the acid was 1·263 and the total weight of this acid allowed for the electrolyte was 13lb. 14oz. (CXIX.). The percentage of H_2SO_4 in acid of this density is N = 35 (Otto's table). What will be the final density of the acid after a discharge of 260 ampere-hours? To answer this question we must obtain from the formula for total weight of acid (CVI.) an equation for the final percentage (n) of H_2SO_4. When this is known we can, of course, find in the tables (Otto's or Kolb's) the corresponding specific gravity.

Formula for the Percentage (n) of H_2SO_4 in Residual Electrolyte.

$$W = A + Aq + aq \frac{Aq + aq}{\frac{100\,A}{n} - (A + Aq)} \times A + Aq.$$

(Section CVI.)

$$[W = A + Aq + aq + x\,(A + Aq)].$$

$$W = A + Aq + aq + \frac{(Aq + aq)\,A + Aq)}{\frac{100\,A}{n} - A + Aq}$$

$$W - (A + Aq + aq) = \frac{(Aq + aq)\,(A + Aq)}{\frac{100\,A}{n} - (A + Aq)}$$

$$\frac{100\,A}{n} - (A + Aq) = \frac{(Aq + aq)\,(A + Aq)}{W - (A + Aq + aq)}$$

$$\frac{100\,A}{n} = \frac{(Aq + aq)\,(A + Aq)}{W - (A + Aq + aq)} + A + Aq$$

$$n = \frac{100\,A}{\frac{(Aq + aq)\,(A + Aq)}{W - (A + Aq + aq)} + A + Aq}$$

In the formula for the weight of H_2SO_4 (A) corresponding to Q ampere-hours, given in Section CVI., this weight is in ounces avoirdupois, the constant being in this case ·129. If the weights (A and W) were required in grains, the constant would be 56·4; if they were required in grammes, it would become 3·656. If we require the weights (A and W) in pounds avoirdupois, the constant becomes ·00805 (CIV.). Thus, in the present case, Q being 260 ampere-hours, the required weight of monohydrated sulphuric acid will be—

$$A = 260 \times \cdot00805 = 2\cdot093\text{lb. av.}$$

The weight of water in the monohydrated acid will be:

$$aq = 2\cdot093 \times \cdot1837 = \cdot38\text{lb.}$$

The additional weight of water in acid of specific gravity 1·263, containing 35 (N) per cent., and A pounds, of monohydrated acid is

$$Aq = \frac{(100 - N)\,A}{N} = 3\cdot9\text{lb.}$$

And the value of n, according to the above equation will be:

$$n = \frac{100\,A}{\frac{4\cdot28 \times 5\cdot993}{13\text{lb.}14\text{oz.} - 6\cdot373} + 5\cdot993} = \frac{209\cdot3}{\frac{25\cdot65}{13\cdot875\text{lb.} - 6\cdot373\text{lb.}} + 5\cdot993}$$

$$= \frac{209\cdot3}{9\cdot41} = 22\cdot24.$$

The specific gravity of the acid containing this percentage of H_2SO_4 is 1·162. This is certainly a very high final specific gravity. That what I usually aim at—viz., 1·145, in which the percentage of H_2SO_4 (n) is about 20—may also be considered a high value. Such high final specific gravity necessitate a high initial specific gravity to avoid undue augmentation of weight; and 1,263 (N = 35) is perhaps the highest permissible specific gravity, since, if the acid be stronger, its action upon the spongy lead, attended with the evolution of hydrogen, becomes very observable. The same action, which may be greatly intensified by the presence of impurities (electro-negative to H and Pb) in the spongy metal, occurs to some extent when acid of much lower specific gravity is used as the electrolyte. It may here be noted that, by calculation from the formula given in Section CVI., the weight of electrolyte per ampere-hour, when the initial specific gravity is 1,263 (N = 35) and the final specific gravity is 1·144 (n = 20), comes out as ·74oz. avoirdupois = ·585 fluid oz. = 1·015 cubic inches. The acid most usually employed for accumulators has the inital specific gravity of 1,190 (N = 26); the final specific gravity—as we shall see in one notable case where the weight of electrolyte per ampere-hour is excessive—may fall no lower than 1·174; although it may fall to 1·134, or even in extreme cases even below 1·100.

Many manufacturers of secondary cells would no doubt opine that the specific gravity of the electrolyte I regard as most suitable for traction cells is dangerously high; and I may here admit that in the case of stationary or "waiting" batteries, especially where the "waiting" may take place after partial discharge, I should employ electrolytes of lower density. But a careful consideration of the diagrams given under Section CV. is sufficient to show the great importance, in the case of traction batteries, of working with percentages of H_2SO_4 between 35 (beyond which I

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think we may not go) and 20 (as about the lowest limit). The peroxide element is safe when fully charged, and whilst being discharged, so long as the E.M.F. between it and spongy lead is not below 1·85 volts, and admitting that some local action on the spongy lead does occur, it need never extend over a long period of waiting, and it is rendered nearly harmless by the provision of spongy-lead active material in considerable excess.

The weight of acid of the given specific gravity I should myself allow is

·74oz. × 260 ampere-hours = 102·4oz. = 12lb. (nearly)

instead of 14lb. (nearly).

CXXII.

The density of the current at the normal rate of discharge is

$$\Delta = \frac{20 \text{ amp.}}{a\,(n-1)} = \frac{20}{81 \times 10} = \cdot 024.$$

This is a low density of current (*vide* Section LXXXVI.). At the maximum rate of discharge, however, it becomes ·120, and during the *coups de fouet*, extending over a few minutes, it may rise to ·191. These are high current densities, but the battery appears to be well able to withstand them. For the current of 62·5 amperes the density was ·077, or about twice the maximum safe density with the E.P.S. (T) cell. It will be interesting to observe how far these higher current densities may tell upon the life of the cell.

CXXIII.

In the cell under consideration, the weights of peroxide and spongy-lead active materials are approximately equal—or, rather, would be equal if the capacity per unit of surface had been made the same for the terminal as for the intermediate spongy-lead elements. Thus, the former of the two equations for the total weight (W) of the contents of a cell (CXVI.) is in this case applicable.

By formula (1) (CXII.), the weight of metal removed per square inch by perforating the supports is:

$$w_1 = 6 \cdot 56\ t - w.$$

In the present case (CXX.), $t = \cdot 05$in. and $w = \cdot 188$oz., and $w_1 = 6 \cdot 56 \times \cdot 05 - \cdot 188 = \cdot 14$oz.

By formula (IIIA.),

$$p = w_1 \frac{\text{sp. g.}}{11 \cdot 4}.$$

Taking the average specific gravity of the active materials approximately as 8 (a low value),

$$p = \cdot 14 \frac{8}{11 \cdot 4} = \cdot 098\text{oz.}$$

Allowing ·623oz. of each kind of active material per ampere-hour (which is a somewhat higher value than that specified under Section CXVI.), the total weight of active materials of both kinds will be ·623 × 2 × 260 ampere-hours = 322·76oz. = 20·17lb. (say 20lb., or 10lb. of each kind). Then the weight of active material per square inch of *surface* $= p_1 + \frac{p}{2} = \frac{322 \cdot 75}{2q(n-1)} = \frac{322 \cdot 75}{1{,}620} = \cdot 2$oz. nearly. Subtracting from this $\frac{p}{2} = \frac{\cdot 098\text{oz.}}{2} = \cdot 049$, the remainder $= p_1$ = ·151oz. Thus the total weight of the *contents* of the cell should be:

$$W = [\cdot 188 + (\cdot 302 + \cdot 098) \times 1 \cdot 6] \times 810 \text{ (oz.)} = 670 \cdot 68 \text{ (oz.)} = 42\text{lb. (nearly)}.$$

To this we have to add, for the total weight of the cell:

The weight of the ebonite box and lid	5lb. 2oz.
The weight of connections, etc.	1lb. 4oz.
Giving for the calculated total weight of the cell	48lb. 6oz.

The calculated value thus being 6lb. 10oz. lighter than the actual weight of 55lb.

ELECTROLYTIC THEORIES AND THEIR RELATION TO COMMERCIAL ELECTRO-CHEMISTRY.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

The first stones of an experimental foundation for a theory of electrolysis was, as is well known, laid by Faraday in the seventh and eighth series of his "Experimental Researches." It is somewhat surprising, when one surveys the vast amount of experimental data which has since been accumulated, to notice how poorly Faraday's discoveries have been followed up in this country. Indeed, the names of the most prominent labourers in this field, either in theory or practice—Davy, Grotthus, Clausius, Lord Kelvin, Helmholtz, Arrhenius, Ostwald, Hittorf, Kohlrausch, Nernst—alone are sufficient to indicate our backwardness in this respect. Nevertheless, it has long been surmised, and is at present becoming more evident day by day, that there are few classes of research which hold out more brilliant possibilities, either in relation to discoveries of a merely theoretical interest, or in the application of the principles deduced from such discoveries to commercial processes, than in connection with the passage of electricity through electrolytes. Of course, the invention of new forms of galvanic cells presents few attractions at present; the dynamo, and, for certain classes of laboratory researches, even the thermopile, offers advantages which no one can ignore. The problem which presents itself to electrochemists of to-day is of an entirely different nature. Given a supply of electrical energy, how may we best utilise this in connection with chemical and metallurgical operations? This is the question to which an answer is becoming day by day more pressingly urgent in numbers of different fields of industry.

Consider the consequences of such an invention as the electrolytic production of aluminium. Not many years ago the whole supply of this metal was obtained by heating a mixture of the double chloride with cryolite and metallic sodium in a reverberatory furnace. By a simple extension of the principle originally used by Davy to obtain metallic sodium and potassium, aluminium is now obtained electrolytically on a scale that renders it as cheap, volume for volume, as copper. The benefits thus arising can hardly be estimated from a consideration of the direct applications of aluminium in the arts; new possibilities are opened up in directions previously unsuspected. Thus if "aluminium dust" is heated when intimately mixed with a salt of chromium, an intense reaction takes place, the whole mass being raised to a state of incandescence; on cooling, metallic chromium is found at the bottom of the crucible in which the operation was performed. Chromium is a metal which is capable of being utilised for many purposes, and will doubtless in some cases take the place of platinum; but even here we have by no means exhausted the benefits which cheap aluminium affords. It has recently been pointed out that the heat evolved in the reaction by which chromium is produced may be utilised for the purpose of brazing, or for softening small areas of specially hardened steel plates, in order that holes may subsequently be drilled. A mixture of the chromium salt with "aluminium dust" and sand is placed at the point where the heat is required, and the reaction is started by means of a small ball or "cherry" of a similar mixture, in which a length of magnesium wire is partially buried. If the magnesium wire is lighted the heat generated is sufficient to start the reaction in the "cherry," the whole of the rest of mixture becoming subsequently incandescent.

Another application of an electrolytic method may be noticed; I mean that used in the production of caustic soda and bleaching powder, due to Castner and Kellner. If a brine solution be electrolysed between platinum electrodes, chlorine is given off at the anode, whilst metallic sodium is formed at the cathode. The sodium, however, immediately reacts with the water, producing caustic soda, which, being mixed with the brine, cannot be immediately utilised. On the other hand, if mercury is used for the cathode the sodium forms an amalgam with it; if this is now shaken up with water, caustic soda will be formed. A diagrammatic representation of the arrangement used commercially is given in Fig. 1. A containing vessel of slate has two grooves at A B running across its base; two slate partitions, A C, B D, descend some distance into these grooves, leaving, however, a space between their lower extremities and the bottoms of the grooves. Mercury is now poured into the vessel so as to close the connections between the three compartments, F, G, H. The compart-

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ments F and H are filled with brine, G being filled to an appropriate height with pure water containing a trace of caustic soda in solution. An electric current enters F and H by carbon electrodes, and passes by way of the mercury at the bottom of the vessel into G, and leaves this by an iron electrode, K. In this way sodium amalgam is formed in the mercury at the bottom of F and H, and by tilting the whole arrangement a great part of this can be run from either F or H into G, where the passage of the current facilitates the formation of the caustic soda. The chlorine given off in F and H is utilised in the production of bleaching powder.

Returning, now, to a consideration of the reasons for the far greater fertility of Germany in regard to investigations and inventions in connection with the electrolysis of solutions, much must doubtless be ascribed to the encouragement which Continental governments extend to scientific investigators. In England, science, except of the popular sort, is little more than tolerated, as is instanced by the reluctance of the ruling powers to sanction the establishment of a national physical laboratory; any comparison with the spirit shown in the establishment of the German Reichsanstalt is superfluous. But another factor which has unquestionably exercised a most stimulating influence on the branch of science at present under consideration is the theory of electrolytic dissociation in dilute solutions. This

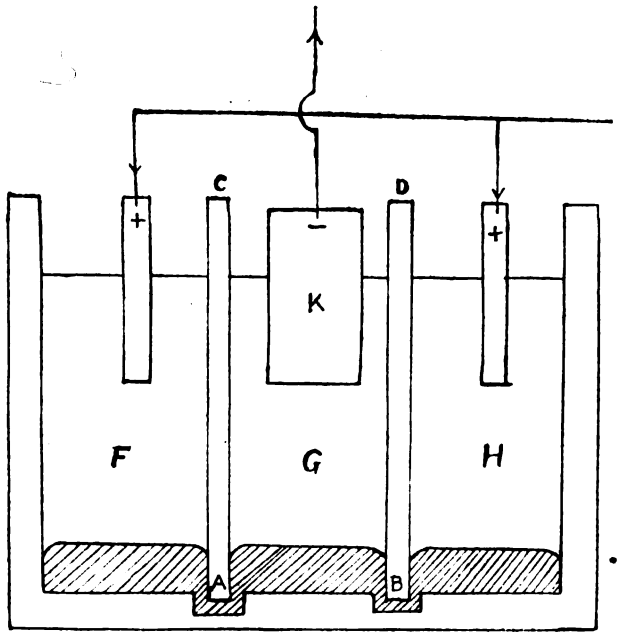

FIG. 1.

theory, except in so far as it was adumbrated by Clausius, originally sprang from an attempt to explain the failure of Van t' Hoff's hypothesis of the nature of osmotic pressure when applied to certain aqueous solutions. On the Continent it has gained ground at such a pace that many scientists now support it with a conviction heartier than they feel, for example, for the kinetic theory of gases. In England the same theory has as yet made little progress. Amongst physicists it has to a great extent been ignored; many chemists have greeted it with an opposition as fierce as, in some cases, it was uncalled for. As a consequence, little in England is generally known of this branch of science, even by students of physics and chemistry; and it is to be deplored that Prof. Nernst's "Theoretical Chemistry" has been so badly translated into English that irritation is continually felt in reading it, whilst in many places the meaning is rendered obscure to the point of incomprehensibility. It is not my intention at present to offer any criticisms either for or against the essential assumptions involved in this theory; but one thing must be said: if we are to judge of a tree by its fruits, we cannot but give a high place to a theory which has led to so much brilliant experimental work—work whose results embody quantitative measurements concerning many interesting though perplexing phenomena which will have to be explained by any theory of electrolysis which may ultimately be adopted. Under these circumstances the advantages which would be likely to spring from a careful and systematic study of this theory cannot be too emphatically predicted, since it is hardly too much to say that if it is erroneous, we can hardly hope for a more satisfactory one till this has been given a fair and open hearing. It is therefore with no small satisfaction that the rumour has been greeted that the London County Council is considering the advisability of appointing at no distant date an expert in this branch of physical chemistry to deliver a course of lectures on electrolytic theory to students throughout the Metropolis.

VERBAND DEUTSCHER ELEKTROTECHNIKER.

FRANKFORT MEETING.

[BY OUR SPECIAL CORRESPONDENT.]

(*Continued from page 756, Vol. XXI.*)

The lunch at the Palmgarten on the Friday was served in a spacious verandah running the full length of the building, which, although open on one side, gave shelter from the showers of rain which fell at intervals. The ladies were present on the occasion, and they remained behind to visit the garden after lunch. The gentlemen were provided with brakes to convey them to whichever of the electric works in the district they might wish to see. The alternative visits were as follows: The factory of Messrs. W. Lahmeyer and Co., the accumulator factory of the Pollak Company, and the works of Messrs. Hartmann and Braun. The first two could be managed in the afternoon, as the works are almost adjoining. Still, I found so much of interest in the shops of the Elektrizitäts Aktien-Gesellschaft vorm. W. Lahmeyer und Co. that I did not get away till it was too late for further sightseeing. The workshops were not scattered, as too many of our works are in England, but consist chiefly of a long iron building well lighted by glass sides and with two floors of bays for light tools on each side. The centre of the building was devoted to the large machine tools, all of which were electrically driven, and further down the shops space was left for erecting the large alternators. The firm has recently supplied the equipment of the Wiesbaden electricity works, and some large alternators for this noted watering place were still in the shops. For these an internal and radial revolving field magnet is used, and the armature is fixed. The armature is built up of laminated iron, with holes for the conductors, which are wound *in situ*. I was specially struck with the rapid way in which this winding was done by the workmen, and also by the work turned out by the armature winders. The English armature winder would, I think, be disgusted at the skill of the men, and more particularly at the speed with which the turns were put on. After leaving the works, we returned to the heart of Frankfort again, just in time to dress for the special performance of the opera arranged in our honour. The performance was preceded by a dumb show representing a supposed marriage lottery, which was not appreciated after the corresponding variety entertainment in England. The real opera was magnificent, and the only regret from the electrical standpoint was that such a splendid opera house should not have the benefit of the electric light. After the performance, at 9 p.m., carriages again waited to take us to the electricity works which supply the town. Mr. Melms acted as host as representative of the firm of Messrs. Brown, Boveri, and Co., and entertained the company most royally. One end of the station was converted into a supper-room, where the whole of the guests, numbering at least 400, sat down to a repast, and the space round the alternators in the station was ample for the dancing which followed.

It may not be out of place here to give a few particulars regarding the electricity works at Frankfort. The history of the undertaking—as at a good many places nearer home—extends over a considerable period. Indeed, to be precise, the question of erecting a central supply station was first mooted in 1882, yet it was not until March, 1894, that

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building operations were actually taken in hand. If we look for the reasons of this protracted delay, we find that in the first place the town authorities were unable to make up their minds whether or not to keep the supply in their own hands, and, secondly, the commission appointed later on to make enquiries as to the peculiar advantages or disadvantages of rival systems of supply with regard to the special requirements of Frankfort were unable to arrive at a definite agreement. Out of the various controversies over this latter point arose a strong wish on the part of interested townsmen to see the various then existing methods of production and distribution in actual working. The electrical exhibition held at Frankfort in 1891, and which assisted in considerably hastening matters, was the memorable outcome. Shortly after its close, Oscar von Miller, consulting engineer, of Munich, and Mr. F. Lindley, the architectural adviser to the town authorities, were commissioned to prepare a general scheme for the erection of a central supply station, etc. These two gentlemen, working conjointly, eventually submitted three alternative schemes, in each of which it was proposed to utilise a site outside the town and adjoining the harbour on which to erect the necessary buildings. Of the three projects, that providing for an alternating-current supply with transformers was, at the same time, recommended as the one best adapted for the requirements of Frankfort. This latter vital question proved, however, to be by no means ended here. What with an undecided commission, and the influence brought to bear by firms interested in rival systems, the battle of the systems still waxed fiercely, until at last, in October, 1893, a final decision was made in favour of the original proposition—viz., alternating-current generating plant, with transformer distribution. Matters went apace after this, the contract for the whole of the work being entrusted to Messrs. Brown, Boveri, and Co., and regular supply to consumers was commenced on Jan. 1, 1895. The demand proved so great that an additional steam alternator, together with a corresponding increase of boiler power, had to be put on order even before the whole of the originally specified plant had been installed. This new machine, the fourth, was got to work early in 1896, but the number of consumers continued to increase so steadily that the necessity of another addition soon became evident, and in October of the same year an order for a steam alternator of 1,500 h.p. capacity was given out. A second machine of equal output, which will probably be installed during the coming winter, is now building. These latter additions, with the entailed increase of boiler power, etc., have necessitated an extension of the buildings and the erection of a second chimney shaft.

Description of the Works.

As already mentioned, the site of the station adjoins the harbour. The fact of its being some distance removed from the centre of supply is more than counterbalanced by the natural advantages in other respects which the position offers. For instance, the site affords excellent facilities for coaling, and being only about 100m. distant from the River Main, ample water is therefore at hand for condensing and other purposes, besides which its adaptability for future extensions must not be ignored. The total area of the site amounts to 14,400 square metres in round figures, whereof 5,930 square metres will ultimately be covered by the engine-room and boiler-house, the remaining area being reserved for yard, workshops, offices, workmen's dwellings, etc. When extended to the full limits of the site the machine-room will be capable of accommodating 9,000 h.p., while an ultimate increase of boiler plant corresponding to this plant is also projected

The plant at present installed comprises four machines of 750 h.p. each and one of 1,500 h.p. Further 15 boilers are fixed, three of which are of the water-tube type. The present length of the machine-room is 62m. and its breath 23m. Without further extensions room is afforded for the instalment of another 1,500-h.p. machine, together with three more boilers. Adjoining and opening into the machine-room is the pump-room, in which four pumps are at present arranged, the remaining space being used as a workshop.

Up to date the boiler-house has a length of 92·5m., the total projected length being 120m., while its breadth amounts to 18m., of which 5m. fall to the stoking floor. The illumination is by means of arc lamps suspended in line over the stoking floor. Under the latter is situate an ash tunnel in which rails are laid enabling a tip-wagon to be run up in front of each boiler. After collecting the ashes these wagons are run on to a turntable and conveyed thence to the west side of the coalhouse, at which point an electrical hoist elevates them to the ground-level outside. The boiler blow-off pipes are likewise placed in the ash tunnel.

Immediately behind the stoking floor are situate the coal bunkers; they have a breadth of 11·50m., and extend the whole length of the boiler-house. A siding is laid over the same at a height of 3·80m. from the floor-level, thus enabling them to be filled expeditiously from railway trucks. But the substitution of an automatic arrangement for coaling directly from barges is under contemplation.

A feed-water reservoir, with a capacity of 130 cubic metres, which may be supplied either with spring or river water, is built under the coal bunkers. Besides this, there are five iron reservoirs situated over the boilers, each having a capacity of 20 cubic metres. These are connected directly with the spring source of supply, the water being heated by exhaust steam from the feed pumps. As a rule, only the latter reservoirs are employed, the first-mentioned standing in reserve, water being pumped from it by steam power into the iron service reservoirs in case of necessity. The two chimney shafts provided for to meet ultimate requirements are 50m. in height, measured from the stoking floor level, and have an inner diameter of 2·80m. at their caps. The second shaft is, however, only now in course of erection.

The main flue, at its exit from the boiler-house, has a height of 2·40m., a breadth of 1·80m., and a cross-sectional area of 3·80 square metres. It decreases in size progressively towards the middle of the boiler-house, and along the stretch under the pump-room has a length of 2·20m., a breadth of 1·00m., and a cross-section of 2·05 square metres, or about half of the sectional area at its exit from the boiler-house. In this manner it is rendered possible to shut off one or the other shaft, together with an adjacent length of the flue, for examination or repairs, allowing the remaining shaft to take the waste gases from the whole of the boilers which may be kept under steam. To attain this end the main flue is equipped with four isolating dampers at different sections of its length. The socket of the chimney shaft is composed of firebrick masonry work faced with sandstone, while the wall has a thickness of 83·5 cm. at its base, decreasing to 25cm. towards the summit. In order to obtain the least possible weakening of the base the main flue decreases in breadth from 2·80m. at the boiler-house to 1·50m. where it enters the shaft, increasing at the same time in height from 2·60m. to 4·30m.

Returning again to the boilers, it must be mentioned that these are arranged in pairs (except for the odd one), and walled in with well-burned vitrified kiln bricks, so as to obtain a wall of maximum air-tightness. The whole battery comprises 12 corrugated flue boilers and three of the water-tube variety. The former have a heating surface of 86 square metres each, with a length of 8·78m. and a diameter of 2·346m., while the latter have each a heating surface of 310 square metres. The water-tube boilers are each provided with a steam dome of 0·70m. diameter by 0·85m. depth, and the remaining boilers with domes of 1·00m. diameter by 1·20m. depth, on which the high-pressure and safety valves are brought.

The boilers originally installed feed to a steam collector arranged under the boiler-house immediately behind the partition wall, between the same and the engine-room. This consists of four iron drums, each of 630mm. diameter, connected together by means of copper expansion pipes. A valve divides this collector into two separate portions if desired. Experience, however, proved the arrangement to work unsatisfactorily. In consequence, it was supplemented in the new extensions by a ring system of steam-piping, the two systems now working conjointly. One-half of the steam-ring is supported on brackets along the boiler-

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house wall, while the other is suspended from the roof of the pipe gallery under the boiler-house. The coal bunkers are provided with openings on to the stoking floor directly opposite each group of boilers.

Water for condensing purposes is conducted by gravitation from a point close to the harbour entrance through a deep-lying brick conduit into four wells situate immediately in front of the engine-room. This arrangement obviates the necessity of a long suction pipe. After being forced through the condensers the water is conducted by means of cast-iron pipes to a common sump, whence it is conveyed *vid* a return conduit back again to the river. The incoming conduit has a uniform section of 1·00m. breadth by 1·50m. depth, and a fall of 1 : 880; while the return conduit is circular in form, with a diameter of 1·00m. and a fall of 1 : 212.

The steam-engines are of horizontal tandem construction and compounded. The normal effective horse-power of each of the four smaller engines is 560, and their maximum output 750 h.p., while the normal effective capacity of the large machine amounts to 1,125 h.p. and its maximum output to 1,500 h.p. The respective dimensions of the machines are as follows:

	750-h.p. machines.		1,500-h.p. machine.
Diameter of the high-pressure cylinder	620mm.	...	775mm.
Diameter of the low-pressure cylinder.	960mm.	...	1,250mm.
Stroke	1,200mm.	...	1,500mm.

Each machine works at 85 revolutions per minute, and is mounted on a cast-iron bed-plate. The flywheels of the small machines have a diameter of 4·80m., and weigh 28,000 kg. each, that of the large machine having a diameter of 6·10m. and weighing 50,000 kg. Below the engines are situate the condensers, together with the air-pumps, which latter are actuated directly from the respective crankshafts. Provision is also made for exhaust into the atmosphere in the case of the smaller engines, but not with the larger one.

The alternators, which were furnished by Messrs. Brown, Boveri, and Co., Baden, are of the flywheel type, with rotating fields excited by means of dynamos built up on continuations of the respective main shafts. The field system in each of the several machines comprises 64 cylindrical magnets, radially bolted to the outer periphery of the engine flywheel. The pole surfaces of these magnets consist of forged rectangular shoes, and the field windings are of copper strip, wound round successive cores alternately from right to left. When the alternator is working up to its full capacity, the tension of the exciting current amounts to 70 volts, and since each of the 64 magnet coils contains 50 turns of copper strip, it follows that the difference of potential between neighbouring coils is 1·09 volts, and between each turn only $\frac{1}{10}$ volt. In both sizes of machine installed the field magnets are of similar form and interchangeable. The armature is carried by a hollow, wheel-shaped, cast-iron frame, which rests concentrically with the shaft upon two cylindrical bearings cast on to the main journals, and around which the armature may be turned. This frame consists of four semicircular castings bolted together, while the armature core itself is divided into 16 equal sections. The latter are built up of laminated iron plates, insulated from each other with paper, the whole 16 being bored out to form a true hollow cylinder within the supporting frame. The armature sections are, moreover, drilled and wound with four coils each, so that a single section, together with its complement of four coils, constitutes an independent and interchangeable segment. Each armature coil consists of a few turns of copper wire insulated with paper tubing from the iron core. The armature is secured to the bed-plate of the machine by means of bolts, the simple loosening of which enables it, together with its supporting frame, to be turned about the axial supports above mentioned. This arrangement greatly facilitates inspection, etc., of the lower coils, while, in case of necessity, a damaged armature section may be taken out and replaced with a spare segment very expeditiously. It may be further mentioned that the exciters are six-pole series-wound dynamos in the case of the 750-h.p. alternators, while the 1,500-h.p. machine is excited by an eight-pole shunt-wound dynamo.

Both the leads from the alternators and those from their exciters are conducted on porcelain insulators through a cable gallery situate under the machine floor to a switch-board. There are two of the latter: one, the machine board, carrying the machine switches, fuses, rheostat regulators, indicating instruments, etc.; and the other the fuses, switch-gear, together with lightning arresters and all controlling instruments, etc., appertaining to the main feeders. The machine switchboard is erected upon a projecting balcony facing the centre of the engine-room, access to the back, where the different connections, fuses, synchronising transformers, etc., are arranged, being obtained through glass doors. Each machine is provided with a main switch, and each exciter, as already mentioned, with a rheostat, the latter being housed underneath the machine switchboard. By means of the main switches individual alternators may be coupled on to the 'bus bars as required, which latter are arranged on the closed-ring principle, and form the connecting link between the machine and distributing switchboards. This ring system comprises two main bars and two supplementary or hospital bars. The first-named have a cross-sectional area of 875 square millimetres each, and the latter 175 square millimetres. On the one side of the system, that carried by the machine board, the alternators may be coupled in parallel or separately, while the disposition on the other side, that carried by the distributing board, enables the different main feeders to be switched in or out as desired. Provision is also made whereby the ring itself may be broken at various points, thus enabling short or long sections on either side to be cut out without interrupting the working of the remaining portion.

MUNICIPALISATION OF TRAMWAYS.

The British Electric Traction Company have sent us the following on the question, "Is the Municipalisation of Tramways in South Staffordshire the Right Policy?":

The thickly-populated industrial district lying between Birmingham and Wolverhampton, and forming what is sometimes called the "Black Country," contains a number of large towns, such as West Bromwich, Walsall, Wednesbury, Dudley, etc., with numerous smaller towns, having a total population of nearly a million inhabitants, whose business and work are for the most part essentially interconnected. It is, therefore, of the utmost importance that every possible facility should be given for intercommunication between all the various towns and centres of industry in this district; and though this is done to some extent by means of a network of railways for goods, mineral, and passenger service, yet obviously a still more flexible means of transit than the railway, with its fixed stopping places and infrequent service, becomes essential.

To give the further travelling facilities required by the public the existing tramway companies in South Staffordshire are now proposing (with the help of the British Electric Traction Company) to spend large sums in extending and converting their present systems for operation by means of electric energy, and the success that has so far attended the working of electric lines owned by the South Staffordshire Tramways Company (and shown in the annexed map by the lines with heavy black circles) appears to offer sound reasons for the adoption by the companies concerned of a similarly improved method for the other lines in the district. There is, however, a difficulty to be overcome before the very desirable end of giving South Staffordshire a complete network of electric tramways can be reached. This difficulty, which consists briefly of a desire on the part of some local authorities to take over and work the tramways within their respective areas, is not so great in itself, being, indeed, easily demolished when the arguments on both sides receive unbiassed consideration; but it gathers force from those who bring it forward—that is, from the local authorities, since the position of the latter naturally entitles them to a large measure of respect and consideration.

Now, it may be shown clearly that the essence of a tramway system operated by electricity is to spread as

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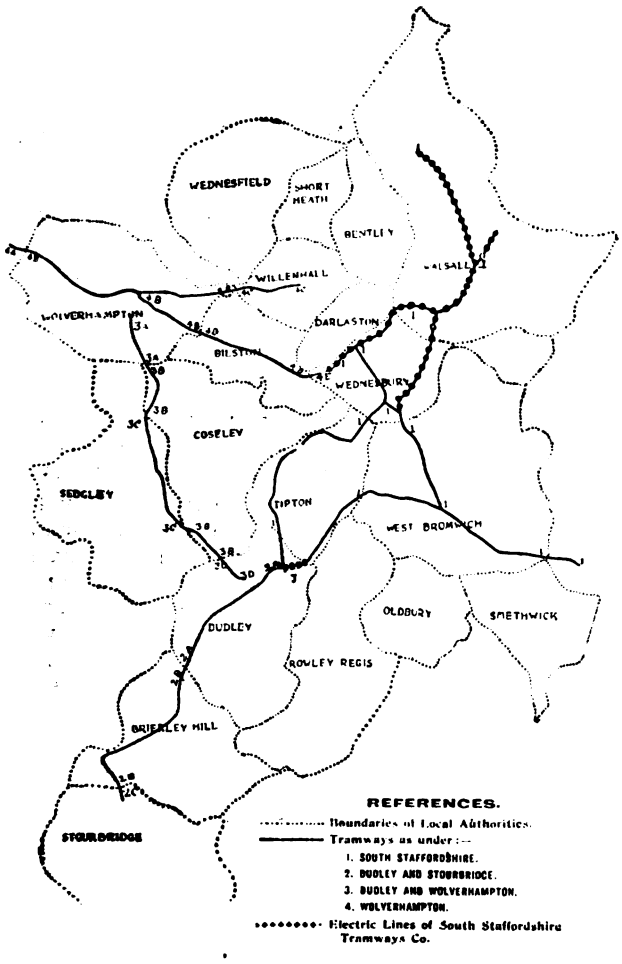
much as possible—that is, to go out, into and through the suburbs and country districts, not only for the purpose of giving rapid, safe, clean, comfortable, and cheap transit in the towns themselves, but also in the suburbs and areas intervening between towns; that, in short, an electric tramway ought to be of a three-fold character—urban, suburban, and interurban.

Some local authorities in other parts have already acquired tramways within their areas; but these have been for the most part worked by means of horses, and obviously horse traction is quite useless for an extended system. The moment such authorities convert the lines for working by electricity, they find it necessary to extend and spread outwards, and thereupon are met at once with the difficulty of boundaries. Even supposing that parliamentary consent could be obtained to the construction and working of electric tramways by a local authority outside its boundaries, the natural sequence of tramway development at once brings in a contest with the neighbouring authorities, which properly object to be dictated to or perhaps even absorbed by a neighbouring



authority. The mere fact of boundaries being fixed between the districts of local authorities, ought surely to imply that the enterprise of such authorities shall be kept within those respective boundaries. Otherwise there is no logical limit to the extent over which their jurisdiction might spread. The only true alternative to the operation by private enterprise of telephones, telegraphs, railways, and electric tramways would be that of nationalisation or State ownership. The difficulties thus pointed out will be very manifest from an examination of the tramways in South Staffordshire, and the accompanying map will serve to illustrate this. On the map are shown the various South Staffordshire district tramways, and the boundaries of the various local authorities through whose areas they run. It will be seen that there is not a single tramway (out of the four which serve the district between Stourbridge, Walsall, and Wolverhampton) which is contained wholly within the area of any one authority. How, then, can the latter work such portion of the lines as are within its boundaries and leave the rest of the system out of consideration? Is Wolverhampton, for instance, to work that portion of the Wolverhampton Tramway Company's system marked 4B, lying within the Wolverhampton municipal boundary, and leave others to work the remaining portions (marked 4C and 4D) which serve Willenhall and Bilston? Similarly, is the Dudley Corporation to work the small terminal portions of the Wolverhampton and Dudley (marked 3D) and the South Staffordshire Companies' lines (between Tipton and Dudley) within its area, together with the somewhat greater length of line belonging to the Dudley and Stourbridge Company (marked 2A)? Of what use to the Dudley ratepayers or to the public generally will it be to work such short pieces of line, beginning in Dudley and ending on the boundary line? Moreover, one terminal portion of the South Staffordshire Company's line within the Dudley boundary (marked J in the map) is used jointly with the Birmingham and Midland Company's system, and therefore the Dudley Corporation in regard to this piece alone would have to deal with two distinct companies with separate interests. The Dudley Corporation cannot obtain any powers over the remaining portions of these lines, and therefore "municipalisation" by this or any other local authority in a similar position means simply that a ring fence of isolation is built round the district, which loses forthwith all advantage of tramway interconnection with the surrounding centres.

There is, however, a still more important feature for consideration in regard to the tramways in the South Staffordshire district. The majority of the lines in this district are on the 3ft. 6in. gauge. If the Wolverhampton Corporation were to take over the tramways within its area, is it prepared to alter the present gauge of 4ft. 8½in. to the prevailing gauge of the district? Even if it does so, can it force the Wolverhampton Tramway Company to do the same in regard to the lines held by the company outside the Wolverhampton boundary? The same remarks apply with even greater force to Dudley, for here the Dudley and Stourbridge line, part of which is now being converted to electric traction, forms the greater part of the tramway system within the borough boundary, yet it is on a 3ft. 6in. gauge (like the South Staffordshire Company's lines, which also enter the Dudley authority's district). The Dudley and Wolverhampton tramway has, however, a gauge of 4ft. 8½in., so that the Dudley authority (in order to give the through services and the means of rapid intercommunication demanded by the public, and capable of being afforded by electric traction alone) must be prepared not only to convert to a 3ft. 6in. gauge such portion of the Dudley and Wolverhampton lines as may be within its boundaries, but must also ensure that the tramway company shall do the same with the remainder of the line running through the districts of three other authorities. Exactly the same conditions apply in the case of the South Staffordshire Company's line in regard to the West Bromwich authority and any other which may be considering the question of "municipalising" the tramways within their respective areas.

However attractive it may appear to the ratepayer to be told that he has a splendid property in the shape of the tramways which ought not to be "alienated from public ownership and operation," it cannot be too strongly impressed upon him that the moment a local authority takes over the tramway system in its area with a view to working the lines, then that particular district is shut off from intercourse by means of tramways with the surrounding areas, however much the public may demand a rapid, comfortable, clean, safe, and easily accessible service of electric tramcars over the whole district irrespective of boundaries altogether. What do passengers by tramway between Dudley and Stourbridge or Dudley and Wolverhampton care about the position of the respective boundaries? All they want is to be safely, quickly, and cheaply carried; and if the municipalisation of tramways were to imply that passengers must change cars at every boundary, then the traffic will speedily be reduced to a vanishing quantity. Even supposing that the Wolverhampton and the Dudley local authorities were in a position to give a tramway service within their areas, there would be no unanimity over the whole district either with regard to fares or mode of construction, or supply of energy, these being points upon which each local authority has its own views and generally insists

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upon their adoption. The interests of the public, as ratepayers, as tramway passengers, or as both, are best served by private enterprise in regard to the actual operation of such an undertaking as that of the South Staffordshire District Tramways, and private enterprise is prepared to carry through the business, and to properly safeguard the public interest. The British Electric Traction Company, Limited, which has already acquired a large interest in the South Staffordshire and Dudley and Stourbridge Companies' lines, is prepared to equip and work them in conjunction with the other lines of the district, on one uniform electric system, with the same gauge throughout, making also a number of important extensions and connecting lines for the public convenience. This company has the courage, the confidence, and the means to unify the South Staffordshire District Tramways; and its efforts deserve to meet with success. At any rate, the advantages which it offers to the public are so numerous and important that the various local authorities of the district should support the proposal as affording the best and quickest means of improving the present most inadequate service from the public point of view.

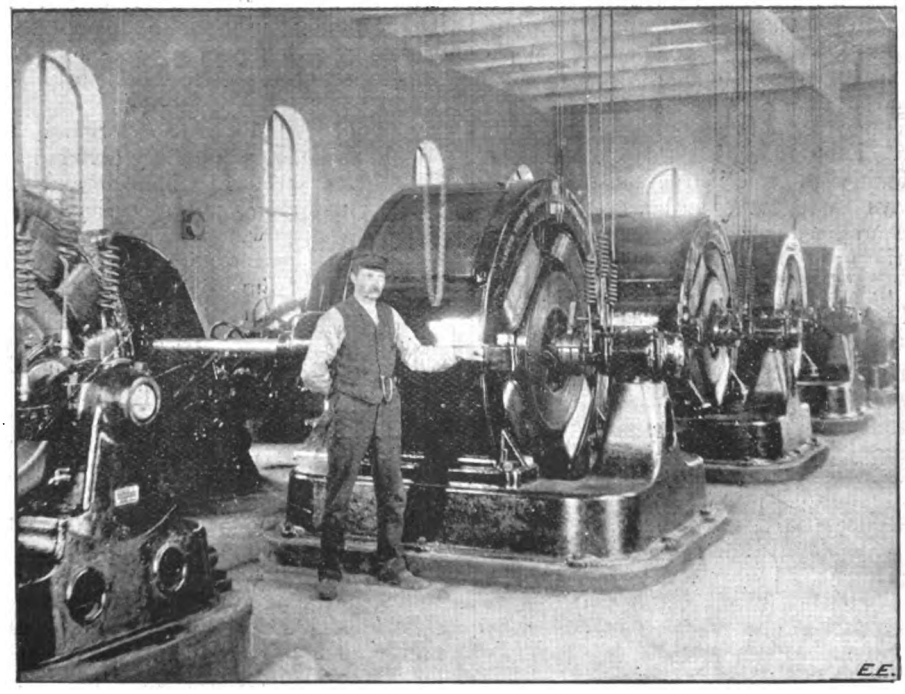

FIG. 1.—Three-Phase Power Station at Hofors, Sweden.

A NEW MANUFACTURING COMPANY.

The name of Wenström is well known in electrical circles, as the late Swedish electrician bearing this name did much to advance our practical and theoretical knowledge of electricity. Hence we welcome the new firm, the Fuller-Wenström Electrical Manufacturing Company, of 28, Bush-lane, Cannon-street, into our list of English manufacturing firms. Messrs. Fuller and Co. have been agents for some years for the excellent single-phase motors made by the Swedish firm of which Mr. Wenström was head, and we have had occasion before to describe these motors and the starting switches in detail. Now, the machines are no longer to be imported from the Allmänna Svenska Elektriska Aktiebolaget of Westeras, Sweden, but to be manufactured in England. The new firm will take up all branches of electrical engineering, including direct-current and three-phase installations. In this work they will draw on the experience of the Swedish designers, who, with the large water powers available in that country, have had ample opportunity of developing three-phase design. The illustration (Fig. 1) shows one of their plants as erected at

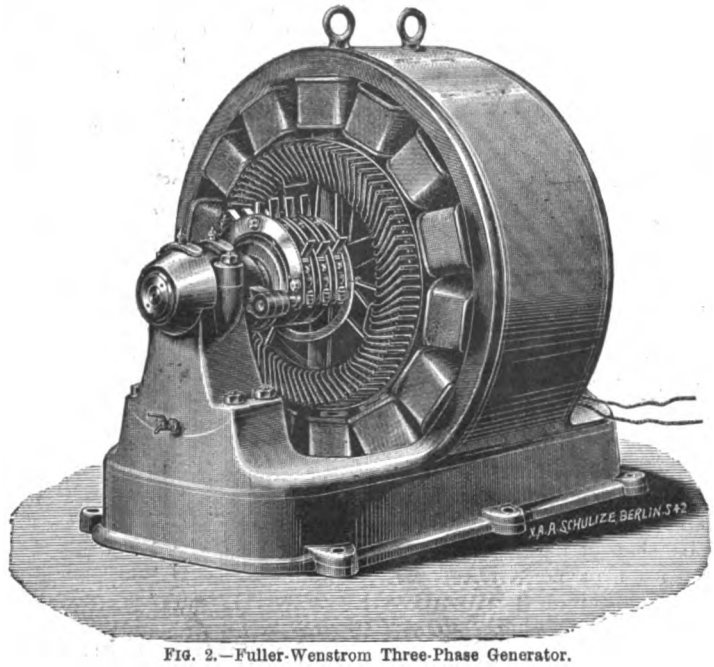

FIG. 2.—Fuller-Wenstrom Three-Phase Generator.

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Hofors, where some 1,600 h.p. was obtained from a waterfall and transmitted for 1½ miles to a factory. This installation is about to be largely exceeded by a transmission scheme to bring some 20,000 h.p. to some works from the waterfall at Trollhättan. Fig. 2 shows the general appearance of the three-phase generators to be made by the firm, from which it will be seen that the disposition of parts is not unlike that for a direct-current dynamo of the multipolar type.

The next illustration (Fig. 3) is of the single-phase motor, but in outside appearance it is practically similar to the

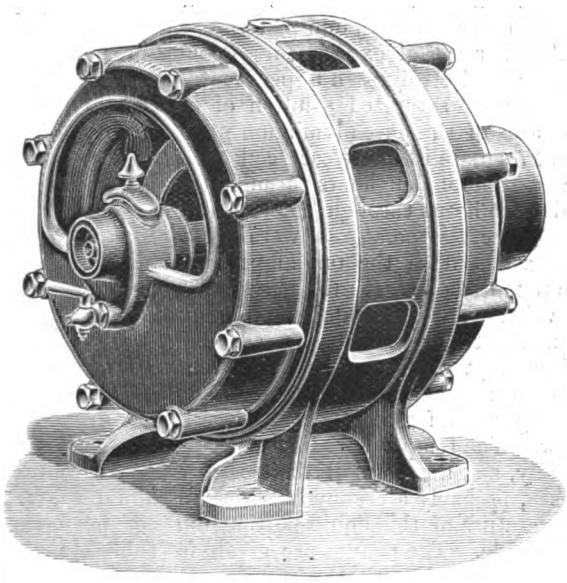

FIG. 3.—Fuller-Wenstrom Single-Phase Motor.

three-phase motor. It will be remembered that these single-phase motors are started by placing two resistances, one non-inductive and one inductive, in series with the two circuits of the motor. These are cut out as soon as the speed has got up to about the normal revolutions per minute. The motor is automatically relieved of all load in starting by the use of a centrifugal clutch in the driving pulley. This consists of four quadrants, which are grouped inside the pulley. These are held in by springs when the motor is at rest, thus leaving the pulley free on the shaft. At a high speed these fly out and grip the inside of the pulley

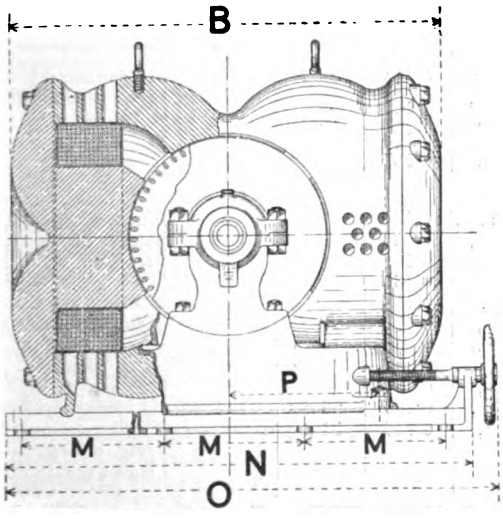

FIG. 4.—Direct-Current Dynamo or Motor.

and start against the load, using the momentum of the armature to get over the dead friction at starting. This greatly relieves the mains, as large starting currents are not needed.

The direct-current generators and motors for sizes over ¼ h.p. up to about 60 h.p. are made of the four-pole type (shown in Fig. 4). This is a most ingenious design, as all the machining required can be done either in the lathe or a boring machine. The outside of the smaller motor is almost cylindrical. The framework of the motor consists of three castings, two of which can be made from the same pattern. These two are the circular end covers covering the two wound poles, and after machining, these ends are bolted on to the cylindrical centre casting. In cases where very exact speeding is required, the insertion of a thin liner in this joint allows the speed to be easily adjusted. The armatures are drum-wound, the wires being placed in holes in the core and well protected by insulating composition, which renders the armature practically waterproof. The bearings are provided with the usual ring lubrication. The other details, such as slide rails and belt tighteners, can be seen in the illustration.

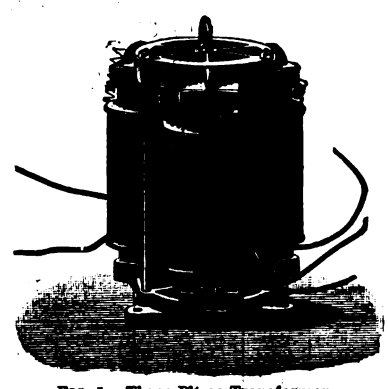

FIG. 5.—Three-Phase Transformer.

The new firm will also devote attention to the manufacture of transformers. The core type, with vertical iron cores and external coils, will be used. The general appearance of the three-phase transformer is shown in Fig. 5. We wish the Fuller-Wenström Electrical Manufacturing Company every success in their business.

ALUMINIUM AS AN ELECTRODE IN CELLS FOR DIRECT AND ALTERNATE CURRENTS.*

BY E. WILSON.

(Continued from page 84.)

The following test was then made. The cells had opposed to them aluminium to positive, in turn from 1 to 20 storage cells, without extra resistance, rising a cell at each step, the resulting current and potential across the terminals being noted. The results are given in Table II.

TABLE II.

Number of storage cells applied.	Plate formed in dilute H_2SO_4			Plate formed in alum solution		
	Volts across cell.	Amperes.	Temperature C.	Volts across cell.	Amperes.	Temperature C.
1	1·89	0·0005	13	1·89	0·0009	13
2	3·78	0·026	—	3·87	0·026	—
3	5·67	0·034	—	5·76	0·036	—
4	7·65	0·036	—	7·56	0·053	—
5	9·54	0·036	—	9·45	0·053	—
6	11·3	0·050	—	11·3	0 077	—
7	12·6	0·055	—	12·6	0·062	14
8	14·4	0·062	—	14·4	0·098	—
9	17·1	0·069	—	16·2	0·108	14·5
10	19·8	0·070	—	19·8	0·12	15·5
11	21·6	0·079	—	21·6	0·13	15·7
12	23·4	0·089	—	23·4	0·144	16
13	25·2	0·096	—	25·2	0·161	17
14	27·9	0·120	—	27·9	0·178	—
15	29·2	0·127	20	29·2	0·20	18
16	31·5	0·191	—	31·5	0·191	—
18	34·2	0·987	—	35·1	0·34	—
20	39·1	increased rapidly to 4 amperes, circuit then broken	21½	39·6	increased rapidly to 1 ampere, circuit then broken	19½
16	29·7	0·9	23	30·6	0·29	—

We see that from 1 to 18 storage cells the currents gradually increase in each, the plate formed in H_2SO_4 having an apparent greater resistance, up to about 16 cells. With 20 cells applied the H_2SO_4-formed plate gave way

* Paper read before the Royal Society, May 26. Communicated by Dr. J. Hopkinson, F.R.S.

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with great rapidity, and in a very short time, about 15 seconds, the current was four amperes, the temperature of the cell rising also from 21deg. C. to 23deg. C. The alum-formed plate seemed more stable with 20 cells, but speedily allowed a current of over one ampere to pass. On going back to 16 cells the currents were 0·9 ampere in the H_2SO_4-formed plate and 0·29 ampere in the alum-formed plate.

This brings us to the effect of temperature upon potential for a given current. The cell containing the aluminium plate formed in alum solution above referred to was placed in an oil bath, the temperature of which could be varied. The current was that due to 56 storage cells through a considerable external resistance, about 650 ohms during heating and 2,280 during cooling. There was an excess of alum in the cell, and the solution was kept saturated. The variation of potential between the aluminium and carbon electrodes was noted, as also the temperature of the cells. The results are given in Table III.

TABLE III.

Time.	Amperes.	Volts.	Temperature, C.	Remarks.
h. m.				
0 0	0·16	rising	13·5	Current switched on + to Al
0 5	0·124	29	,,	,,
0 10	,,	30	,,	,,
0 15	0·169	1·3	14	− to Al
0 16	0·122	32	,,	+ to Al
1 55	0·132	26·1	20·4	,,
2 0	0·172	1·1	,,	− to Al
1	0·124	31	,,	+ to Al
8	0·132	24·7	25	,,
12	0·139	20·2	29·5	,,
20	,,	11·7	36·5	,,
22	0·141	7·65	43	,,
27	0·143	7 2	52	,,
28	0·155	1·1	,,	− to Al
30	0·141	7·2	56	+ to Al
33	0·143	5·4	61	,,
37	0·148	3·0	70	,,
44	0·0518	0·18	72	,,
3 15	,,	0·72	63	,,
25	,,	1·3	56·5	,,
31	0·0509	2·3	51	,,
50	,,	2·7	40	,,
22 50	0·048	10·3	12	,,

We see that as the temperature of this cell rises from 13·5deg. to 70deg. C., the potential difference falls from 30 to 3 volts. The experiments already made on the resistance of the electrolyte will only account for 0·043 volt at 13·5deg. C., and 0·025 volt at 57deg. with the currents 0·124 and 0·141 ampere, as given in Table III. The conclusion is that temperature has an effect upon the apparent high resistance of an aluminium plate and its film, the subject of this paper. This points to the fact that in practice for high apparent resistance it would be necessary to cool or circulate the electrolyte with such dissipation of energy that the cell would otherwise acquire a high temperature. In Table III. we see that as the cell cools with a smaller current of about 0·051 ampere, the potential between the aluminium and carbon plates rises. In this case, at 56deg. and 12deg. C. the electrolyte would account for 0·0093 and 0·017 volt respectively.

It was thought that if a plate of aluminium with its film were submerged in mercury the resistance between the metal and mercury might give an idea as to whether resistance, pure and simple, played an important part in the effects observed. The plate originally formed in H_2SO_4 solution was carefully removed, washed in distilled water and dried, and half submerged in clean mercury. Storage cells ranging in number from 1 to 15 were applied, as in Table II., but in each case the poles were also reversed so as to test the insulation with the two directions of currents. The results show that this film on aluminium is a fairly high insulator, but it was not stable. At times the resistance was zero when a sharp noise occurred in the cell like sparking between points in air, and the insulation was immediately restored. With 16 volts applied the apparent resistance was about 10,000 ohms, whereas from Table II. we see the apparent resistance of the whole cell is 230 ohms at 14 volts, the positive pole being connected to aluminium. I should say, judging from the number of times the film broke down, that it was more stable when the positive pole of the charging battery was to aluminium, but in either direction the resistance, when established, had the same order of magnitude. Up to six cells no extra resistance was included in the circuit as the film was stable. After this a resistance was inserted so as to keep down the current when the film broke down, as then the potential between Al and Hg was zero. Even at 30 volts the film was able to restore its insulating properties, but very rarely. On removing the plate a film was left on the mercury where it had been in contact with the film on the aluminium plate.

Another set of experiments was made with two cells having as electrolytes a 5 per cent. solution of H_2SO_4 in water, and a saturated solution of potash alum in water. The area of the pure aluminium plate exposed to the fluid was 17 square inches in each cell. A current of one ampere was passed for four hours through the H_2SO_4 solution cell, and three hours through the other. At the end of these times the temperatures were respectively 33deg. and 51deg. C. With the one ampere passing from Al to C, the potentials between the plates were respectively 6·3 and 20 volts. The cell containing the plate formed in potash alum solution was then heated, the current through it being kept fairly constant by means of a considerable external resistance and 110 volts. It was then cooled by placing it in a freezing mixture of ether and carbonic acid snow. The temperature in this case was reduced somewhat rapidly, and a portion of the electrolyte at the bottom was frozen, probably a cryohydrate, leaving liquid above. The temperature of this liquid portion did not fall below zero centigrade. The results are given in Table IIIA. When comparing these with the results of Table III., one must remember that the areas of the plates in the electrolyte are 17 square inches in Table IIIA. and 8¼ square inches in Table III. This paper does not deal with the chemistry of the effect discussed. It is known that a clean aluminium plate acquires this film when simply submerged in alum solution in the presence of oxygen without the passage of currents. We have seen that with a given film, time is required to develop the effect.

TABLE IIIA.

Time.	Amperes	Volts across one cell.	Temperature.	Remarks.
		Heating.		
			Deg. C.	
12.45 p.m	0·154	28·8	17	Al connected to positive pole of charging cells.
1.0 ,,	0·154	27·0	18	
3.40 ,,	0·174	15·3	24	
4.20 ,,	0·170	16·2	25	
6.40 ,,	0·187	16 6	26·5	
		Cooling.		
11.0 a.m.	0·161	29·2	13	The temperatures are those of the liquid electrolyte.
11.3 ,,	0·160	30·1	11	
11.35 ,,	0·158	30·8	3	
12 noon.	0·160	31·0	1	
12.30 p.m.	0·168	26·3	2	Bottom portion of electrolyte found frozen.
1.0 ,,	0·170	25·2	2	
1.10 ,,	0·055	4·95	2	
1.12 ,,	0·058	1·35	2	Al to negative.
1.14 ,,	0·235	2·25	2	,, ,,
1.15 ,,	0·165	26·6	2	Al to positive.
2.50 ,,	0·158	31·2	not known	Fluid portion of electrolyte poured away, only frozen portion remaining.

Note added May 19, 1898.

[The film on these plates has been examined by Mr. Herbert Jackson, of the chemical department, King's College, London, and the following is his communication:

"King's College, London, May 12, 1898.

"DEAR WILSON,—I waited to send you the results of my examination of the aluminium plates until I had looked at them carefully with the microscope. Not much information, however, is to be gained from this. The skin over the plates is, however, seen to be full of minute cracks in every direction giving the impression of a dried gelatinous pellicle, not an unexpected appearance if the

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plate had been covered when wet with a thin coating of the gelatinous aluminium hydroxide. The analysis of the film over the metal shows it to consist of basic aluminium sulphate. The origin of this may of course have been the formation in the first place of aluminium hydroxide, which subsequently reacted with some of the alum solution to give the basic compound. How far the formation of this may have anything to do with electrolysis would, I should think, be difficult to say without further and more elaborate experiment, and it must be remembered that a similar coating can be obtained on an aluminium plate by immersing it in an alum solution and leaving this fully exposed to the air.—Yours sincerely, HERBERT JACKSON."

I have tried an experiment which I think shows that a film formed on aluminium by first being placed in contact with an alum solution and then exposed to the air, gives the same effect as a film formed in the cell when a current is passed from the aluminium to a carbon plate through the electrolyte. Two similar bright aluminium plates were prepared with carbon plates on either side of them, the area of aluminium in the electrolyte being 8¼ square inches. The electrolyte consisted of a saturated solution of potash alum in water. One plate was left in the solution for seven hours with no current passing, and then exposed to the air for 16⅔ hours. The other plate was submerged in the fluid and immediately readings were taken of the current passing and potential difference in volts between the aluminium and carbon plates. The effect in this case was exactly what was previously observed. That is to say, the current being maintained constant at 0·055 ampere by about 2,000 ohms being inserted in circuit with the cell across about 110 volts, the potential difference immediately passed from a small negative value through zero, and after three minutes and forty minutes had respectively the values 1·8 and 2·27 volts, the temperatures being 12½deg. and 15½deg. C. The test was continued. For the next 5¼ hours the current was 0·204 ampere, it was then dropped to 0·055 ampere and kept at this value for 16⅓ hours. At the end of this time the potential was 10 volts with 0·055 ampere, and 28·6 volts with 0·163 ampere, the temperature being 15deg. C.

The other plate was submerged in its solution, the potential difference and current being immediately noted as before. The results in this case show that the potential, with 0·054 ampere, rose immediately from a small negative value of about 0 2 volt to a positive value of 1 8 volts. After four minutes and forty minutes respectively the potential with current 0·054 had the values 2 07 and 2·56 volts, the temperatures being 13deg. and 15·5deg. C. This, I think, shows that a film formed by exposure to the air after being submerged in a saturated alum solution has the same effect as another formed in this electrolyte during the passage of current. This test was continued. After 24 hours, during which the current was 0·0523 ampere, the potential was 11 volts, with this current passing, and the temperature 16deg. C.

The two cells were then placed in series and an average current of 0·048 ampere passed through them from the aluminium to carbon plates for 50 hours. At the end of this time, with current 0·048 ampere, the potentials were 10 in the case of the plate partially formed without current, and 10·3 in the case of the other, the temperatures being 19deg. and 17½deg. C. respectively. With current 0·121 ampere, the potentials were 26·2 and 27 4 respectively at temperatures 21deg. and 19½deg. C.]

Sodium hydrate, forming a weak solution in water, was tried as an electrolyte, the area of the Al plate being the same as before—17 square inches. The forming current of ·8 ampere was passed from Al to C for 2 hours 20 minutes, when the potential between the plates was 13·6 volts, the aluminium plate being covered with a thick black deposit.

PART II.

Alternate Currents.

The experiments with alternate currents were undertaken in order to investigate the instantaneous values of potential and current. One object was to see if the effect we have dealt with in the first part of this paper has time to properly develop with ordinary frequencies, and if so, under what conditions. Another object was to see if aluminium is a valuable metal for use in condensers for alternate currents.

Aluminium-Carbon Cells.

If the time taken to develop the effects dealt with in the first part of this paper were very small compared to the time of a complete period of an alternating potential applied to the cell, one would expect to get a practically unidirectional current in the circuit of the cell under favourable conditions as to temperature and applied potential. This is not the case with the cells and frequencies dealt with in this paper. In all these experiments the author has endeavoured to make the cells the controlling part of the circuit—that is to say, between the terminals of the alternate-current machine a small non-inductive resistance and a Siemens dynamometer were the only part of the circuit other than the cells experimented upon. The copper resistance of the circuit including armature was from one to five ohms.

TABLE IV.

Experiment.	Frequency.	First half-period. Maximum volts.	First half-period. Maximum amperes.	First half-period. Phase difference. 360deg. = one period.	Second half-period. Maximum volts.	Second half-period. Maximum amperes.	Second half-period. Phase difference. 360deg. = one period.	Ratio of maximum coulombs.	Average watts per period.	Amperes given by Siemens dynamometer.	Average temperature of cell C.
(1)	92	8·9	5·2	24°	26	4·0	56°	1·35	26·8	3·28	27
(2)	91	7·8	1·6	57	8·9	1·5	69	1·07	2·65	1·10	9
(3)	91	14·2	16·2	6	33	9·9	42	1·97	120	8·99	26
(4)	74·5	21·1	39·8	3	18·6	26 5	3	1·78	294	21·0	36
(5)	52	13·4	14·5	6	20·2	9·6	24	1·54	86	8·16	35

In the first portion of these experiments, the results of which are given in Table IV., the instantaneous values of the current and the potential difference between the terminals of the cell were observed by aid of a Kelvin quadrant electrometer and a revolving contact maker. The cell across which the potentials were observed consisted of one aluminium plate $\frac{1}{16}$in. thick separated by ⅛in. from a carbon plate ¼in. thick, the electrolyte being a saturated solution of potash alum in water. The surfaces thus opposed to one another in this electrolyte have each an area of 36 square inches. Another cell of the same size as the above was placed in series with this cell. Four smaller cells were used in some of the experiments, as will be set forth. Each of these consists of a thin aluminium plate opposed to a carbon plate. The opposed surfaces in a saturated solution of alum have each eight square inches area, the distance between such surfaces being ⅜in.

In Table IV. the arrangement of these cells was as follows: Experiments (1) and (2) all the six cells in series; experiment (3) the two large cells in series with one another and with the four small cells arranged two series, two parallel; experiments (4) and (5) only the two large cells in series were used. No attempt was made to cool or circulate the electrolyte, but it had considerable volume and took some time to heat and cool. In all cases there was an excess of salt to insure saturation. Table IV. contains the important information obtained from the tests.

These figures show that small currents are accompanied by large phase difference, but the effect we are looking for—namely, a large ratio between the maximum coulombs in the two halves of a period—mainly develops with large currents for a given frequency accompanied by high temperature and small phase difference. The average watts have been deduced from the product of instantaneous volts and amperes at 20 equal intervals during a period.

The experiments in Figs. 1, 2, 3 give results obtained with an exploring electrode inserted between the plates in the electrolyte as in the first portion of this paper. The aluminium and carbon plates in one of the large cells were separated to ¼in., and the two cells kept in series as in experiments (4) and (5), Table IV. The curves refer to this cell, and provision was made for obtaining the instantaneous values of the current in the cell and the potentials between the exploring electrode and either the aluminium or the carbon plate.

(To be continued.)

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TO BUY OR NOT TO BUY.

This is a world of surprises, hence an old writer asserted that nothing is so certain as the unexpected. Quite recently the action of the Marylebone and Bermondsey Vestries have caused a wave of expectancy in the electrical world. The history of these cases may be broadly stated in a few words. It is well known that metropolitan areas are, so to speak, hypothecated to certain companies as lighting areas. Most of the areas overlap to a smaller or greater extent. A few years ago the vestries declined to undertake the work themselves, and, in fact, worked on the whole harmoniously with companies seeking orders. The orders have been granted, and work has been continuously extending of late years. So successful has electric lighting become that the various authorities are now recognising—in some cases too late—that the work is really and truly municipal work. Marylebone and Bermondsey seem to have reached the stage of reason on this point, and having given away their cake tried to get it back in a way not usually admired by Englishmen. These vestries each promoted a provisional order, although the area over which it was to operate was already occupied, and large sums of money had been spent upon works. The provisional orders were, to the astonishment of most people, whether such people were interested or not in the matter, provisionally granted, but before becoming operative such orders have to be sanctioned by Parliament. When the Bill to confirm these provisional orders came on, the Select Committee of the House of Commons refused to sanction that for Marylebone, and suggested that for Bermondsey should be withdrawn. Although in our opinion the reasons for municipal control are overwhelmingly strong, we congratulate the companies upon having won this victory. The only honest course for the vestries is to buy out the rights of the companies. If the country had had to wait for the initiative of municipal authorities for the introduction of the electric light, it would have had to wait till doomsday. Even when its success was amply proved, the various London authorities refused to move. Provincial towns proved less recalcitrant, till at last the pig-headed bumbledom of the largest city of the world perceives a little of its pig-headedness. Of course, we must acknowledge that there were one or two bright exceptions in the general metropolitan obscurity. Again, every provisional order is obtained with a proviso or stipulation which arranges for ultimate municipal control, but that control is naturally and rightly obtained by purchase. The terms of purchase, too, are perhaps more favourable to the authorities than to the companies. It will be seen that the Legislature had more foresight than the authorities, and actually arranged for the obtaining of what they considered must eventually be municipalised. Surely, with all this knowledge before them, the Vestries of Marylebone and Bermondsey should have approached the companies with a view to purchase rather than have attempted to kill the companies by competitive action at the expense of the ratepayers,

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Undoubtedly the authorities have it in their power to hamper the work of companies, but the cost to the ratepayers of a competing scheme can hardly be estimated, and might, probably would be enormously greater than the cost of honest purchase.

TRANSFORMER ECONOMY.*

BY PROF. WINDER ELWELL GOLDSBOROUGH.

A great deal has been said and written about the transformer of alternating currents, and yet we are only just beginning to understand this much-discussed piece of apparatus. The manufacturers have made it and experimented with it, the theorists have experimented with it and disputed over it, the underwriters have disputed over it and endured it, and the central-station men have endured it and made use of it to the great good and comfort of the public. No other piece of apparatus in the field of electrical engineering has been lauded higher or been the subject of greater abuse, and to all it has served a purpose.

We are constantly impressed with the fact that the refinements of exact scientific methods are being made the subject of everyday discussion, and that the more difficult problems of the technical side of the profession are being so well elucidated by our "practical theorists" that it is possible for all of us to enjoy a concrete appreciation of electrical science without an excessive expenditure of mental energy on the theoretical.

Our principal manufacturing companies freely advertise and guarantee the specific economic performance of which each and everyone of the transformers that they place upon the market is capable. They severally advertise to supply us with transformers equalling in efficiency, regulation (and what not) any other transformer that can be found upon the market.

With a view to investigating the present status of the transformer and the ability of transformer manufacturers to meet in all cases the exacting specifications which they have laid down for themselves, I have had a number of transformers of recent design tested in the Purdue laboratories within the last year. The results of these tests are especially gratifying when gauged from the standpoint of our present commercial requirements, and to the specialist a detailed statement of the results would be interesting. In view of the fact, however, that the electrical literature of the day contains numerous matter of this kind I will not bore you with many figures, but rather discuss the results in a general way.

With but one exception the transformers tested have surpassed the requirements of the specifications laid down by Prof. Jackson in his excellent article on transformer testing, with which we are all familiar, and generally speaking they have conformed fairly closely to the published guarantees of the companies submitting the transformers for test. To what extent this is true may be better appreciated if I cite one or two examples.

A 2·5-kw. transformer was submitted for test that was guaranteed to conform to or improve upon the following specifications: core loss, 48 watts; regulation, 2·1 per cent.; and full-load efficiency, 96·1 per cent. The test of this transformer gave: core loss, 42·19 watts; regulation, 1·9 per cent.; full-load efficiency, 96·2 per cent.

The showing made by this transformer is good. The core loss is 5·81 watts less than the stipulated value, and the efficiences are in excess of the stipulated values. In this case the manufacturers more than substantiated their guarantee, and supplied a transformer that is a greater revenue producer than the specifications call for. If the core iron of this transformer can be relied upon as not materially increasing in its hysteretic loss with age, it is an easy matter to figure the money value of the excess economy that the transformer develops.

Suppose, for instance, a contract should be made for 40 of these transformers at 30·00dol. each to meet an increase in a station load of 100 kw. On an all-day schedule these transformers would probably carry a commercial load equivalent to full load working for five hours. This assumption may seem to represent a better condition of service than is usually met with in practice, but it is an assumption that is fair to the manufacturer in considering the all-day efficiency. The transformers would therefore be working under no load for 6,935 hours and under full load for 1,825 hours per year, and under the conditions of the test would save 1,794 kilowatt-hours to the station. If we figure the cost of producing this power at two cents per kilowatt-hour, the saving per year would be 35·88dol. for the 40 transformers, or, practically, 3 per cent. on the amount invested in the transformers. If this power were sold for six cents per kilowatt-hour it would represent a net gain to the purchaser of $1,794 \times \cdot 06 = 107 \cdot 64$dol. per year more than he had any right to expect under the contract specifications.

Another 2 5-kw. transformer submitted for test is advertised by the makers to show a core loss of 57 watts, a quarter-load efficiency of 91 per cent., a full-load efficiency of 96 per cent., a regulation of 2 per cent., and a no-load current of ·1 ampere. Under test it was found to have a core loss of 63·6 watts, a quarter-load efficiency of 90 per cent., a full-load efficiency of 94·8, a regulation of 3 per cent., and a no-load current of ·087.

Suppose we estimate the economy of transformers of this type just as we did those of the type previously considered. The 40 transformers, working on the same schedule, would waste 4,014 kilowatt-hours more power than they should under the specifications advertised. At two cents per kilowatt-hour the total money loss would be 80·00dol. per year, or over 6·5 per cent. of the cost price of 1,200dol.

Many engineers may claim that the cost of checking up the performance of the transformers would more than eat up the saving effected by the small margin that these results represent, and in many cases under the present organisation this would doubtless be true, but if a well-advised stand was taken by the central-station managers for mutual protection the result would be markedly beneficial.

A percentage of the transformer output of each of the manufacturing firms could, for instance, be tested in some one place, where a record of the individual performance of all the transformers submitted for trial could be kept, and not only efficiency but ageing and insulation and temperature trials could be made at a merely nominal expense.

But these examples do not cover the ground. I will cite two others: In the case of a 15-kw. oil-insulated transformer, guaranteed to develop a quarter-load efficiency of 96 per cent., a full-load efficiency of 97·4 per cent., and to have a regulation of 1·77 per cent., the test showed a quarter-load efficiency of 94·5 per cent., a full-load efficiency of 96·1 per cent., and a regulation of 1·6 per cent. The core loss of this transformer, which operates at 60 cycles, is 186·6 watts, and the specifications under which it was built require that the core loss should be about 150 watts.

It would take seven of these to give an output of 100 kw.—and they would cost not less than 115dol. each. The seven transformers in this case would waste 3,855 kilowatt hours in a year, which represents a financial loss of 77dol. in one year over and above the loss to be expected. This approximates 10 per cent. of the original cost of the transformers, and is an item that cannot be neglected. If, on the other hand, this waste power could be sold at six cents per kilowatt-hour, it would represent a part of the just return on the investment contemplated when the transformers were purchased, and would mean 221dol. to the company.

Not long ago a manufacturing company requested permission to send a 1-kw. transformer to the university laboratories for a special test, as the transformer was of a new type and highly efficient. There was no direct guarantee in this case, but the impression was given that the transformer would develop an efficiency equal to, if not exceeding, the efficiency of any other transformer of like capacity on the market. The results of our tests indicated a core loss of 178 watts, a full-load efficiency of 83·6, a quarter-load efficiency of 62·4, and an all-day efficiency of only 54·5 per cent.

There are probably to-day a goodly number of these so-called "highly efficient" transformers eating up the

* Abstract of paper read before the National Electric Light Association, Twenty-first Convention, Chicago, June, 1898.

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profits of various of our lighting companies throughout the country, simply for the reason that in many cases business managers of electric light and power plants are not sufficiently alive to the importance of looking after the efficiency of the apparatus forming their equipments just as closely as they look after and check up every item of operating expense and maintenance that is necessitated by the exigencies of the service.

The use of transformers such as the one just referred to would be pitiable. It is fortunate that they do not grow to large proportions, but nevertheless they have a telling effect wherever they fall.

As regards the ageing of the modern transformer irons, I hold rather a conservative opinion at the present time. A great deal has undoubtedly been accomplished within the last few years in the way of improvement in this respect, and the modern transformers that are supplied to us for testing show a wonderful gain in efficiency, due both to the lower initial core losses and to the diminished per cent. of increase of these core losses with the ageing of the iron.

The general opinion seems to prevail at present to the effect that ageing is due directly to the reversal of the direction of flow of the magnetic flux in, rather than to long continued heating of, the iron forming the core of the transformers, and this opinion is also expressed in much of the printed matter that has come into my hands.

In a recent lecture delivered by Prof. Fleming he said: "It was also discovered some time back by Mr. W. Mordey that prolonged slow heating of iron to only 60deg. C has a marked effect on the hysteretic constant, and the result is often to increase this constant two or three times. The effect varies with the annealing of the iron, and in many cases the iron which shows the least hysteretic constant at starting experiences the largest percentage increase of it on prolonged heating. This effect is called the magnetic ageing of the iron. Owing to the enormous use of iron for transformer purposes, this ageing had now become a very important matter.

"The electrician lays no very great stress on the mechanical qualities—such as tensile strength, elasticity, and so on—but he requires high permeability, small hysteretic constant, and small ageing; and the iron and steel manufacturer has been able of late years to meet these new requests by producing steel of the necessary quality. Iron and steel can now be produced with a maximum permeability of 4,000 C G.S. units, a hysteretic loss of about ·15 watt per pound, with 100 cycles and 2,500 flux density, and of non-ageing quality. I do not mean to imply that all these qualities can be equally combined in the same sample, but that the iron or steel can be varied to suit the demand. Steel can be produced with a higher permeability than wrought iron for large magnetic forces, and with a superior non-ageing quality."

The fact seems to be well established that non-ageing transformer iron is a commercial possibility, but the fact remains to be demonstrated practically that material of the necessary quality can be obtained in sufficiently large quantities to supply the demands that are being made upon the manufactories.

Failure in this regard is not the fault of the builders of the transformers, and I have reason to know that there are cases in which disquiet prevails in the minds of managers as to whether or not they are getting what they are paying for. I know that the general claim is made that iron with an "inappreciable ageing effect" is used, and I do not wish to go on record as claiming that it is not used, but what I do wish to point out is that there are transformers being placed on the market to-day that do not contain non-ageing iron. From a large transformer company I have received notice that "at the present time we have no non-ageing iron which will fulfil our specifications of core loss; that which we have on hand will give a core loss of from 20 per cent. to 25 per cent. greater than the amount stated in our specifications." At the present time, therefore, it is needful to make just as careful tests for ageing as for efficiency or for insulation, in spite of the fact that the former take a longer time and are, therefore, relatively more expensive to make.

During the last three months six transformers of different types have been subjected to most carefully conducted ageing tests in our laboratories. The completed report on these tests has come to me within the last few days, and I can give you a *résumé* of the results.

The core losses of transformers A and B were high to begin with, the first being 72 watts and the latter 83 watts. The per cent. increase in the core loss of these two transformers does not, however, seem to be as great as the per cent. increase in the core losses of transformers C and D that are of more recent manufacture, and that showed initial core losses of 31·5 and 37 watts respectively.

Transformers B and D are of 1·5 kw. capacity, and transformers A and C of 2·5 kw. capacity. An increase of from 5 to 10 per cent. is shown in all the transformers.

To get an idea of what this means, suppose we consider the effect upon the economy of the 2·5-kw. transformers, considered in the second case discussed above, of a 10 per cent. increase in the core loss. It will add 1·11dol. per year to the cost of operating each transformer at two cents per kilowatt-hour, or 44·4dol. for the total number.

This represents an additional gain of 3·7 per cent. per year on the investment in three months, or a possible percentage loss on the investment of 14·8 per cent. after the first year on the supposition of a uniform increase in the core loss.

These figures are not startling in any way. They are too small for that; but they are matters of fact to be taken into consideration when making investments. The opinions that I am voicing regarding the ageing of modern transformer irons are conservative, as I believe the transformers built to-day will show a marked improvement upon the performance of transformers built even as late as one year ago. As far as the ageing tests that we have made go to throw light upon the subject, I am inclined to believe that the ageing problem has as yet not been solved, as none of the transformers tested have met the requirements of the specifications under which they were submitted, and some have fallen very far short of it. All of the transformers tested were new except transformer A, which at the time these tests began had a core loss already increased to 13 per cent. above its initial value. Transformer A was built about two years ago.

The ageing of transformer iron does not increase at a constant rate with the time. The rate of increase diminishes as the service continues, but the increase may go on indefinitely. Until the use of non-ageing iron becomes more generally possible than at present, it is probable that it will pay to replace the majority of the transformers placed on the market by new ones every few years.

It is our present intention to inaugurate next fall a series of one year ageing tests under continuous full-load conditions of a representative number of transformers that will be built during the present summer by the manufacturing companies who are interested in having these points thoroughly ventilated, and I trust to be able to publish a record of fine performance in this respect at the time of the completion of the tests.

The correct insulation of transformers is another important point that should be considered by the central-station manager. Like many of the problems with which we have to deal in the effort to make the transformer a commercial success, this one seems to be subject to a wide variety of opinion. The oil insulation of transformers has deservedly come into great favour, and where care is taken in the selection of the oils used and in the proper design of the transformer case, high protection is secured. Oil insulation under all circumstances does not, however, secure to the purchaser the protection which he feels he is paying for. The claims that are usually made for the superiority of oil insulation, to wit, that it serves to preserve the insulation from oxidation, reinforces the resistance of the insulation to puncture, reinsulates punctures after the passage of the discharge, and facilitates the diffusion of the energy liberated as heat in the core of the coils, can in general be readily substantiated.

My experience, however, is that these statements must be regarded as having only a relative bearing upon the subject. Under certain circumstances the insulating value of an oil will be very materially impaired. We are told that transformers will last indefinitely when insulated with

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oil, whereas without oil the insulation will be so deteriorated after five or ten years that the transformers should be replaced, and it may, therefore, be a matter of surprise that the insulating qualities of the oil itself are ever seriously diminished. As a matter of fact, experiment shows that the insulating properties of the oils commonly used in transformers are increased as their temperatures are raised up to about 110deg. C., and that if allowed to cool, they will not lose their augmented power of resisting a disruptive discharge. This much might be said in favour of oil insulation, in view of this two or three fold gain in insulating power, were it not for the fact that a continued heating of the oil for any considerable length of time changes the oil to such an extent that on being cooled its breakdown value will be only about one-fifth of its original value. And, therefore, an oil-insulated transformer that will stand an insulation test of 10,000 volts when new may break down under a pressure of 2,000 volts after having been in continuous service for a considerable time. Conditions such as will produce a result of this character are not likely to occur in the case of modern transformers, as the increase in the temperature of even the poorest transformers rarely exceeds 70deg. C. I have, however, met with cases in which excessive heating has resulted when the transformers were kept continuously in service, and I have also in mind a case in which a good modern transformer was so situated above a tin roof and in a position where it was protected from any breeze that might be stirring, that, when the sun played upon it, its temperature reached perfectly distressing values.

For all commercial purposes the best oils will be found to give thoroughly satisfactory results and retain their insulating properties unimpaired so long as the maximum temperature of the oil does not exceed 60deg. or 70deg. C. In making a station test of a transformer, if the rise in the temperature of the windings, as measured by the increase of resistance method, does not exceed 50deg. C. after a 10 hours' run at full load, the transformer may be passed as satisfactory in this respect.

In connection with oil insulation, it must be remembered that its efficiency as an insulating medium is impaired by discharges in the oil. One of the foremost claims made in behalf of oil insulation is that it will flow in and fill up a rupture in the insulation of the coils. Every electric discharge that takes place through the oil, however, disintegrates and breaks up the normal structure of the oil, and causes carbon and other conducting compounds to form. These will rapidly multiply if the discharges are at all frequent, and will destroy the insulating properties of the oil.

There is a city in the West in which the conditions under which electricity is supplied for incandescent lighting are somewhat unusual. There are two companies interested in the business, and both employ the alternating-current converter system of distribution. The plant that is operated by the older company was installed about six years ago, and its equipment has grown slowly from year to year as business expanded. Its development has followed the waves of evolution modifying electric lighting practice within this period with a lag factor approximating 90deg. The plant has some strictly modern machinery, but much of the line equipment is old. A number of its transformers have been burnt out on account of defective insulation, some have been burnt out by lightning, and some have shown their efficiency by getting so hot when switched in on an all-day schedule under light load that the "oil used to insulate them boiled up and over and ran down the outsides of the cases."

The lines of the old company are not protected by lightning arresters, except where they enter the station, and the secondaries are not grounded.

The new company has been in operation two years, and its plant is thoroughly up to date and highly efficient. Oil-insulated transformers of from 80 to 200 lights' capacity are used, and are kept in continuous service. The transformers are of modern design, and stand an insulation test of 7,000 volts without oil. The lines of the new company run over those of the old company, and are protected about every 1,500ft. by lightning arresters. None of the secondaries of these transformers are, however, grounded, and magnetic shields are not used. The new company has never experienced any trouble from burn-outs of any kind, although its lines are very much exposed. In a very violent electric storm which occurred some time since, in which the service of the old company suffered in consequence of transformer burn-outs, the service of the new company was not interfered with in any way, although lightning struck its lines several times.

There has been a great deal of interest expressed recently in the effort to formulate a definite set of specifications covering the construction and insulation of transformers, with the end in view of decreasing the fire hazard and supplying the necessary protection from loss of life and property to both the producer and consumer of electrical energy.

In a letter that I have lately received from a gentleman who is much interested in the success of this project, he says that after corresponding with a number of makers, engineers, and lighting companies to obtain suggestions as to the remedies for the troubles arising from crosses, lightning, insulation, breakdowns, etc., the results were very unsatisfactory, as there seemed to be a vast difference of opinion.

I have read a great many articles for and against the use of earthing devices, grounded shields, and grounded secondaries, but I am yet to be convinced that the prominent American practice of high insulation resistance to a disruptive discharge and a plentiful use of well-grounded short air-gap lightning arresters does not give a sufficiently good protection.

As I have already remarked, the number of modern transformers that are reported as burning out is relatively very small. By far the greater portion of the troubles arise from crosses between the high and the low potential circuits, and in such cases the loss must be attributed to faulty installation and not to any imperfection in the transformer.

An oil-insulated transformer for use on 2,500 volt primary circuits or less, having a maximum temperature at full load not exceeding 65deg. C., and designed to stand an insulation test without oil of 7,500 volts for five minutes, and a prolonged test of 10,000 volts with oil, will be in slight danger from lightning discharges if protected within a distance of 500ft. by a properly-installed arrester.

A transformer should also be able to stand a double primary potential test for five minutes, and the insulation test should be made between the coils and between each coil and the core.

In the case of transformers to be used exclusively on very high-voltage circuits these considerations do not apply, nor should this paper be considered as dealing with this class of alternating apparatus, which has come to form a department by itself.

In considering the economy of transformers, the problem before us is not so much a discussion of their efficiency as a converter of electrical energy, as it is a discussion of this efficiency in connection with the numerous extraneous causes that tend to make the transformer a menace to life and property.

To my mind a great deal would be gained if an understanding could be brought about between the makers and purchasers of transformers that would result in a uniform practice in the several departments of transformer design. The manufacturers would work to better advantage by having definite specifications to work to, and the way would be open for a bonus or forfeit in equitable proportion to an excess of or shortage in the economy of the product. The fad at present tends toward over-production. It is bad practice to run to extremes in any department of engineering, and too much protection may turn out to be just as costly as too little.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE I.

(Continued from page 693, Vol. XXI.).

[N.B.—In continuing the publication of Dr. Obach's classical lectures, we regret that we have been compelled to omit certain

* Cantor Lectures delivered before the Society of Arts.

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tables and analyses. The information so omitted is most valuable, and perhaps to the expert is the part of the paper worth all the rest put together, but the space at our disposal does not permit of their publication.—ED. *E. E.*]

Pure gutta is insoluble in ether and light petroleum spirit at ordinary temperatures, whereas both albane and fluavile dissolve readily in these menstrua. Either of these two solvents is, therefore, suitable for separating the resinous components from the hydrocarbon.

Gutta possesses all the good qualities of guttapercha, but in a much enhanced degree; it becomes soft and plastic* on heating, and hard and tenacious on cooling, without being in the least brittle. But the resins themselves are either soft at ordinary temperatures, or, when hard, quite friable. It is therefore the gutta which forms the valuable constituent of guttapercha, and the resins are only accessory components, which, although admissible and perhaps even desirable in a comparatively small amount, yet have a decidedly detrimental effect when they preponderate. Hence, in order to arrive at an opinion on the technical value of a sample of guttapercha, it is indispensable to determine the relative proportion or ratio between gutta and resin. But besides these two constituents, there are others which have to be taken into account—the mechanically-enclosed water, frequently reaching a high figure, and the coarser impurities, such as wood fibres, bark, sand, etc., which I briefly describe as dirt. The latter two components represent the loss or waste to the manufacturer on cleaning.

We now see that it is necessary to determine for commercial purposes at least four proximate constituents in raw guttapercha—viz., water, dirt, resin, gutta—and the more we find of the latter, the better the material. The water can be determined with sufficient accuracy for most practical purposes by gently heating a weighed quantity first in the open air, and then *in vacuo* over an absorbent substance until no further loss occurs, but sometimes it has to be ascertained by direct weighing. The resinous components also might be determined from the loss of weight, after exhausting the dried material with ether or petroleum spirit, but it is mostly desirable to weigh them directly after evaporation of the solvent. There now remains a mixture of gutta and dirt; these can be separated by treatment with carbon disulphide or chloroform, which dissolves the gutta and leaves the dirt behind, the latter being removed from the solution by filtration, washed and weighed. The gutta also is weighed after distilling off the solvent and drying *in vacuo*, but for greater accuracy it is precipitated from the solution by means of alcohol, when it can finally be obtained perfectly white and pure.

In the manner just described thousands of raw materials have been analysed in our laboratory since 1881, the year in which I first introduced this method for regular use, and in several instances we went even a step further, and separated the resins into albane and fluavile. But let me here add a word of caution. I stated that the relative proportion of gutta and resin forms an important criterion for estimating the commercial value of a material; but this in itself is not sufficient. Even putting aside for the moment the variable composition of the resinous components, there are guttas and guttas, and although the ultimate analysis of two different specimens may give exactly the same result, the physical and mechanical properties, and, most important of all, the durability may widely differ owing to a difference in their molecular constitution. It is therefore absolutely indispensable, in addition to the quantitative determination of the components to scrutinise the gutta itself, which I need hardly say requires much judgment and experience.

As an illustration of such analyses, the author has prepared a table showing the percentage composition of seven different specimens of guttapercha collected by Mr. Wray in Perak from definite botanical sources, and presented by him to Kew Gardens in 1883 and 1884.

The table gives the names under which the plants are known to botanists, the habitat of the trees, and the Malay names of the gums they yield, under which they are known in Perak. It also contains a short description of the materials as received and of their constituent parts, gutta and resin. The figures obtained by analysis are worked out in two different ways—viz., in per cents. of the material as received, and of the guttapercha proper which it contains—to facilitate the comparison between different specimens.

In the present instance the percentages of water and dirt are only of secondary interest, and it is chiefly the two columns headed "Gutta" and "Resin," and marked (g) and (r), to which attention is specially directed, and to the very great difference in the relative amount or "ratio" of these two components in different specimens. Take, for instance, No. 1 from Dichopsis oblongifolia, which contains eight times as much gutta as resin, and compare it with No. 3 from Dichopsis polyantha, containing about an equal amount of both, and, further still, with No. 5 from Dichopsis Maingayi, where the amount of resin is three times that of gutta. Materials in which the percentage of resin reaches that of gutta, or even surpasses it, are of a decidedly inferior description, and it is observed that four out of the seven samples from Perak belong to this category. Of the remaining three, the first two from Dichopsis oblongifolia and Dichopsis gutta are of excellent quality, whereas the third—*i.e.*, spec. No. 6, "Getah sundek" or "soondie," from Payena Leerii—is decidedly inferior to these.

Next to the two columns marked "Gutta" (g) and "Resin" (r) respectively, there is one headed "Quality" (q), and I owe you a word of explanation for these values which were introduced by me some years ago for the sake of convenience at our works.

As I have told you, the commercial value of guttapercha depends principally on the relative amounts of gutta and resin contained therein, and it occurred to me to utilise this fact for the division into qualities. Taking 10lb. as the standard weight of guttapercha proper, I designate its quality as first, second, third, etc., if the amount of resin contained therein is 1lb., 2lb., 3lb., etc., respectively (the percentage of resin divided by 10—*i.e.*, $q = \frac{r}{10}$). This division alone, however, would be too coarse, even for practical purposes, and I consequently subdivide the interval between two consecutive qualities into ¼lb., and distinguish them by affixing the letters a, b, and c. If, therefore, a material is described as being of 3^a quality, it means that the guttapercha proper contained in it has 3¼lb. of resin or thereabouts in every 10lb. (32·5 per cent.); if another is called 5^b it contains 5½lb. (55 per cent.), etc. Qualities with less than 1lb. of resin (10 per cent.) very rarely occur in commercial raw samples, but are described as O^a, O^b, O^c if containing ¼lb., ½lb., and ¾lb. (2·5 per cent., 5·0 per cent., and 7·5 per cent.) of resin respectively, when artificially produced. (The lowest amount of resin hitherto found by me in the guttapercha proper of a commercial raw sample is 11·9 per cent., corresponding to quality 1^a.) Even with this subdivision the description of the quality admits of a certain variation in the percentage of resin in both directions, and this is a decided advantage for practical purposes where it not always desirable to be too strict. The ratio $\frac{\text{Gutta}}{\text{Resin}}$ given in the table, although excellent for descriptive purposes, is somewhat too sensitive for the factory, and consequently not so suitable.

Of the small specimens of guttapercha recently received from Haarlem, and which had been obtained from the various trees cultivated at Tjikeumeuh, and experimentally tapped about 10 years after they had been planted, only those from Palaquium Borneense and Payena Leerii were still in a sufficiently good state of preservation for analysis; whereas the others from Palaq. gutta and Palaq. Treubii had been already badly oxidised.

(To be continued.)

* The property of pure gutta of becoming plastic at higher temperatures shows that it is not a simple body, but a mixture (alloy) of several hydrocarbons, differing probably only in their molecular constitution. The case is similar to that of the tinman's solder in the state in which it is used for making what is technically called a "wiped joint."

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

82. Give a drawing of a good form of insulator for outdoor use which will stand a pressure of 2,000 volts, and will carry a a weight of 50lb. Give the resistance of this insulator both when wet and dry.—P. AULEY.

83. What tests should you make to determine the value of a primary battery for lighting purposes?—P. T.

ANSWERS.

Question No. 76.—How would you calculate the size of steam-pipe for supplying any one engine or set of engines? Give an example.

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Best Answer to No. 76 (*awarded* 10*s.*).—The aim in designing a steam-pipe is, on the one hand, to deliver steam at the engine at as near boiler pressure as possible by reducing the friction of steam against the walls of the pipe, and, on the other hand, to give as little cooling surface in the pipe as possible. The first thing one wants to know in designing a steam-pipe for an engine, is the maximum weight of steam required to be passing through the steam-pipe at one time. If the engine to be fitted has been tested, or even if it is one of a standard size and type, the steam consumption per horse-power will be known with sufficient accuracy for calculation. The total weight per minute will be given by the "steam per horse-power per hour" at full load of engine, multiplied by the maximum horse-power that the engine will develop, and divided by 60. In practice, tables are calculated out giving values for total steam and diameter of pipe for different boiler pressures allowing 1lb. drop of pressure in pipe of length equal to, say, 240 times its diameter. But without these we can work as follows:

We have to get the boiler pressure and decide on the maximum allowable pressure drop in the pipe. Suppose this to be 5lb. Allow for calculation 2lb. of this to be lost in bends, valves, and openings. This gives 3lb. for losses in the plain straight pipe. From the scale plan and elevation of boiler and engine get the total length of piping along centre line, in position proposed. Also reckon the number of elbows and valves.

Let total weight of steam per minute = W.

From experiments, $W = 87\ d^3 \sqrt{\frac{D\ p}{L\ (d+3{\cdot}6)}}$,

where d = diameter of steam-pipes in inches;
D = density of steam (pounds per cubic foot) at boiler pressure;
p = pressure drop in straight pipe (3lb.);
L = total length of pipe in feet.

D can be obtained from tables, though if these are not handy it can be got from the formula: log D = log ·003027 + ·941 log P, where P = boiler pressure (absolute). From the first formula d can be got with two or three trials.

We should now make sure that we have allowed sufficient loss of pressure for elbows, valves, and entrance to pipe. It is found that resistance of entrance is equal to that of length of plain pipe $= \frac{144}{1+\frac{3{\cdot}6}{d}}$, and of each valve is the same, while each elbow has as its equivalent $\frac{2\times 144}{3\left(1+\frac{3{\cdot}6}{d}\right)}$.

All these equivalent pipe-lengths are expressed in terms of diameter of pipe. Add these equivalents to length of measured pipe (in diameters) and reduce to feet. Let it now be L′ feet long. Then if L = measured length on drawing, actual loss of pressure $= \frac{L'}{L} \times p$ (not to exceed our 5lb.).

Supposing, however, that the engine's "steam per horse-power per hour" is not known. In this case we must know the following particulars of the engine: (1) The length of stroke (l) in inches; (2) the maximum point of cut-off on the high-pressure cylinder (K) in ratio of length of stroke; (3) the diameter of the high-pressure cylinder (d) in inches; (4) the maximum number of revolutions per minute the engine makes (n); (5) the number of high-pressure cylinders on the engine (c) as on the Willans, etc.; (6) whether the engine is single or double acting.

Now volume of steam taken by one cylinder in one stroke = $K\ l\ d^2 \times ·7854$, ∴ volume taken by engine in one stroke = $K\ l\ d^2\ c \times ·7854$; ∴ volume taken per minute = $K\ l\ d^2\ c\ n \times ·7854$ if engine is single acting, or $2\ K\ l\ d^2\ c\ n \times ·7855$ if engine is double acting (both in cubic inches. And weight of steam per minute (W)

$$= \frac{\text{volume (as determined above)} \times \text{density}}{1{,}728}.$$

From which value of W we can work as above.

Example.—Steam consumption per horse-power per hour not known.

Data: 1. Length of stroke = l = 6in.
2. Cut-off = K = $\frac{5}{8}$.
3. Diameter of high-pressure cylinder = d = 6in.
4. Revolutions per minute = n = 480.
5. High-pressure cylinder on engine = C = 3.
6. Engine single acting.
7. Boiler pressure = 150lb.
8. Allowable drop = 5lb.
9. Length of pipe = 30ft.
10. Number of valves = 2.
11. Number of elbows = 2.

From data 1, 2, 3, 4, 5, and 6:

Volume taken by engine per minute

$$= \tfrac{5}{8} \times 6 \times 6 \times 6 \times 3 \times 480 \times ·7854 \text{ cubic inches}$$
$$= \frac{5 \times 6 \times 6 \times 6 \times 3 \times 60 \times ·7854}{1{,}728.} \text{ cubic feet.}$$

Density of steam at (150 + 15) pounds per square inch = ·3633,

∴ weight of steam per minute

$$= \frac{5 \times 6 \times 6 \times 6 \times 3 \times 60 \times ·7854 \times ·3633}{1{,}728.} \text{lb.}$$
$$= 29{\cdot}48\text{lb.}$$

$$W = 87\ d^3 \sqrt{\frac{D\ p}{L\ (d+3\ 6)}}$$

(where D = ·3633, p = 2 [since pipe is short L = 30)],

$$\therefore 29{\cdot}48 = 87\ d^3 \sqrt{\frac{·3633 \times 2}{30\ (d+3\ 6)}},$$

or $$d^3 \sqrt{\frac{1}{d+3{\cdot}6}} = \frac{29{\cdot}48}{87 \times ·155} = 2{\cdot}186.$$

The value d = 1·75 satisfies this more nearly than any other standard size.

To see if sufficient pressure drop has been allowed in opening, elbows, and valves:

Length of pipe in diameters	$= \frac{30 \times 12}{1{\cdot}75}$	
	=	206
Equivalent of opening to pipe	$= \frac{144}{1+\frac{3{\cdot}6}{1{\cdot}75}}$	
	=	43·8
There are two valves—equivalent	=	86·16
And two elbows $= \frac{4 \times 43{\cdot}8}{3}$	=	58·4
Added to		206
		394·36

$$\therefore \text{ total loss of pressure } = \frac{394}{206} \times 2 = 3{\cdot}8\text{lb.},$$

which is well within the maximum.

If there is more than one engine to provide for, work the problem for each separately, and where the pipes might be run along the same course, substitute one pipe of equivalent cross-sectional area.

If the designer is certain that not more than a certain proportion of the engines will be working at any one time, he may use his judgment about cutting down the main steam-pipe in the ratio of the maximum steam required at one time to maximum steam capacity of the engines. If there is any prospect of extensions it is better to put in a pipe large enough to carry the full amount of steam, unless the pipes get so large that there is a tendency to condense in them. If a ring main is used, do not cut down the diameter of the main on the assumption that part of the steam will go one way and part the other, as the only reason for the ring is to provide an alternative path of full capacity if one half breaks down.—JAMES A. SEAGER.

Answer to No. 76 (*awarded* 5*s.*).—There are several formulæ which may be used for the purpose, most of them being given in such a way as to express the size of the pipe in terms of the velocity of flow of steam. They are thus only approximately correct, for they make no allowance for the greater density of high-pressure steam. The two following formulæ are both good. No. 1 merely gives the size of pipe required without allowing anything for condensation, friction, etc.; whilst No. 2 takes into account the friction in the pipe, and is more accurate.

When data regarding the position, length, covering, etc., of the pipes are available, the various losses can be separately

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calculated and allowed for, and in such a case the first formula would be a convenient one to use. When, however, the above conditions can only be given in general terms, then the second formula will be of the greater convenience. It is perhaps hardly necessary to say that the theoretical values arrived at by means of these formulæ are not carried out in practice, but the standard size higher used instead, as nothing is gained by sticking closely to the strictly theoretical size.

Formula No. 1: $$Q = V\frac{\pi \times D^2}{4 \times 144};$$

whence $$D = \sqrt{\frac{Q \times 4 \times 144}{\pi \times V}};$$

where Q = total volume in cubic feet of steam required per minute;
V = velocity of flow of steam in feet per minute;
D = internal diameter of pipe in inches;
$\pi = 3{\cdot}1416$.

Formula No. 2: $$Q = 3{,}000\sqrt{\frac{p \cdot d^5 \cdot D}{L}};$$

whence $$d^5 = \frac{Q^2 \cdot L}{3{,}000^2 \cdot p \cdot D};$$

where Q = quantity of steam delivered in pounds per hour;
D = density of steam in pounds per cubic foot;
L = length of pipe in feet;
d = diameter of pipe in inches;
p = loss of pressure in pounds per square inch due to friction.

To take an example. A set of triple-expansion engines of 232 h.p. are built for a steam consumption of 3,240lb. per hour, which amount includes steam used in the jackets. What size of steam-pipe will have to be used to supply them, provided that the velocity of steam be reckoned at the rate of 6,000ft. per minute? The boiler pressure as shown by the gauge is 150lb. per square inch.

As the total steam consumption is 3,240lb. per hour, it will be $\frac{3{,}240}{60} = 54$lb. per minute.

The gauge pressure is 150lb., so if we take the atmospheric pressure as being 15lb. exactly, the absolute pressure will be 150lb. + 15lb. = 165lb. At a pressure of 165lb. absolute per square inch 1lb. of steam has a volume of 2·71 cubic feet; hence the volume of 54lb. will be $2{\cdot}71 \times 54 = 146{\cdot}34$ cubic feet.

Using formula 1:

$$D = \sqrt{\frac{Q \times 4 \times 144}{\pi \times V}}$$
$$= \sqrt{\frac{146{\cdot}34 \times 4 \times 144}{3{\cdot}1416 \times 6{,}000}}$$
$$= \sqrt{4{\cdot}4718} = 2{\cdot}11\text{in.}$$

This formula, as stated, does not take into consideration any losses due to friction, etc.

Using formula 2: The loss due to friction is allowed at the rate of 1lb. per square inch per 100ft. of pipe. The density of steam at 165lb. pressure absolute is 0·3695lb. per cubic foot.

$$Q = 3{,}000\sqrt{\frac{p \cdot d^5 \cdot D}{L}};$$

hence, $$d^5 = \frac{Q^2 \times L}{3{,}000^2 \times p \times D}.$$

Substituting proper values, we get

$$d^5 = \frac{3{,}240^2 \times 100}{3{,}000^2 \times 1 \times 0{\cdot}3695}$$
$$\sqrt{d^5} = \frac{3{,}320 \times \sqrt{100}}{3{,}000\sqrt{0{\cdot}3695}}$$
$$\sqrt{d^5} = \frac{32{,}400}{1{,}823{\cdot}4} = 17{\cdot}76\text{in.}$$
$$\therefore d = 3\tfrac{3}{16}\text{in.}$$

The quantity $\sqrt{d^5}$ may be found for numerous values in some engineering pocket-book tables.

It should be noted that no allowance has been made in the above calculations for loss of pressure due to the intervention of valves, elbows, and pipe openings. These losses for various sizes of pipes are given in the engineering pocket-books, and for a pipe of $3\frac{3}{16}$in. diameter the following lengths of pipe will in each case represent the equivalent loss of pressure, and should be remembered when reckoning the total length of pipe and the necessary allowances made: size of pipe, $3\frac{3}{16}$in.; valve or opening to steam, 8ft.; elbow, 5·3ft. As pointed out at the outset, a pipe of the above size would not be used in practice, but one of either $3\frac{1}{2}$in. or 4in. used, as the latter, besides being more readily obtainable in various bends, elbows, etc., also provides for any minor and obscure losses, and enables the engine to be supplied with a greater quantity of steam than is normally required should it at any time be desirable to overload the plant.—F. STOTT.

Answer to No. 76 (*awarded* 5*s.*).—The size of steam-pipe which supplies an engine with steam obviously depends upon the velocity of flow of the steam allowable without undue loss of pressure between boiler and engine. With such engines as are generally used in electricity supply stations, the velocity of flow should be assumed as at about 8,000ft. per minute when on full load. The loss of pressure between the boiler and valve chest will then be very slight, unless with an exceedingly long range of pipes or with very small engines, when the assumed velocity should be 10 per cent. less. Small pipes have a comparatively larger resistance, both as regards sectional area and length. Upon large engines in marine work 10,000ft. per minute is often assumed as the velocity in main steam-pipe, and in practice been found satisfactory. I notice "Molesworth" gives 85ft. per second for steam and 90ft. per second for exhaust. This is clearly erroneous. The velocity in exhaust should be taken at about 25 per cent. less than steam, and 85ft. per second is unnecessarily slow for steam. With compound or triple engines the passages between cylinders should be calculated at from, say, 5,000ft. per minute, for the pressure between cylinders is not so constant as in the steam-pipe, being subject to more sudden fluctuations when one cylinder is open to exhaust and the other to lead.

The method of calculation may be as follows:

Take 8,000ft. per minute as the assumed velocity;
S the mean speed of piston per minute in feet;
D the diameter of cylinder in inches; then

$$\text{Diameter of main steam-pipe} = \sqrt{\frac{D^2 \times S}{8{,}000}}.$$

Example.—Take cylinder, double-acting, cutting off at half stroke, 12in. in diameter, stroke 18in., running at 200 revolutions per minute. What is the diameter of steam-pipe?

D = 12in.
$S = 1{\cdot}5 \times 2 \times 200 = 600$ft. per minute.

$$\sqrt{\frac{12^2 \times 600}{8{,}000}} = \sqrt{\frac{54}{5}} = \sqrt{10{\cdot}8} = 3{\cdot}29\text{in. nearly.}$$

But if we take 8,100ft. as the assumed velocity it will simplify the calculations thus:

$$\sqrt{\frac{D^2 \times S}{8{,}100}} = \frac{D}{90}\sqrt{S} = \text{diameter of steam-pipe.}$$

Then with the same cylinder as above,

$$\frac{12}{90} \times \sqrt{600} = \frac{2}{15} \times 24{\cdot}494 = 3{\cdot}266\text{in.}$$

If the cut-off is later than half stroke, as is usually the case, then take the length of stroke of engine as equal to twice the distance piston has travelled at point of cut-off, and if with an engine the valve chest be small and there be no separator fitted close to engine, it is advisable to assume the speed of piston rather higher than calculated, inasmuch as the piston speed is below the mean velocity at the early part of its stroke and considerably higher before cut-off. If a separator or other reservoir be fitted so as to keep up a steady supply of steam during admission, this may not be considered.

The loss of pressure at valve chest is often attributed to want of sectional area in the steam-pipe, whereas it is more frequently due to contracted area through throttle or stop valves. The friction through a number of small openings is considerably more than through one equal to their collec-

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tive areas, because the perimeters of the former largely exceed that of the single opening. For a number or number of sets of engines of the same size, simply square diameter and multiply by number of engines. Your resultant will be sectional area of pipe in circular inches.—F. R. S.

Question No. 77.—Which do you consider the best means of circulating the water in the boiler when getting up steam?

Best Answer to No. 77 (awarded 10s.).—The circulation of water in a boiler is caused by the different densities of fluid in various parts of the water-space. Wherever active evaporation is taking place in a boiler the water is rendered porous by the contained steam globules. This portion of the fluid being considerably lighter than the denser portions which contain less steam in suspension, is by the natural law of gravity displaced, and takes an upward course. In this way currents are set up in the water, and circulation consequently promoted. As these currents are not usually produced in a boiler until the water has attained a considerable temperature, it is sometimes desirable to promote active circulation by artificial means. One great object in this artificial circulation is to disengage the steam globules as they form from the heated surfaces, as if permitted to remain on the surface of the plates they act as "insulators," and prevent the even distribution of heat, thus causing waste of fuel. In passing, it may be mentioned that it is for this reason that many boilers have their combustion-chamber backs constructed at an angle sloping away from the front of the boiler and downwards, thus enabling the steam to rise freely as soon as generated.

There are many ways of producing artificial circulation by means of pumps, injectors, etc., but the most economical, and probably the best, is by means of the introduction into the boiler of one or more jets of live steam. The steam must be furnished by an auxiliary boiler, and as a precaution against accidents the steam-pipe should be introduced into the lazy boiler at a point above the water-line, and thence conducted down the boiler front in the interior to a point below the fire-bar level. The jet should be arranged to act on the water at a distance of about 1ft. from the boiler front and in direction with the plane of the water surface. By making the connection in this way, there will not be much risk of the boiler "blowing dry" should the joint at any time break. The jet should not project into the water parallel with its plane for more than 14in. or 15in. for the reason that the most active evaporation in the boiler takes place at a distance of about 12in. from the front of the furnace, and it follows that the greatest circulation should be effected at this point, and thus enable the jet to do the greatest amount of good. For sufficiently obvious reasons the jet should only act directly upon the water in the lower part of the boiler, where the cooler water collects. The above method of producing circulation has several advantages. First, practically all the heat taken in the form of steam from one boiler is returned to the other in useful form, since by heating the water a proportionate amount of fuel is saved; secondly, circulation is promoted in a desirable direction—*i.e.*, from front to back, or in a "tidal direction," as it is sometimes called. Rapidity of circulation by causing a regular flow of liquid over the heated surfaces, and keeping its surface in motion, favours the regular liberation of steam as soon as formed. It also overcomes the capillary adhesion of the globules of vapour sooner than their own buoyancy enables them to do. This is probably one reason for the high evaporative duty of water-tube and locomotive type boilers.

In the majority of central stations it is not probable, except in summer, when boilers may be laid off, that the water in any one boiler will ever be at a very low temperature, save after repairs or an examination, etc. In ordinary practice, therefore, it is by far the best plan to depend for efficient circulation upon an intelligently designed boiler for the particular kind of fuel and pressure to be used. The following points should be studied before selecting any particular boiler: the disposal of heating surface as affecting evaporation, circulation, and priming; the proportion of water to steam space; the provision for ensuring good combustion in the rear flue; the space taken up by the return tubes as affecting circulation. The last item is of very great importance, as although there may be considerable water space between the tubes the facility for circulation is remote, as the water generally has to take a sinuous course downwards. It is desirable, therefore, that there should be ample room between the nests of tubes and also between them and the shell. Although closely packed tubes interfere with the local circulation downwards, a long length of tube is not undesirable, as it promotes circulation along its length. Most modern types of boilers, if made by good firms, include the bulk of the above desiderata, especially boilers of the Galloway and Economic type. Many appliances besides those included in the above types of boiler have been used to aid circulation, such as circulating pockets, the help afforded by corrugated furnaces, Graham's circulating plates, cunningly placed baffle plates, etc., all of which have been of great service in particular cases.

As will be noticed, consideration has only been given to boilers of the Cornish and Lancashire types, though the remarks apply in a lesser degree to marine-type boilers, but not to water-tube and locomotive boilers, which usually have very efficient circulation.—F. STOTT.

Answer to No. 77 (awarded 5s.).—One method of circulating the water in a boiler getting up steam is by means of a hydrokineter. The action of this apparatus is as

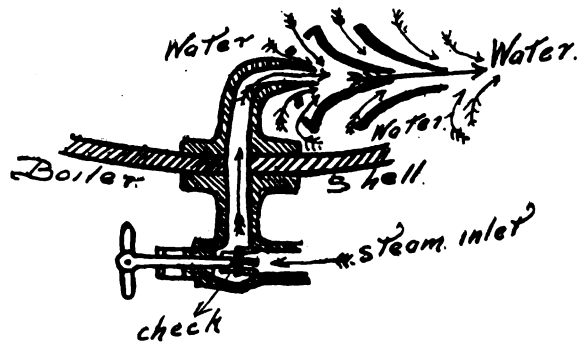

FIG. 1.

follows: Steam is taken from a boiler (in operation) and admitted by the check and stop valve to the first or steam nozzle; the steam getting condensed, throws a jet of water through the second nozzle in the direction which it is set

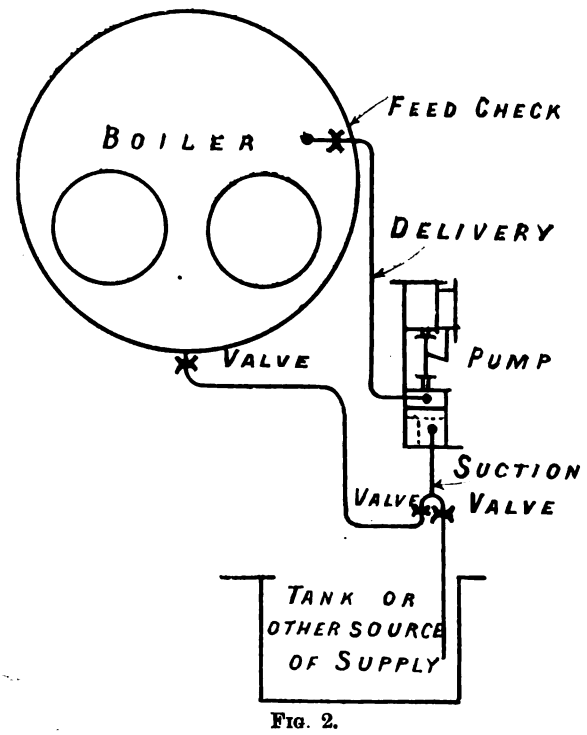

FIG. 2.

and induces a current to flow (see Fig. 1) till the pressure reaches that of the steam-jet, when the valve closes to prevent the water being forced back into the boiler supplying the steam.

This method is open to the objection of the apparatus

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requiring a considerable amount of cleaning and attention where hard water is used.

Another method consists of using the feed pump to do the circulating, the suction being connected to the bottom of the boiler, the delivery being through the usual feed checks (see Fig. 2).

When we consider that three-fourths of the boiler shell is subject to the strains of expansion, and the other one-fourth scarcely lengthened at all, this unequal expansion which boilers are subject to is generally the cause of leakage at the rivets, etc. Therefore, the application of some method of circulating the water while getting up steam will greatly tend to increase the life of the boiler to which it is applied.—J. F. M.

LEGAL INTELLIGENCE.

THE CASTNER-KELLNER ALKALI COMPANY, LIMITED, v. THE COMMERCIAL DEVELOPMENT CORPORATION, LIMITED.

This action was tried before Mr Justice Bigham, sitting as an additional judge of the Chancery Division, and was brought by the plaintiffs, who are the registered owners of letters patent No. 20,259 of the year 1894, granted to Mr. Carl Kellner for an invention of improvements in the electrolytic apparatus for decomposing alkaline salts, for an injunction restraining the defendants from manufacturing or selling caustic soda or other alkali in infringement of their letters patent.

Mr. Fletcher Moulton, Q.C., Mr. Bousfield, Q.C., Mr. J. Graham, Mr. A. J. Walter, and Lord Robert Cecil appeared for the plaintiffs; and Mr. T. Terrell, Q.C., Mr. Astbury, Q.C., Mr. MacConkey, and Mr. J. H. Gray for the defendants.

The hearing of the action was begun on Thursday week.

Mr. Moulton, Q.C., said that before the development of electricity caustic soda had been manufactured from chloride of sodium, or common salt, by a chemical process. But within recent years the process had been introduced of separating the sodium from the chlorine by the action of electricity. In this process carbon was generally used as the anode and mercury as the cathode. A solution of salt was placed in a chamber containing mercury and an electric current was passed through it, the effect of which was to separate the sodium from the chlorine, the latter passing away in gas and the former, being absorbed by the mercury, forming an amalgam. When the mercury was fully charged, the salt solution had to be removed and the amalgam was treated with water. The sodium, having a strong affinity for oxygen, united with the oxygen of the water to form oxide of sodium, or caustic soda, the hydrogen passing away and the mercury being left pure again. The difficulty of this process was that, owing to the strong affinity of sodium for oxygen, before the amalgam could be removed from the salt solution and treated with pure water the sodium began to go back to combine with the oxygen of the water of the salt solution. The plaintiffs were the owners of two patents—one taken out by Mr. Castner and the other by Mr. Carl Kellner—both of which sought to overcome the difficulty by the adoption of a continuous process. In the Castner patent a circular chamber was used, divided into two halves by a diaphragm or partition which did not quite touch the bottom of the chamber. Enough mercury was placed in the chamber to seal the two halves, one from the other. In the one half salt solution was placed and in the other water. The mercury when charged with sodium in the first half was removed to the other half by means of a paddle. Kellner professed to improve on this process by allowing the mercury to remain stationary relative to its containing vessel, and his claim was for "an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode." Instead of a chamber divided into two halves he used a large chamber, called the combining chamber, which contained water and mercury, and a smaller chamber or series of chambers called the decomposing chamber, containing the salt solution. These chambers were in the form of bells, and were so placed as to dip into the mercury, which thus sealed them, separating the water from the salt solution. The bells were moved to and fro slowly, so that the mercury should be exposed alternately to the action of the salt solution and the water. Notches were cut in the edges of the bells to let the mercury pass, or, alternately, grooves were cut in the bottom of the outer vessel. This was the apparatus described in Figs. 1, 2, 3, 4, and 5 of the complete specification. In another form, described in Figs. 7 and 8, the bells were arranged radially, and either the bells or the outer or combining chamber rotated. The defendants proposed to use an apparatus patented by Mr. Rhoden in 1896. They had erected experimental plant, and had formed a company to manufacture caustic soda by means of this apparatus. It consisted of two circular chambers, one inside the other. The outer chamber was the combining chamber, and contained water and mercury. It was filled with radial ribs at the bottom, and rotated. The inner, or decomposing chamber, which contained the salt solution, had at the bottom projecting mouths, which dipped into the mercury, and by means of the rotary motion of the outer chamber the same result was obtained as in the Castner and Kellner patents. The defendants' apparatus was, in fact, identical with the rotating form of the Kellner patent. The plaintiffs claimed that the Kellner patent, which was the one now sued on, differed from the Castner patent in the fact that under it the mercury was kept stationary. All other processes assumed that it was necessary to agitate the mercury. The defendants had added nothing to the Kellner patent. The Kellner patent was attached for disconformity on the ground that the apparatus described in Figs. 7 and 8 of the complete specification was not a natural development of the provisional specification, which was limited to the apparatus described in Figs. 1, 2, 3, 4, and 5 of the complete specification, and on the further ground that in the complete specification, Fig. 9, there had been introduced a device whereby, by means of a separate electric current introduced into the water, the combination of the oxygen and the sodium was accelerated. These, the learned counsel contended, were only natural developments of the invention.

Mr. Swinburne gave evidence in support of the plaintiffs' case.

Cross-examined by **Mr. Terrell, Q.C.**, he said that the method of manufacturing caustic soda from salt by means of electricity was 60 years old. The Atkins and Applegarth patent of 1890 introduced the use of mercury for the purpose of being first charged with sodium and then discharged. In the Hermite and Dubosc patent mercury was poured over a sloping metal plate, where the electrolysis took place, and then flowed down a trough to a chamber, where the sodium was decomposed out of it. In the Castner patent an arm or paddle was used to shift the mercury. The same result would be effected by moving the bottom of the chamber. That was done in the rotary form of Kellner's patent. In the Kellner patent the mercury would be agitated just as much as in Castner's patent, but that in Kellner's patent there were grooves in the lower or outer chamber which to a certain extent prevented the motion of the mercury. The plaintiffs did not use the apparatus upon which they were suing, but an apparatus which they considered was better. It was similar to Castner's with the exception that the mercury was moved from one chamber to the other by means of rocking, and not by means of a paddle. In Kellner's patent the grooves necessitated the use of an increased quantity of mercury. The witness did not think that Kellner's patent had an advantage over Castner's. In Castner's patent a thinner layer of mercury could be used, and a saving thus effected.

Lord Kelvin also gave evidence on behalf of the plaintiffs.

Mr. Terrell, Q.C., in the course of the case, said that there were three methods of accomplishing the particular purpose of exposing the mercury alternately to electrified salt solution and to water. The first was Castner's apparatus. The second was the apparatus described in Kellner's specification in Figs. 1, 2, 3, 4, and 5, having a to and fro movement. The third was the apparatus described in Figs 7 and 8, having a rotary movement. The plaintiffs contended that apparatus described in Figs. 1, 2, 3, 4, and 5 differed from Castner's patent in not agitating the mercury. The defendants' case was that the advantage of not agitating the mercury could not be shown, and, even if it could, it could not be shown that the invention was a substantial one. The defendants' apparatus, which was rotary, like that described in Figs. 7 and 8 of Kellner's specification, was provided with radial ribs introduced for the express purpose of promoting agitation and circulation of the mercury. As the combining chamber rotated the mercury was forced outwards by centrifugal force to the sides of the combining chamber, which extended some way beyond the circumference of the decomposing chamber. It was found that better results were thus obtained, and that 90 per cent. of the sodium absorbed by the mercury in the decomposing chamber could be collected from it in the combining chamber, whereas by Kellner's apparatus only about 50 per cent. could be collected. If, therefore, the defendants' apparatus was an infringement of any patent it was an infringement of Castner's and not of Kellner's. The difference between the Castner and the Kellner patent, which Mr. Moulton laid stress on, was the use in the latter patent of stationary mercury, the object of which was economy in the amount of mercury used. He (the learned counsel) would show that the cost of the mercury used in Castner's apparatus was £3, the cost of the mercury used in Kellner's being £5. There was a saving, therefore, of £2. The mercury lasted practically for ever. The annual saving of the mercury was, therefore, the interest on £2. The value of the products made in one apparatus during the year was £255. The economy, therefore, effected by Kellner's patent was insignificant. The learned counsel contended that Kellner's patent was void because, though it differed from Castner's patent, it involved no substantial invention within the Statute of Monopolies, nor was any substantial increase of utility shown over Castner's patent. He cited Hicks *v.* Safety Light Corporation (4 Ch. D., 615); Williams *v.* Nye (7 Patent Office Reports, 93); Morgan *v.* Windover (*ib.*, 134); Gadd *v.* the Mayor of Manchester (9 Patent Office Reports, 524); and Rickman *v.* Thierry (14 Patent Office Reports, 114). The plaintiffs were in a dilemma because, in order to show a difference between the Kellner and Castner patents, they had to rely on the mercury being stationary. As a matter of fact it was not stationary; but, assuming it to be so, the defendants had not infringed, because in their apparatus the mercury was agitated as in Castner's. If the defendants' apparatus was an infringement of the rotating apparatus described in Figs. 7 and 8 then that apparatus rendered the patent void for disconformity.

Mr. Dugald Clerk, Mr. G. A. Grindle, Prof. C. V. Boys, and **Mr. J. G. A. Rhodin** gave evidence in support of the defendants' case.

Mr. Bousfield, Q.C., in his reply, said that in Castner's patent the object was to mix up the mercury so as to keep the whole of it saturated with sodium in the constant ratio of ·2 per cent. The object of Kellner's patent was to keep the mercury stationary and

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to charge a patch of it with sodium, and then by shifting the bell to charge a new patch and uncharge the first patch. The movement of the rotary form of Kellner's patent, in which the bells were arranged in a circle and rotated, was equivalent to the movement of the original form, in which the bells were arranged in a line and moved to and fro. The two movements had the same effect of alternately covering and uncovering patches of the mercury.

Mr. Terrell, Q.C., contended that the two movements were not equivalent, because for the rotating movement to be equivalent to the to-and-fro movement it ought to be not a continuous rotation, but a rotation through a given number of degrees and then a corresponding rotation back again.

At the conclusion of the case his Lordship reserved his judgment.—*The Times.*

COMPANIES' MEETINGS AND REPORTS.

EASTERN TELEGRAPH COMPANY.

The report of the directors of this Company for the half-year ended March 31 last, presented to the ordinary general meeting yesterday, states that the revenue for the period amounted to £472,734, from which is deducted £118,402 for the ordinary expenses, and £35,979 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing for £2,306 for the depreciation of spare cables and £6,887 for income tax, there remains a balance of £309,160, to which is added £41,904 brought from the preceding half-year, making a total available balance of £351,064. From this balance there has been paid — interest on debentures and debenture stock £29,856, dividend on preference shares £20,296, and interim dividend of 2s. 6d. per share on the ordinary shares £50,000, bonus to staff £27,344, absorbing together £127,496, leaving a balance of £223,568, out of which the directors have placed £10,000 to the reserve fund for maintenance of ships, £10,000 to the fire insurance fund, £10,000 to the land and buildings depreciation fund, and £60,000 to the general reserve fund. The directors recommended a final dividend for the year ended March 31 last of 2s. 6d. per share and a bonus of 4s. per share, amounting altogether to £130,000, both payable on 21st instant, free of income tax, and making, with the three previous payments on account, a total distribution of 14s. per share, or 7 per cent. for the year on the ordinary shares. A balance of £3,568 is proposed to be carried forward. The revenue includes £35,863 dividends for the half-year upon the Company's investments in other telegraph companies. An extraordinary meeting is to be held immediately after the general meeting, at which the shareholders will be asked to convert the 6 per cent. preference shares into 3½ per cent. stock. The directors have decided to issue a further amount of £500,000 3½ per cent. preference stock in order to provide the capital required for additional cables from Porthcurnow to Gibraltar, and from Gibraltar to Malta, and for other purposes. The Company, in conjunction with the other associated telegraph companies, have purchased the lease of a plot of land in Finsbury-pavement, with the object of erecting thereon a suitable building to provide for the present and probable future requirements of the whole of the associated telegraph companies.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The report of the directors for the six months ended June 30, 1898, to be presented at the general meeting to be held in London on the 26th inst., states that the half-year's revenue, after deducting out-payments, amounted to £52,233, as compared with £43,892 for the corresponding period of 1897, being an increase of £8,340. The working and other expenses for the same period, inclusive of income tax, but excluding cost of repairs of cables, amounted to £21,686, leaving a balance of £30,547 as the net profit, giving, with £4,090 brought forward, a total of £34,637. For the corresponding period of 1897 the working expenses and other payments amounted to £19,560. Three quarterly interim dividends of 3s. each per share have been paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, being a total distribution of £39,462, or 3½ per cent. A sum of £10,000 is to be transferred to the reserve fund account, and a balance of £3,389 carried forward.

DISPUTED LIABILITY FOR ELECTRICAL WORK.

In the Westminster County Court on Wednesday his Honour Judge Lumley-Smith, Q.C., had before him the case of Foster *v.* Harriss, in which the plaintiff, an electrical engineer, sued the defendant to recover payment of an account of £12. 10s. in respect of electrical work done to his order and materials supplied. Evidence was called to prove that the order was given by the defendant, and that the work was carried out at a house in Soho which was formerly used as a club. When the defendant was applied to for payment he alleged that the committee of the club would pay, but as the club had now ceased to exist the plaintiff was unable to get payment. As a matter of fact, however, he had always looked to the defendant personally, and did not know anyone else in the matter.

The Defendant appeared, and said it was true he gave the order for the work, but he never intended to be personally liable.

His Honour said it was quite obvious that defendant had rendered himself personally liable, and therefore judgment would be for the plaintiff for the amount of the claim, with costs.

NATIONAL TELEPHONE COMPANY.

The report of the directors of this Company for the half-year ended June 30 last, to be presented at the general meeting to be held in London on the 27th inst., states that the income for the half-year amounts to £538,866, as compared with £476,954 for the corresponding period of 1897, being an increase of £61,912. The working expenses for the half-year were £298,651, as compared with £261,796, an increase of £36,855. After deducting the Post Office royalties amounting to £49,665, there remains a profit balance of £190,550, as compared with £171,978 for the corresponding period of 1897, being an increase of £18,572. The rentals carried forward for unexpired terms of running contracts amount to £565,620, as compared with £499,963 at the corresponding period of 1897, or an increase of £65,657. Out of the avilable balance of £167,854 the directors recommend the following dividends: on the first and second preference shares at the rate of 6 per cent. per annum, less income tax; the third preference at the rate of 5 per cent. per annum, less income tax; ordinary shares at the rate of 6 per cent. per annum, free of income tax; carrying £50,000 to reserve and about £5,000 forward. The transfer books in respect of the preference and ordinary shares are closed until the 27th inst, preparatory to the payment of the dividend. The dividend warrants will be posted on 27th inst.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The half-yearly general meeting of the above-named Company was held on the 19th inst. at the offices, Old Broad-street, E.C., Sir R. G. W. Herbert presiding. No accounts or resolutions were submitted, but the interim dividend of 5 per cent. provided by the articles of association was announced.

The **Chairman** said both the guttapercha works and the cable factory were actively employed, although the price of materials had been rising. With regard to their cable ship, the "Anglia," lately launched, he stated that the same was so constructed as to be able to be used for commercial purposes, and thus earn money when not being used on cable work.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY.

At an extraordinary meeting of this Company on Saturday last, Mr. A. Bruce (chairman) presiding, it was decided to charge the separate undertaking of the Laxey and Ramsey section with one-fifth of the general charges of the Company, a maximum of £500 being fixed. It was also decided to work such separate undertaking for 45 per cent. of the gross receipts of the undertaking. A meeting of the shareholders in the separate undertaking was afterwards held, and the above terms were accepted.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq. Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts, for the half-year ending June 30, 1898, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at the offices of the Company, 46, King William-street, in the City of London, on Tuesday, July 26, 1898, at 12 o'clock noon:

The receipts from all sources for the past half-year have amounted to £27,552. 10s., and the cost of working has been £15,614. 6s. 5d., leaving a profit of £11,938 3s. 7d. Inclusive of the balance brought forward from Dec. 1 last, the net revenue account shows an aggregate total of £13,506. 4s. 9d. After making provision for the debenture stock interest, a balance remains available for dividend of £10,498. 2s. 8d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 2½ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,005. 9s. 3d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Recipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,158 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3,383,154	23 564 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23,780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3,368,480	25,456 6 9
June 30, 1897	3,437,810	26,403 3 6
Dec. 31, 1897	3,337,861	25,472 12 10
June 30, 1898	3,478,977	26,356 16 4
Total since the opening of the line	47,257,409	£350,537 14 8

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Although the receipts from passenger traffic show no increase over the corresponding period last year, it is very satisfactory that they have been maintained in spite of the fine mild weather that prevailed during the first portion of the half-year, and that last year the receipts for the month of June were abnormally swollen by the heavy traffic occasioned by the Diamond Jubilee festivities. This result has been obtained by a steady increase of the mid-day and short-distance traffic. The progress with the works of the extension to Moorgate-street has been continuous and the tunnelling is rapidly approaching completion. The work of upholding St. Mary Woolnoth Church has been successfully carried out, and the large shaft for the lifts at this station is now being sunk. At Moorgate-street both station tunnels are completed, while at Lombard-street and Denman-street the construction of these tunnels is proceeding rapidly. A contract on favourable terms has been entered into for the construction of the extension to Clapham Common. The sites for the stations having been acquired, the work has been commenced, and should be completed by the end of August, 1899. The property adjoining the depôt at Stockwell, referred to in the last report, has been purchased, and preparations are being made for the erection of the new engine and boiler house for the reception of the additional plant required for the working of the extension to Moorgate-street and Clapham Common, and the requisite engines and boilers have been ordered. Of the new locomotives required three are under contract, and several others are being constructed in the Company's own works. Thirty additional carriages have also been ordered. The Bill promoted in the present session has received the Royal assent. Its provisions, as explained at the special meeting in February last, were but slightly varied in its passage through Parliament. The City and Brixton Bill has also received the Royal assent. At the conclusion of the ordinary business the meeting will be made special, in order to sanction the creation and issue of the additional capital authorised by the Act of the present session, and the exercise of the borrowing powers conferred under the same Act. The 22,500 ordinary shares offered to the proprietors in February last were all subscribed for and allotted. The 5 per cent. terminable debenture bonds have now all been paid off. The dividend warrants will be posted on the 6th prox.

Dr.	Revenue Account.	£	s.	d.
Maintenance of way, works, and stations		746	17	6
Locomotive and generating power		5,733	9	4
Carriage repairs		554	12	9
Traffic expenses		5,913	9	3
General charges		1,820	5	11
Passenger duty		52	17	5
Law charges		3	2	6
Rates and taxes		789	11	9
		15,614	6	5
Balance carried to net revenue account		11,938	3	7
		£27,552	10	0
Cr.		£	s.	d.
Passengers ((3,478,977)		25,070	12	8
Season tickets (526)		1,286	3	8
		26,356	15	4
Parcels, etc.		143	18	4
		26,500	14	8
Transfer fees		37	15	0
Rent of property		897	16	4
Sundry receipts		116	4	0
		£27,552	10	0

Dr.	General Balance Sheet.	£	s.	d.
Balance from net revenue account		10,498	2	8
Unclaimed interest		67	3	3
Interest payable or accruing and provided for		984	13	6
Sundry outstanding accounts		5,810	15	8
Loan account		141,000	0	0
Contractors' retention fund		15,743	0	0
Reserve fund		1,000	0	0
		£175,103	15	1
Cr.		£	s.	d.
Cash at bankers, current accounts		7,521	4	10
Cash on hand		1,078	2	0
		8,599	6	10
General stores		4,183	3	9
Sundry outstanding accounts		829	9	6
Investments—balance Dec. 31, 1897, £149,728. 15s.; less (proceeds stock sold, £15,443. 14s.; depreciation on ditto, £464. 11s. 6d.), £15,908 5s. 6d.		133,820	9	6
Balance from capital account		27,671	5	9
		£175,103	15	1

Accidents.—On Saturday night, a serious accident befell two electric tramcars on the Fleetwood and Blackpool overhead electric tramway. A car stopped near a curve, when another car rounded the curve at full speed and dashed into it. One passenger had her leg fractured. On Sunday night another accident occurred with the overhead wires in Fleetwood, and the traffic was stopped for about two hours, but no one was hurt.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Melbourne (Victoria).—The Town Council invite tenders for a supply of arc lamp carbons. Particulars may be obtained of, and tenders addressed to, the Town Clerk by Aug. 16.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns Tenders by Aug. 10.

Tiflis (Russia).—Tenders are invited by the Municipal Authorities, from whom particulars may be obtained, for the electric lighting of the central part of the town. Tenders by Aug. 1/13.

Exeter.—Tenders are invited by the Corporation for about four miles of high and low tension concentric mains, four transformers, about 50 meters, and a feed-water heater of about 1,000 gallons capacity. Tenders by 25th inst.

Aberdare.—Tenders are invited for a ventilating fan and engine, for a duty of 350,000 cubic feet per minute. Further particulars may be obtained on application to the Powell Duffryn Steam Coal Company, Aberaman Offices, Aberdare.

Barking Town.—The District Council invite tenders for the supply and delivery of electricity meters, main cut-outs, lamp brackets and columns, and wiring of premises in their district. Further particulars appear in our advertising columns. Tenders by Aug. 3.

Stavelot (Belgium).—The Municipal Authorities invite tenders for the installation and working of an electric plant for light and power for 30 years. Conditions, etc., may be obtained for 2s. 8d. from the Town Clerk, at Stavelot. The deposit is £120. Open until Aug. 2.

Hendon.—The Managers of the Central London Sick Asylum District invite tenders for supplying the necessary plant and for installing the electric light at their new asylum, Hendon, Middlesex. Further particulars appear in our advertising columns. Tenders by Aug. 15.

Eccles.—Tenders are invited by the Corporation for the wiring of the Town Hall, Eccles. Specifications, etc., may be obtained at the office of the Town Clerk on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders to be sent to the Town Clerk by July 23.

London.—Messrs. Twining and Co. invite tenders for the supply and erection of two 6-h.p. motors, with all wires and accessories, at their premises at 216, Strand. Specification and all details from Mr. J. G. Lorrain, consulting engineer, of Norfolk House, Norfolk-street. Tenders to be returned by July 23.

Hapton (Padiham, Lancs.).—Tenders are invited for lighting the Hapton township with electricity from Sept. 1, 1898, to April 30, 1899. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, St. Anne's-terrace, Padiham, by Aug. 1. Full particulars on application.

West Hartlepool.—The Town Council of West Hartlepool invite competitive plans, designs, and tenders for the erection of refuse destructor, boilers, etc., adjoining the electric light station, Burn-road. Conditions, etc., can be obtained upon application to Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on July 27.

Manchester.—Tenders are invited by the Electricity Committee for the supply during 11 months ending June 30, 1899, of brass and iron castings, cables, carbons, incandescent lamps, meters, etc. Particulars and forms of tender may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by 26th inst.

South Shields.—Tenders are invited by the Tramways Committee for the constructional work and paving thereto of 185 lineal yards double line of steel girder tramway, including points and crossings, with electrical bonding. Specification may be obtained at the office of Mr. S. E. Burgess, A.M.I.C.E., borough engineer, Chapter-row. Tenders by 12 noon on 23rd inst.

Glasgow.—Tenders are invited by the Corporation for providing and erecting the following plant required for their new generating station at Port Dundas—viz.: (1) cast-iron and mild-steel tanks; and (2) cast-iron hoppers, chutes, bolts, etc. Particulars, etc., may be obtained on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by July 28.

Pemberton (Lancs.).—Tenders are invited by the Urban District Council for suitable schemes for carrying out the electric lighting in their district. Schemes must be sent to Mr. Paul Partington, clerk, before Aug. 14. They should be accompanied by explanatory details, and must be such as will satisfy the requirements and comply with the regulations of the Board of Trade. Information as to the area and population of the district and other essential particulars may be obtained on application to the Clerk.

RESULTS OF TENDERS.

York.—The Corporation have accepted the tender of Parker and Sharp, Peasholme-green, York, at £7,170. 19s. 5d., for the erection of an electric light station.

Bootle (Lancs.).—The Corporation have received the following tenders for the erection of an electric station on their land in Pine-grove:

W. Musker, Bootle (accepted)	£6,598
J. Corkell, Liverpool	7,261
Hughes and Stirling, Bootle	7,150
J. Paterson and Son, Liverpool	7,097
P. Tyson, Liverpool	7,000
S. Webster, Bootle	6,950

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Ipswich.—The Guardians have accepted the tender of the National Telephone Company to provide telephonic communication between the exchange and Tower-street for £6. 16s. annually, and between the exchange and St. John's Home, and thence to the new workhouse, for £18 annually. They have also accepted the tender of Messrs. Crompton and Co., at £1,650, for the electric installation, exclusive of motor power.

Kingston-on-Thames.—The Committee of the Kingston-on-Thames Workmen's Club and Institute have received the following tenders for the fitting-up of an installation for the electric light at their club premises, Fairfield-road, Kingston-on-Thames:

Tender A.

Sar, Slatter, and Co.	£234	16	3
Spagnoletti and Crookes, Goldhawk-road, London, W. (accepted)	150	6	10
A. H. Wood	165	0	0
Thames Valley Electrical Engineering Company	150	0	0
National Electric Wiring Company, Limited	157	0	0
Bergtheil and Young	170	0	0
T. H. Taylor	156	16	0
Thompson, Howard, and Co.	244	12	6
Jackson and Coley	292	10	0
W. Adams, Kingston, Surrey	266	15	0
J. R. Offer, Kingston, Surrey	143	5	0
C. A. Hemingway, Richmond	175	0	0
Safety Concentric Wiring Company	197	10	0
Brush Electrical Engineering Company	167	13	6
Prestwich and Burt, Kingston, Surrey	203	17	6
Christian and Phipps, Hampton Wick	165	15	0

BUSINESS NOTES.

Leeds.—Workmen are busy preparing for the electric light installation at Holbeck.

Birmingham.—The lighting of the reference library and the Council-house by electricity is being considered.

Radcliffe.—A report from Mr. Bennett has been received, and will be considered shortly, on a scheme for the lighting of Radcliffe by electricity.

Ryde.—The Council have formed a committee to decide what course to adopt with regard to the installation of the electric light in the borough.

Personal.—We are informed that Mr. John Hart has resigned his position as secretary and manager of Messrs. H. M. Salmony and Co., Limited.

Manchester.—The Special Tramways Committee of the Corporation have decided to visit Liverpool for the purpose of inspecting the electric trams.

Towyn.—A proposal is under consideration respecting the lighting of Towyn and Aberdovey by electricity at an estimated cost of between £4,500 and £6 000.

Croydon.—A Local Government Board enquiry has been held by Colonel W. Langton Coke, M I.C.E., into the application of the County Council to borrow £23,278 for electric lighting.

Dover.—The cost of the electrical illumination of the Dover sea-front from the middle of July till the end of September is stated at £165, including the special installation of the 1,000 lights.

Stockport.—The Gas and Electric Lighting Committee of the Corporation have decided to recommend the Council to lay down an installation of 36 arc lights for use in the centre of the borough.

Falmouth.—The Urban Sanitary Authority have received a notice from the United Electric Supply Company to apply for a provisional order for power to supply electric power and light at Falmouth.

Crystal Palace District.—The Crystal Palace District Electric Supply Company intend to open the ground in Westow-hill and Beardell-street and lay three rows of cast-iron pipes for the reception of high-tension mains.

Bury St. Edmunds.—An enquiry was held on Wednesday by Mr. H. Boulnois, M.I.C.E., Local Government Board inspector, into the proposed expenditure by the Town Council of £20,000 for purposes of electric lighting.

Dumfries.—The Town Council have agreed to oppose a proposed application by the Edmundsons' Electricity Corporation, Limited, for a provisional order to establish electric lighting in the town, it being the intention of the Gas Commission to take up the matter.

Lincoln.—The Town Council have petitioned against the General Power Distributing Company's Bill enabling that company to supply electricity within a radius of 26 miles of Warsop Church, and which would include the city of Lincoln or some part thereof.

Portsmouth.—Arrangements are being made to drive all the workshop machinery at Portsmouth Dockyard by electricity. A generating station is to be built on the site of the old Portsea convict station, and the whole plant is estimated to cost half a million sterling.

Falkirk.—The Town Council have received a letter from Messrs. Bergtheil and Young, London, intimating that they intend to apply for a provisional order authorising them to supply electricity within the district, and have replied that such application, if made, will be opposed.

Battersea.—The site for the electric lighting station is to be considerably extended, and property is to be acquired for the extension at a cost of some £9,000. As the station will be situate on the banks of the Thames, the cost of conveying coal, etc., will be reduced to a minimum.

Alloa.—The Burgh Commissioners have resolved to apply to Parliament for a provisional order in respect to the introduction of the electric light in the burgh. The Urban Electric Light Company have given notice that they also intend to apply for a provisional order for the burgh.

Lymington.—The Town Council have received notice from Edmundsons' Electricity Corporation that it was their intention to apply for a provisional order to carry out electric lighting at Lymington during the parliamentary session of 1899.

Johnstone.—Upon a request from the Electric Traction Company a deputation has been appointed by the Commission Board to inspect the electric tramway system on the Continent at the expense of the company. Several other members of the Board also received a similar invitation.

Greenock.—At the monthly meeting of the Greenock Police Board, on the 20th inst, a letter was submitted from the North British Electricity Supply Company, Limited, intimating their intention to again apply for a provisional order for the burgh. The letter was referred to committee for consideration.

Appointments Vacant.—A clerk is required in the Electricity Department at Hammersmith. The Lighting Committee of the Corporation of Wolverhampton invite applications for the post of junior assistant electrical engineer. Particulars of the above and other vacancies appear in our advertising columns.

Wakefield.—There appears to be a controversy between the Electric Light Committee and the Corporation whether the electrical engineer should appoint his assistants or not. We incline to the view taken by the former body, as the responsible employer of labour should certainly be allowed to choose his own staff.

Gourock.—At the monthly meeting of the Burgh Commission on the 20th inst., a letter was read from an electric light company stating that they intend to apply to the Board of Trade for an order to supply the burgh with electric light. It was agreed to reply that the Commissioners would oppose the application.

Tynemouth.—Tenders have been received by the Town Council for the supply of machinery for the electric lighting installation. They will probably be brought up for consideration at the next meeting of the Council, after the sanction of the Local Government Board to purchase land for the station had been received.

Darfield.—The District Council have under consideration the Bill of the General Power Distributing Company, which is being formed for supplying an area, including Darfield, with electricity. There is a resolution on the books to have municipal electric lighting plant. A special meeting is announced to decide the matter.

Bradford.—Major Cardew, as Board of Trade inspector, on the 20th inst. made an inspection of the new Bolton-road tramways at Bradford, which are to be worked by the Corporation on the electric system. The line is nearly complete in its equipment, and the Corporation are hoping to open it to the public on August 1.

Hove.—In reply to an enquiry made at the last meeting of the District Council as to whether any steps had been taken with regard to coming to terms with the electric light company with a view to purchasing the interests of the company, it was stated that nothing had been done with regard to the purchase of the electric light undertaking.

Brazilian Submarine Telegraph Company.—A preliminary agreement, providing for a closer alliance between the two companies, has been arrived at between the directors of the Brazilian Submarine Telegraph Company and those of the Western and Brazilian Telegraph Company. Meetings of the shareholders of both companies to ratify the agreement are announced for the 27th inst.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing the sum of £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ended June 30 last of 15s. per cent. on the ordinary stock and 30s. per cent. on the preferred stock, less income tax, payable on Aug. 2 to the stockholders registered on the books of the Company on 11th inst.

Leamington.—At a meeting of the Town Council it was reported that the Board of Trade could not proceed with the electric lighting order being promoted by the Leamington Corporation this year. The proposal that a standing electric lighting committee be appointed to watch events, and to consider the question of further negotiations, was agreed to, and the matter was referred to the General Purposes Committee.

East Barnet Valley.—The Urban District Council have received a notice from the North London Electricity Company intimating that it was their intention to apply to the Board of Trade and Parliament in the ensuing session for a provisional order authorising them to supply electricity within the area of the East Barnet Urban District Council. The Council have agreed to allow the matter to rest until application for the order is made.

Inverness.—At a meeting of the Town Council on the 18th inst. the special committee's recommendation was adopted to the effect that, as the first step towards ascertaining whether or not electric lighting was desired by the community, they should be informed of the approximate cost of the introduction of the light, and that the committee be empowered to frame a report as to the best method of introducing it, and the cost to the consumer.

Kensington.—At the last meeting of the Vestry the Special Electric Lighting Committee appointed to consider the resolutions, referred to in our last issue, were discussed, and it was resolved

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that the several companies be notified that the Vestry withhold their consent to the applications, intending themselves in due course to apply for a provisional order for the supply of electricity within the parish. The other recommendation was withdrawn.

Southgate.—At the last meeting of the Urban District Council the Tottenham and Edmonton Gas and Coke Company and the North London Electric Lighting Company wrote giving notice of their intention to apply for provisional orders to provide electric lighting, etc., in the district. The Chairman said that the Tottenham and Edmonton Company withdrew their previous scheme when they found that it only applied to the eastern side.

Edmonton.—At the last meeting of the Urban District Council the clerk was instructed to write the promoters of each of the companies giving notice of intention to apply for provisional orders for lighting the district by electricity, and stating that the Council could not support their proposals. Directions were given for enquiries to be made as to the formalities to be observed in view of an application by the Council to adopt the electric light.

Broadstairs and St. Peter's.—The Works Committee of the Urban District Council are considering letters from the Isle of Thanet Light Railways Company and from the County of London Brush Provincial Electric Lighting Company, Limited, giving notice of their intention to apply to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the area of the Council's jurisdiction.

Edinburgh.—The Electric Lighting Committee have fixed their estimate for electric lighting in the city for the year from May 15, 1898, at £31,820, as compared with an estimate last year of £21,165, and an actual expenditure of £24,444. The revenue on account of the expenditure was estimated at £51,250, as compared with an estimate last year of £35,455, and an actual revenue of £38,649. For capital expenditure they estimate a sum of £130,500.

Whitechapel.—The following notices of motion respecting electrical matters have been given by a member of the District Board of Works: (1) "That the committee to be appointed to consider the subject of the electric lighting of the district be a standing committee, and consist of not more than 25 members"; and (2) "to appoint a special committee to consider the subject of the electric lighting of the district, and to define the duties of such committee."

Walsall.—The Lighting Committee's report, as adopted by the Town Council, states that the total number of consumers supplied on June 30 last was 105. The total units generated at the station during the month of June was 8,118. The committee have recommended the payment of accounts amounting to £756. 19s. 7d. Instructions have been given for the additional plant provided at the generating station and the two transformer stations in Park-street to be insured.

Parliament.—In the House of Lords the Metropolitan Railway Bill has been read a third time. With regard to the Bridgwater, the Shrewsbury, the Melton Mowbray Electric Lighting, and the General Power Distributing Company Bills, the examiners have decided that the standing orders have been complied with, and ordered the Bills to be reported for second reading. In the House of Commons the Metropolitan Electric Supply Bill has been read a second time.

Hackney.—At the meeting of the Vestry two intimations were received of intention to apply for provisional orders to supply electricity in Hackney, one from Mr. S. Morse, Fenchurch-avenue, and the other from the Metropolitan Electric Supply Company. It was decided to take all possible steps to prevent the obtaining of the orders. Mr. Kohler, of 100, Lenthall-road, requested to be informed of the terms on which the Vestry would sell their electric lighting order, and was informed that the Vestry did not intend to sell.

Harrogate.—The Lighting Committee's report recommending that the engineer be instructed to erect in West Park five pairs of poles complete, with suspender wires and gear, and upon these fix various sample lamps for an extended test and public trial under actual working conditions, and that the Council be recommended to allow in future the following discount on electric lighting accounts—namely, if paid within 15 days, 5 per cent.; if paid within a month, 2½ per cent.—has been adopted by the Town Council.

Stock Exchange.—Business in electric shares was very large on Saturday and Monday, but slackened down later in the week. The dealings were of an investment character, no speculation being in favour in the market. The change in the quotations will be found in the usual column. The City of London Electric Lighting Company have made application to the Stock Exchange committee to allow 10,000 ordinary shares of £10 each, fully paid—Nos. 90,001 to 100 000—to be quoted in the official list in lieu of the provisional certificates now quoted.

Bootle.—The Watch Committee recommend for the approval of the Council the following scale of charges: for lighting—7d. per unit for an average consumption of one hour per day at maximum demand, and 3d. per unit for all energy used in excess of that amount; for power purposes—7d. per unit for an average consumption of one hour per day at maximum demand, and 1½d. for all energy required in excess of that amount; also, that the maximum readings of the indicator be taken over the half-year, and accounts issued quarterly.

Birkenhead.—The *Birkenhead and Cheshire Advertiser* says that the business-like manner in which the Town Council at a recent meeting tackled and discussed the proposals of the Electric Tramways Special Committee concerning the question of routes, and the unanimity with which the majority of the lines suggested and the addition to them of certain other routes was accepted, was a satisfactory indication that the Council are in earnest in their endeavour to supply the inhabitants with a system of tram haulage adequate to their requirements.

Taunton.—From the report of the Electric Lighting Committee to the Town Council it appears that the Local Government Board have intimated that they would shortly hold an enquiry as to the proposed loan, and that the Board do not question the revised figures sent them by the town clerk as to the Corporation's balance of borrowing powers The committee asked the Council to authorise notice to be given under Section 11 of the Electric Lighting Order Confirmation Act, 1893, to the owners of certain private roads of the intention of the Council to lay the cable and execute other authorised work under or in such street.

Hyde.—The electric tramway between Oldham and Hyde, *vid* Ashton-under-Lyne and Denton, is approaching completion, and the Council have received a letter from the British Electric Traction Company offering £500 towards proposed alterations in Stockport-road, at the Ring of Bells corner, subject to the sanction of the Board of Trade being obtained to the necessary deviations; and the company were also prepared to widen the river bridge between Hyde and Denton. A committee was appointed to interview representatives of the committee and owners of property, also the county authorities, on the subject.

Hampstead.—There is a rumour that the Hampstead Electric Supply Company will issue almost immediately a prospectus in order to attempt the formation of a company with a capital of £200,000. The company will operate on the overhead system, and we are curious to know how they intend to apply that fleabite of 200,000 sovereigns. They claim that they cannot be interfered with by the municipal authorities. This claim can only be supported if they do not intend to cross any streets, as the local body has power to prevent them from doing so. Therefore, their operations would be confined to the working of a small area only.

Wombwell.—At the monthly meeting of the District Council on the 19th inst., the Clerk said there had been a conference at Mexborough, at which it had been decided that the best course to take in further opposing the General Power Distribution Company's Bill would be for the districts of Mexborough, Swinton, Wath, and Wombwell to present an independent petition against the Bill in the House of Commons. It was unanimously decided to adopt this course, and take the necessary steps under the Borough Funds Act to authorise the further opposition. The seal of the Council was ordered to be attached to a petition against the Bill.

Ilkeston.—At a special meeting of the Town Council it was unanimously agreed that it was expedient for the Town Council to construct tramways within the borough, under the provisions of the Tramways Act, 1870, and that direct application should be made forthwith, in accordance with plans and sections which may be prepared and approved of by the Board of Trade, as well as authoring the Corporation to place and run carriages, and work and use tramways for carrying passengers, and other purposes, and to take tolls and charges therefor. A similar resolution was unanimously agreed to with respect to the supply of electric energy.

Douglas.—At the Town Council meeting last week it was reported by the Highways Committee that they had had an interview with the directors of the Isle of Man Tramways and Electric Power Company with regard to the Upper Douglas cable tramway, and that the chairman of the company had stated that if the Council would take the section over at the amount it cost the company, the company would pay a fixed sum of £1,500 per annum for the Douglas Bay section in addition to the 15 per cent. on the gross receipts now payable to the Council. A proposal that the offer be referred to a committee was not entertained by the Council.

Penzance.—Edmundsons' Electricity Corporation have given notice, on behalf of the Urban Electric Supply Company, that they intended to apply to the Board of Trade for a provisional order for electric lighting in the borough of Penzance, and for confirmation by Parliament in the session of 1899. To obtain the Council's approval of this application the company would be prepared to insert clauses in the provisional order providing that the Council might purchase the undertaking, if they wished to do so, at an early period, and giving special terms for the supply of electric current for public purposes. The matter is now before the Lighting Committee.

Southampton.—At the meeting last week the Electric Lighting Committee recommended the Corporation to increase the salary of Mr. Lee, the resident electrical engineer, from £180 to £250 per annum. The adoption of the recommendation was negatived. An amendment that the salary be increased to £210 per annum, increasing £20 annually until £250 was reached, was carried. Notice of motion was given by one of the opposing party to rescind the above resolution. We are astonished to see such a policy advocated, as it must be apparent that a good man is worth a good salary, and the success of the undertaking seems fully to warrant the committee's action.

Ipswich.—The Workhouse Erection Committee reported at last week's meeting of the Guardians that they had instructed Mr. Dalby to alter the original specification so as to make it in accordance with Messrs. Crompton and Co.'s tender to carry out the electric installation, exclusive of the motor power, for £1,650, and to prepare a specification for the supplying of the necessary 32-h.p. gas engine by the Ipswich Gas Company, including laying the mains, for £400. The committee also recommended that the

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laundry machine should be driven by an electric motor, and that Mr. Dalby obtain a tender for the same, with all necessary fittings, from Messrs. Crompton and Co.

Tees-Side Tramways.—As anticipated in our last, the electric tramway system was formally opened to the public on Saturday morning at 8 o'clock. At 7 30 a car containing the managing director of the Imperial Tramway Company (Mr. Clifton Robinson), the member for Stockton (Alderman J. Samuel), the Mayor of Stockton (Alderman A. G. Rudd), and the Mayor of Middlesbrough (Councillor Carter), and a number of invited guests, went over the system to inaugurate it. The Mayors drove the cars into their respective boroughs, and afterwards formally declared the system open. During the day the cars ran every five minutes, and afternoon and night every one was packed.

Edison and Swan United Electric Light Company.—The accounts for the year ending June 30, 1898, have been considered by the directors, and they have determined to recommend the payment of a dividend in respect of the six months ending June 30, 1898, at the rate of 7 per cent. per annum on the A share capitital of the Company as now paid up, carrying forward about £11,500, as against £8,493. 7s. 6d. in the previous year. The above distribution, together with the interim dividend at the rate of 5 per cent. per annum, already paid in February in respect of the first half-year, will be equal to a dividend of 6 per cent. for the entire year. The dividend warrants will be posted on Aug. 12, 1898, upon the register as it stood on the 19th inst.

Lambeth.—Amongst the correspondence placed on the agenda for consideration at the Vestry meeting last evening were letters from Messrs. Fladgate and Co., enclosing notice of the intention of the County of London and Brush Provincial Electric Lighting Company to apply for a provisional order to supply so much of Lambeth as lies to the north of Westminster Bridge-road with electrical energy for lighting, motive power, and other purposes, and from Mr. S. Morse, enclosing notice of the intention of the County of London and Brush Provincial Electric Lighting Company, Limited, to apply for a provisional order for the purpose of taking their mains through Lambeth, so as to connect the detached portion of Wandsworth district with the main portion.

City of London Electric Lighting Company.—The return of the gross revenue from the supply of electricity only during the quarter ended June 30, 1898, is reported as follows: from public lighting, £3,176; private lighting, £24,950—making a total of £28,126. The returns for the corresponding quarter were £3,155 and £23,001, this year's showing an increase of £1,970. In making a comparison, it must be remembered that since the commencement of 1898 the reduced charges of 7d. per unit, with a sliding-scale reduction down to 4d. per unit for lighting, and 4d. and 3d. for motive power, have been in force. The equivalent of 8-c.p. lamps connected on June 29 last were 321,700 (increase during the quarter of 11,040), as against 270,898 on June 30 last year, when there was an increase during the three months of 9,962 lamps.

Ashton.—The following report of the Electricity Committee has been adopted by the Town Council: "Mr. Clirehugh reported on the progress of the works generally, and expressed his opinion that current would be available at the end of August. It was resolved that a person be engaged to learn and carry out jointing of cables and connecting up of services; that 25 demand indicators of assorted sizes and that 25 fuse-boxes be purchased; that the Highways Committee be requested to pave the level road, and form and pave the proposed inclined road leading to the works in the town's yard. The question of free wiring was introduced, and it was decided that the chairman and comptroller should wait upon the town clerk with a view to ascertaining whether the Local Government Board would be disposed to grant borrowing powers to the Corporation for that purpose."

Enfield.—The North London Electricity Company have written to the District Council stating that it is their intention to put down large works for the supply of a number of districts in the North of London, and should their powers be granted they would probably be in a position to offer electricity to the Council wholesale at least at as low a price as the Council could generate it themselves. The consideration of the letter has been referred to committee. The Clerk has reported that he has received a scheme from Mr. Theodore Ridge for lighting the district, and an offer from another gentleman offering a preliminary report for £25. These have been referred to committee. The sub-committee appointed to consider the matter have reported that they held a meeting and discussed the question of making application for a provisional order to supply the district with electric light, but as yet they were not prepared with a recommendation. The chairman is making enquiries on the subject.

Wolverhampton.—The special committee appointed by the Wolverhampton Corporation to consider the advisability of the Corporation exercising, on the expiration of the term of 21 years mentioned in the Tramway Act, 1870, their power under Section 43 to purchase the portion of the undertaking of the Wolverhampton Tramway Company, have issued their report. With regard to the future working of the line, the committee state that on the assumption of the Corporation becoming the owners of the tramways the British Electric Traction Company have made an offer to take the lines on lease and reconstruct them, and take their electric supply from the Corporation, in addition to paying a rental of £50 per mile and a sum equal to 5 per cent. on the capital outlay by the Corporation. The committee do not offer any comment upon the terms, but they express the opinion that the electric overhead system is the best mode of traction for the borough; and, in conclusion, they recommend that the Corporation should acquire such portion of the tramway as lies within the borough.

Fleetwood.—A syndicate has been formed to undertake the supply of electricity for lighting and other purposes in the town of Fleetwood, under the provisional order granted to the Urban District Council of Fleetwood, and since transferred, with the sanction of the Board of Trade, to the syndicate on what are deemed highly favourably terms. The share capital is to be £22,000, divided into 20,005 ordinary shares and 1,995 deferred shares, and £7,000 4 per cent. debenture stock is also offered for subscription, interest at the rate of 5 per cent. being guaranteed on the ordinary shares for the first three years. We note from the prospectus that in consequence of its fine docks and harbour accommodation, and of its bracing air, it is fast becoming, on the one hand, an exceedingly important trading centre, and, on the other, a favourable health resort. We "hae oor doots" about the important trading centre as well as about the "health resort," for to the ordinary observer a collection of fishermen's huts interspersed with a few not too extravagantly built residences, with a population of under 10,000, most of which cannot afford gas, hardly warrants an expenditure of £22,000 on electric light.

Bethnal Green.—At the last meeting of the Guardians the Infirmary Committee reported as follows: "(*a*) Messrs. Calvert and Co. have declined to approve of the draft contract submitted to them, and have intimated that their tender must be accepted as it stands; (*b*) that if their tender were accepted as it stood, there would be no limit to the amount which could be claimed for extras; (*c*) the committee, under these circumstances, therefore instructed the clerk to inform Messrs. Calvert and Co. that unless they heard from them to the effect that the firm were prepared to do the work in accordance with the specifications prepared by Messrs. Owen Lucas and Pyke, without any reservation whatever, the committee would recommend the Board to provisionally accept the next lowest tender. The committee were informed by Mr. Pyke that all the contractors were informed before sending in their tenders that the maximum horse-power required for driving the machinery could not be included in the specification, because the buildings were not then sufficiently advanced to enable the calculation to be made, hence there is no need for any reservation being included in any tender." The report was adopted.

Hammersmith.—The Vestry have received a letter from Messrs. Hind and Robinson, solicitors, stating that the Vestry are and have been for some time past infringing some patents in respect of an invention for improvements in distributing electricity and apparatus therefor, demanding payment of damages for the past unauthorised use of the invention, and an undertaking to cease to use the same until the license has been obtained from the owner of the patents. A letter has been received from the London County Council stating that they would be prepared to advance the Vestry the sum of £15,500, that part of the loan of £31,000 which is required at once for the electric light extensions, the repayment to be spread over a period of 42 years and to bear interest at the rate of £3 per cent. per annum, also stating that as the Vestry has elected to spread the whole of the initial cost of the proposed additions and extensions over 42 years, the Council would decline to give its sanction to any loan to replace any of the plant or machinery during the currency of the loan, but would expect the renewals and replacements required to be provided out of a sinking fund or maintenance account. The committee recommend the Vestry to close with the offer on these terms.

St. James, Westminster.—At a meeting of the Vestry held yesterday, a deputation of ratepayers attended to further the application of the National Telephone Company for permission to lay their wires underground. [The telephone question seems to be getting into a stage resembling that of two drivers and their passengers; while the drivers do the quarrelling the passengers are suffering. One authority won't permit the company to erect wires overhead; another refuses to allow the laying of the same underground. In the meantime the would-be subscriber has an opportunity to practice expressive and variegated language, which will come in useful later on after he has been finally put in possession of the instrument and tries to find out what it is talking about.] The St. James's and Pall Mall Electric Light Company, Limited, have written to the Vestry stating, with reference to the company's charges for the supply of electricity in the parish, that they regret that they are not in a position at the moment to reopen the question, but are prepared to give the views of the Vestry full consideration in arranging their charges for the ensuing year, and suggesting that the views of the Vestry would be met by bringing the question in a friendly way before the Board of Trade, with a request that the Board should see a representative of the Vestry and the company and advise generally.

Warwick.—An extraordinary meeting of the shareholders of the Warwick and Leamington Tramways and Omnibus Company was held on Friday last for the purpose of considering a proposal for the transfer of the undertaking to the British Electric Traction Company, Limited. The provisional agreement provides that the company and the British Electric Traction Company, Limited, shall use their best endeavours to obtain from the local authorities of Leamington and Warwick and from Parliament a postponement for a period of at least 21 years of the right of such local authorities to purchase the undertaking, and also their consent to the necessary reconstruction and equipment thereof for working it by means of electrical energy. Upon such authority for extension of the undertaking by means of electrical traction being obtained, the British Electric Traction Company are to purchase the shares of the tramway company at the price of £10 per share, and give the shareholders the option of receiving this amount per

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share in cash or in £5 per cent. cumulative preference shares at par of the tramway company or of any companies which may be formed to acquire the shares of the undertaking of the tramway company, and also to discharge or provide for the existing mortgages of the company. A resolution confirming the provisional agreement was carried. The Chairman said the British Electric Traction Company proposed to work the line by means of the overhead system.

The Midlands.—It would appear, says the *Birmingham Daily Post*, that the British Electric Traction Company have the option of taking over the whole of the leases of the South Staffordshire tramways companies with a view to the adoption of electric traction on that section of the lines at present worked by steam. The company has undertaken as part of such agreement to introduce into Parliament next session a Bill to confirm the leases, and to give powers to the lessee to reconstruct and adopt to electric traction the whole of the tramways. They proposed to unite the whole of the tramways of South Staffordshire with other companies in the neighbouring districts. The scheme is a comprehensive one, and includes the tramways of the Dudley and the Stourbridge Company, the Wolverhampton Companies, the light railways of Kinver, Kingswinford, and Cradley. The statement that the Board of Trade have conceded the application of the company to reconstruct the tramways is hardly likely to be correct, although it is possible that the Board of Trade have given some kind of qualified consent, provided the local authorities are contented with the scheme. This is not so, however, as there was a meeting of local authorities held at Wednesbury on Wednesday, already referred to by us, when a resolution was unanimously adopted in favour of the local authorities taking steps to purchase the tramway lines within their respective districts, and also to oppose the application of the British Electric Traction Company for a Bill to confirm the leases of the tramways to that company.

Worksop.—At the fortnightly meeting of the Urban District Council the General Power Distributing Company's Bill was further discussed, the Clerk stating that there were improvements since they last had the matter before them, the most important of which was the introduction of a clause taking away the monopoly which the original Bill would have created had it been passed. A clause had also been inserted protecting the local authority, and according to Clause 44 a street authority might give notice of their intention to break up the streets and do the work instead of the company. A large number of clauses had been inserted for the protection of various persons, and the East Retford Rural District Council had succeeded in obtaining the insertion of a very important one for their own benefit, to the effect that in the event of any injury being done to the roads or pipes through the Council repairing existing sewers, or through the steam-roller passing over the roads, the Council should not be liable to the company. A clause had also been inserted on behalf of the Duke of Newcastle, to the effect that the company should not enter upon or construct any works on roads, streets, plantations, paths, or elsewhere on his Grace's property without his consent. The Notts County Council, too, had procured a clause requiring their sanction before their roads were interfered with. The proposal that all should bear an equal proportion of the charges, irrespective of their distance from the generating station, was discussed, and in the end the further consideration of the matter was adjourned to a special meeting of the Council.

Shoreditch.—At the meeting of the Guardians it was reported that the House Committee, having considered the best means of lighting the workhouse, were of opinion that electric light was indisputably preferable, as the advantages of the light could be secured without increased cost, and the Vestry had intimated their willingness to supply current at the same charge as to other public buildings—viz., an all-round rate of 3½d. per unit. The committee recommended that the Vestry be requested to instruct their engineer to prepare electrical specifications for the installation of electric light throughout the infirmary, workhouse, dispensary, casual wards, and relief offices. On receipt of the specifications, the House Committee asked that they be empowered to obtain tenders for the work and lay them before the Board. Mr. Loder took it for granted that the Guardians were not binding themselves in any way to have a specification. He quite agreed that electric light was necessary for health in the infirmary, but he could not agree to spend from £1,000 to £1,500 in fixtures before the Board had decided to have the light through the whole establishment. It was all very well to say that electric light at 3½d. per unit was as cheap as gas, but it was nothing near as cheap; beyond the expense of fitting it would cost one-fourth as much again as gas. Mr. Winkler stigmatised the discussion as a lot of claptrap and gas. The present recommendation was simply to get estimates of the whole work proposed to be done, so that the Guardians could see how much they were going to pay. The recommendations of the committee were unanimously agreed to.

Newcastle.—Referring to the Midlands tramways scheme, dealt with by us in another note, the *Newcastle Daily Chronicle* advocates a similar arrangement for the Gateshead tramways, and says: "Quite as striking an instance of the populous industrial district as that of South Staffordshire may be found within a radius of 10 miles from Newcastle on-Tyne. Here, with a population of more half a million, there is a total length of tramway equal to barely 30 miles, or one mile for over 16,000 inhabitants. In addition to this, however, the discrepancy of gauge is even more ludicrous than is seen to be the case in the South Staffordshire district, for the Newcastle, Gateshead, and Sunderland tramways are all on the standard gauge of 4ft. 8½in., whilst the South Shields lines are of 3ft. 6in. gauge, and the North Shields (with the proposed extensions) only 3ft. Intercommunication by means of tramways between all these places is most desirable and necessary, but it cannot be effected if each local authority operates the tramways in its particular district, for obviously the smaller towns will not consent—if they can help it—to bear the expense of changing the gauge in their areas for the convenience and accommodation of the larger towns, nor yet can the intervening links of line in the county or rural authorities' districts be made by any of the urban or town authorities. The Gateshead Tramway Company has now succeeded in making an arrangement whereby, after wisely writing off the greater part of the original capital as lost beyond recovery, the additional new capital necessary for completely remodelling and extending the lines, and for their equipment for electric traction, will be provided by responsible interests, who have sufficient confidence in the prospects of electrical working under fair conditions to risk their money in the enterprise."

Telegraph Manufacturing Company, Limited.—This Company has been formed to acquire and develop the well-known business of the Telegraph Manufacturing Company, Limited (incorporated in 1886), manufacturers of insulated cables and wires as used for electric lighting, transmission of power, telephonic, telegraphic, and other purposes, telephone exchange materials and other electrical apparatus, whose works are situate at Helsby, Cheshire, and Liverpool, with branch offices at London, Manchester, Glasgow, Belfast, and elsewhere. The business was formed in 1886, and has been carried on with great success. It has increased so rapidly of late years that the work offered cannot be carried out without additional capital, which will be provided by the present issue. The principal manufactures of the Company consist of electric cables and wires as used for town lighting, electric tramways, etc., telegraph and telephone cables, house wiring, complete telephone exchange equipments, railway and telegraph instruments, electric batteries, and line construction materials, for all of which there is a large and increasing demand. Amongst the principal customers of the Company are the Government and numerous important corporations in the United Kingdom and abroad, as well as the chief railways of Great Britain and Ireland, the Eastern Telegraph Company, the National Telephone Company, Limited, and the principal electric light companies, manufacturers, and contractors. For the purpose of extending the above company the new company will issue out of its capital of £200,000, equally divided in 5 per cent. cumulative preference and in ordinary shares at £5 each, 13,400 preference shares and 13,400 ordinary shares. The vendor company (the Telegraph Manufacturing Company, Limited, incorporated in 1886) and its nominees take 6,600 preference shares and 6,600 ordinary shares in part payment of the purchase-money, that being the largest proportion of shares allowed to be taken by the rules of the Stock Exchange. The subscription lists will open on the 25th inst. and close on or before the 27th.

Cardiff.—At a meeting of the Cardiff Corporation Electric Lighting Committee last week tenders were presented for one 300-kw. steam alternator and two steam-boilers. We are indebted to the *Western Mail* for the following report: "Mr. N. Appelbee, the electrical engineer, reported upon the merits of the various tenders. He did not consider that the work should be entrusted to Messrs. Ferranti, as a machine constructed by them, which they had contracted to supply in five months, was now, after the lapse of two years and three months, still in such a state that he had not finally accepted it. He recommended that the alternator should be obtained from Messrs. Easton, Anderson, and Goolden, which complied with the specification on all important points, and which the makers guaranteed would stand being overloaded 50 per cent. for two hours. Messrs. Ferranti offered a duplicate of the plant still unpassed and now at the Corporation works. Mr. Hallett characterised the recommended firm as being experimental makers of such plant as was required, and stated that they had never constructed such a large alternator, and he condemned certain details in construction. On the other hand, he described Messrs. Ferranti's machine as the finest ever constructed of that particular kind. Replying to Mr. Fox, Mr. Appelbee (the engineer) stated that the machine which they had of that firm was still being experimented with, and referred to a recent trial as being extremely unsatisfactory. After a very considerable discussion it was decided, upon the motion of Mr. W. Evans, seconded by Alderman Sanders, that the matter should be deferred until further information respecting the experiences of other towns with the machines of the two firms named could be obtained. Mr. Fox gave notice of his intention to press for the imposition of the full penalties against Messrs. Ferranti for non-compliance with their present contract. The tenders for boilers were considered, and, upon the recommendation of the engineer, that of Messrs. Babcock and Wilcox was accepted. The boilers were of the water-tube type, and the cost £1,520. Mr. Hallett did not vote, as he had objected to types being adopted at their present station other than the 'marine,' which were at present in use there, and gave satisfaction. His reason was that the multiplication of types caused confusion and increase in labour. Mr. Appelbee stated that the boilers now in use were not so economical, and did not give anything like satisfaction. During the meeting Mr. Hallett said that he held no brief for Ferranti, but he could not support the electrical engineer. He only wished to give the ratepayers the benefit of his knowledge and to obtain the best plant possible. Mr. Fox considered they were placing their official in an invidious position, and ridiculed the idea of wasting time in seeking information about Ferranti's engines in other parts when they had their own experience."

Dudley.—On the 14th inst., at the Board of Trade offices, Whitehall, Sir T. Courtenay Boyle, secretary to that Board, who was accompanied by Mr. Hopwood, C.B. (secretary of the Railway

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Department), Sir Francis Marindin, Sir Thomas Blomefield, Mr. A. T. Thring, and Mr. H. A. Steward (secretary to the Light Railway Commissioners) held an enquiry in regard to the objections raised by the Dudley Town Council to the confirmation of the order made by the Light Railway Commissioners authorising the construction of certain lines by the British Electric Traction Company. Mr. Freeman, Q.C., appeared for the Corporation, and among those present were the Mayor of Dudley (Mr. G. H. Dunn), Alderman Claughton, Councillors Hooper and Haynes, Mr. Warmington, town clerk; Mr. Gamage, borough surveyor; and Mr. Wilson, consulting engineer; Mr. Bassano, chairman of Rowley Regis Urban Council; and Mr. Cooksey, solicitor to that authority; Mr. Chambers, chairman; and Mr. James, solicitor to the Kingswinford Urban Council; Mr. Waldron, solicitor and clerk to the Brierley Hill Urban Council; Mr. Rowland Moore, solicitor to the Amphlet Urban Council; and Mr. Thorneycroft, on behalf of the Quarry Bank Urban Council. The company was represented by Mr. Morse, solicitor; Mr. Garcke, managing director; Mr. Sellon, engineer; and Mr. J. N. Lycell, its superintendent for the Birmingham district. Mr. Freeman, Q.C., opened the case on behalf of the Corporation of Dudley. While Mr. Morse was replying, Sir Courtenay Boyle interposed, and said a written suggestion of a possible arrangement had been handed to him, and he thought the suggestion was one that should be considered by both sides. Representatives of the Corporation and the company held a private consultation for a few minutes, and after further conversation in the presence of Sir Courtenay Boyle, they returned, and Mr. Freeman announced that, on behalf of the Corporation of Dudley, he consented to the order being confirmed, adding that certain terms would be agreed between Mr. Morse and himself respecting some minor points, with which he would not trouble the officials of the Board of Trade. The clauses of the order were then gone through, and some questions of detail decided. The Board of Trade insisted upon the insertion of a clause stipulating that no tramway rail shall be laid within 9ft. 6in. of the kerb, unless with the sanction of the Department, and Sir Courtenay Boyle suspended decision in regard to clauses in which the usual wording of provisions as to opening roads and disturbing gas and water mains had been varied by the Commissioners. The terms of the arrangement between the parties were not mentioned before the enquiry closed, but we have authority for stating that the basis of the compromise was that the company shall construct and work the tramways, and that the Corporation shall have power to purchase the undertaking after a certain period upon terms to be embodied in an agreement.

London County Council.—At the usual weekly meeting of the Council on Tuesday it was agreed to lend the Hackney Vestry £2,190 for electric lighting and other works, and the Hampstead Vestry £39,980 for electric lighting. The report of the committee on the last-named Vestry's application is as follows: "We have considered an application from the Vestry of Hampstead for the further loan of £51,500 for buildings and additional electric lighting plant at their station in Lithos-road, repayable by annual instalments in 42 years. The Vestry have furnished a statement showing that the present loan is required to provide for £10,162 for buildings and £41,451 for machinery, mains, transformers, etc., making a total of £51,613. The architect of the Council reports that the amount included for buildings in the present loan is reasonable and covers the balance to be borrowed in respect of that expenditure up to Lady Day, 1898. The engineer reports that the time at his disposal has not been sufficient to enable him to examine properly the details of the proposed engineering works, and he suggests that an advance of £30,000 be made on account pending further enquiry. The sum of £162. 19s. 3d. has been included in the loan for the cost of office furniture and fittings, which we think it is undesirable to include in a loan having 42 years to run, and we have therefore deleted that amount, and propose that the present loan should be restricted to £39,980, and accordingly recommend (*a*) that, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Hampstead, for a loan of £51,500, towards defraying the cost of buildings and additions to the existing plant at the Lithos-road generating station, be granted at present to the extent of £39,980, on condition that the loan be taken up as soon as the Council is in a position to make the advance, interest being charged thereon at the rate of £3 per cent. per annum, payable quarterly on Jan. 31, April 30, July 31, and Oct. 31 in each year, and the principal being repaid by equal annual instalments on each July 31, within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund. (*b*) That it be notified to the Vestry of Hampstead that as they have elected to spread the repayment of the whole of the initial cost of the proposed additions and extensions of the electric light installation over 42 years, the Council will decline to give its sanction to the raising of any loan to replace any of the plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all replacements and renewals required during that period out of a sinking fund to be provided for that purpose, or from maintenance account." The committee reported on the revocation of the Southwark order as follows: "The Council on Feb. 15 last disapproved certain works proposed to be carried out by the County of London and Brush Provincial Electric Lighting Company under its Southwark Order, 1892. The Council took that course in consequence of the Vestry of St. George-the-Martyr, Southwark, having stated that it refused sanction to the works, and had applied to the Board of Trade for the revocation of the order, having regard to the default of the company in not having complied with the requirements of the order, which was granted five years ago, that the mains within a certain defined area should be laid within a specified time. The Vestry further stated that it had under consideration the question whether it should itself undertake the supply of electric current in the parish. The company subsequently served a fresh notice (registered No. 1,201) of intention to execute the works referred to, and the Council, for the reason above stated, again disapproved them. The company appealed to the Board of Trade against the decision of the Council and of the local authority, and the appeal was heard before Major Cardew at the offices of the Board on June 27. The Board expressed a desire to hear any representations which the Council might wish to make with regard to the matter, and, at our request, our chairman (Mr. Benn) and Mr. Thornton attended, and supported the views of the local authority. The Board gave its award on July 11, allowing the appeal and approving the works subject to the following conditions: '(1) that the undertakers give a written undertaking to the Board of Trade that they will at once commence and diligently proceed with the execution of the said works, and that if within 18 months from the date of this order the undertakers are unable to give a supply of energy in the parish of St. George-the-Martyr, Southwark, from any generating station belonging to them and existing at the expiration of the said period of 18 months, they will at once proceed to erect within the said parish or within some adjoining district a generating station from which a proper and sufficient supply of energy in the said parish can be given; (2) that the undertakers without delay furnish the local authority with a correct plan of the said works, together with details of the size and situation of the proposed transformer chambers and street boxes; (3) that this order shall not be held to fix the exact position of any transformer chamber, but that in case of any difference arising between the local authority or the County Council and the undertakers with regard to the position of any transformer chamber the matter shall be determined by an inspecting officer appointed for that purpose by the Board of Trade.' It will thus be seen that safeguarding conditions of considerable importance have been secured through the action taken by the Council and the Vestry of St. George-the-Martyr in the matter." The Council have issued a circular letter to the London local authorities stating that they have had under consideration a letter from the Strand District Board of Works, calling attention to the necessity, in the public interest, for regulating the methods of advertising by the electric light and other similar devices, and asking the Council whether they cannot, by a clause in their General Powers Bill or otherwise, obtain the prohibition of advertising by means of "search" or "flash" lights thrown on the public highways; and asking to be informed whether the Boards addressed know of any "search" or "flash" light advertisements in their districts, and whether they consider it desirable that some by-law should be made for the regulation generally of such advertisement.

PROVISIONAL PATENTS, 1898.

JULY 11.

15155. An improved method in the production of white lead by the electric arc and the introduction of compounds during volatilisation of the lead in a closed chamber. Ernest Bailey and Walter Thomas Hey, 4, Low Ousegate, York.

15203. Improvements in arrangements for exciting the magnets of dynamo machines. Max Déri, Birkbeck Bank-chambers, London. (Complete specification.)

15208. Improvements in electric heaters. Edward Ethel Gold, 55, Chancery-lane, London.

15222. Improvements in electric accumulators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John Burns, France.) (Complete specification.)

JULY 12.

15235. Improvements in electrical time switches. Arthur John Wheatley, 8, High-street, Harborne, near Birmingham.

15246. Improvements in automatic break or interrupter apparatus for electric currents. Thomas Burton Kinraide, 55, Chancery-lane, London. (Complete specification.)

15285. An electrical generator. Gordon Earl Adams, 75, Chancery-lane, London.

15300. Improvements in electrically-heated rolls for drying paper or fabric and for similar purposes. Fred P. Snow, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15303. An improved method of and apparatus for generating and utilising electricity. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John James Feely, United States). (Complete specification.)

15304. Improvements in and relating to primary batteries for generating electricity. John Bridges Lee, 6, King's Bench-walk, Temple, London.

15346. Improvements in secondary batteries or electric accumulators. John Irving Courtenay, 47, Lincoln's-inn-fields, London. (Camille Alphonse Faure, France.)

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15347. Improvements in electric switches. John George Dixon, 70, Palace-chambers, Westminster, London. (Complete specification.)

15349. Improvements in and relating to moulds for casting electrodes. E. Franke, 18, Southampton-buildings, London.

JULY 13.

15359. Improvements in electric arc lamps. William Ernest Burnand, 31, Edge Hill-road, Netheredge, Sheffield.

15388 Improvements in dynamos to be applied to cycles and other vehicles. James Moores and Henry Oliver Farrell, 4, St. Ann's-square, Manchester.

15421. An improved electric lamp shade and terminal combined. Alfred Maurice Day and Henry William Cole, 60, Queen Victoria street, London.

15430. Improved diaphragm for electrolytic apparatus. William Phillips Thompson, 322, High Holborn, London. (Erich Langguth, Germany.) (Complete specification.)

JULY 14.

15443. Improvements in electrical switches. Verity's, Limited, and Louis John Steele, Plume Works, Aston, Birmingham.

15463. Improvements in porous cells or porous division plates for primary batteries, electrolytic cells, and the like. Frederick James Gillibrand, 34, Castle street, Liverpool.

15467. Improvements in electric time switches. Charles Orme Bastian and Alfred Horswill Gibbings, 31, Southampton-buildings, Chancery-lane, London.

15473. Improvements in or relating to electrically-operated station indicators or the like. James Wynes, Lionel Walter Perryman, and John Charles Lloyd, 111, Hatton-garden, London.

15486. Improvements in conduits for electric tramways. Sebastian Ziani de Ferranti, Hollinwood, near Oldham.

15493. Improved electric hippodrome and apparatus for use therewith. Arthur Harry Roper Pulman and George Cuddon, 322, High Holborn, London.

15496. Improvements in or relating to electrical time switches. Tom Bousquet Browne and Francis Leigh Martineau, 165, Queen Victoria-street, London.

15498. Improvements in and relating to wireless telephony. Thomas Tommasina, 45, Southampton-buildings, London.

JULY 15.

15509. Improvements in electric clocks. Harry Whidbourne and Alfred Ernest Joseph Ball, West Hooe, near Plymouth.

15548. Improvements in electrical tumbler switches. Richard George Evered, 7, Staple-inn, London.

15573. An improved process for the manufacture of metal paper by electro-metallurgy. Isidor Landauer, 11, Southampton-buildings, London.

JULY 16.

15613. Improvements in electric and other pressure motors. Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

15646. Electrically-operated cloth cutters. Nicholas Garland, 4, South-street, Finsbury, London. (Complete specification.)

15647. Improvements in electrically-ignited fuses for blasting purposes. Heinrich Bettermann, 18, Buckingham-street, Strand, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

15168. Method of measuring electrical power and appliances for that purpose. Field.

15721. Electric arc lamps. Haddan. (The Patent Verwerthungs Gesellschaft.)

16339. Dynamo-electric machines. Cheffey-James and Ward.

17528. Springjacks for telephone switchboards. Kingsbury. (The Western Electric Company.)

18235. Arc lamps. Jones, Chaplin, and Jevons.

18438. Coil for electric instruments. Baron Kelvin.

18801. Electric switches. Lloyd and Newitt.

19307. Electric arc lamps. Worsley.

19714. Electric traction. Bede.

1898.

5186. Secondary batteries. Haddan. (Dolter.)

6704. Switchboards for the control of high-voltage electric circuits and apparatus. Parshall.

7384. System of lever drawbridges with overhead conductors for electric railways. Clements. (Union Electricitäts Gesellschaft.)

8999. Application of "X" rays. Wagg.

10615. Automatic apparatus for receiving the charges for telephone conversations and telegrams. Ericsson and Ritter.

10868. Morse telegraph apparatus. Siemens Bros. and Co., Limited. (Tribelhorn.)

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended July 17 were £1,691, as compared with £1,506 in same week of 1897, being an increase of £185.

Birmingham Tramways.—The traffic receipts for the week ending July 16 were £3,977. 14s. 6d., as compared with £3 793. 11s. 10d. for same week in 1897. being an increase of £184. 2s. 8d.

Dover Tramways.—The traffic receipts for the week ending July 16 were £226. 0s. 7d. The total receipts for the year 1898 are £3,630. 18s. 6d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending July 16 were £3,126. 1s. 1d., compared with £2,804. 8s. 9d. for same period of last year, being an increase of £321. 12s. 4d.

South Staffordshire Tramways.—The traffic returns for the week ending July 15 were £667. 7s. 3d., as compared with £704. 1s. 1d. in same week of 1897. The aggregate receipts for the year are £17,117 11s. 11d., as against £17,381. 12s. 0d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended July 17 were £929, compared with £844 for same week of 1897, being an increase of £83. The total receipts for the half-year amount to £2,828, compared with £2,777 for the same period last year, being an increase of £51.

Dublin S.D. Tramways.—The traffic receipts for the week ending July 15 were £1,077. 4s. 8d., as compared with £918. 16s. 9d. in the corresponding week in the previous year, being an increase of £158. 8s. 1d. The number of passengers carried was 153,625 in 1898 and 126 550 in 1897. The aggregate returns for the half-year are £1 997. 1s. 3d., as compared with £1,735. 19s. 9d. last year, being an increase of £261. 1s. 6d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	10½ xd
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p.c. Cm.Pf.,30,001-40,000 (iss.at £2. 10s. pm.,all pd.)	7	10½-11
Brush Company, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2¼-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10½-11⅛
Central London Railway, Ordinary	10	9⅜-10¼
——	6	5¾ 6¼
—— Pref. Half-Shares	1	1½-1⅝
—— " "	5	4¼-4½
Charing Cross and Strand	5	12½-13½
—— 4½ per cent. Cum. Pref.	5	5¾-6¼
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	26-27 xd
—— Prov. Cert. 90,001-100,000	5	26-27 xd
—— 6 per cent. Cumulative Pref.	10	16½-17½ xd
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-71
—— Ordinary	3	3⅜-3½
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15-16
—— " " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13½-14½
—— " " "	6	9½-10¼
—— 6 per cent. Cum. Pref.	10	14½-15½ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	128-130
—— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	5	2½-2⅝
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Elmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	3½-4½ xd
Electric Construction, Limited	2	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	2½-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107 xd
Elmore's Copper Depositing	1	⅛ ¼
Elmore's Wire Company	2	¼-⅜
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9½-10½
—— 7 per cent. Preference	5	9½-10½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½ xd
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	15-16 xd
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	4-4½
Metropolitan Electric Supply, Limited, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5⅜-5⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Notting Hill Company	10	16½-17½ xd
Oriental, Limited, £1 shares	1	1½-1⅝
—— £5 Shares	5	7½ 7⅞
—— £4½ shares	4½	6-6½
Oriental Telephone and Electric Company	1½	⅜-½
Royal Electrical Company of Montreal	—	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	2	2⅜-3½
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	103-108
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	116-121
Westminster Electric Supply, Ordinary	5	15½-16½
Yorkshire House-to-House	5	8⅜-8⅝ xd

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NOTES.

More Szczepanik.—*Dingler's Polytechnisches Journal* has a detailed description and diagrams of the Fernscher, but says that sufficient details have not been made known and that the instrument is not at all ripe for practical use.

Crystal Palace School of Engineering.—We are invited to attend the ceremony of the awarding of certificates for the summer term of the above school. The several departments of the school, situated at the base of the south tower, will be open for inspection on Thursday, Aug. 4. Mr. George Byland Roche, M.I.C.E., the consulting engineer to the London, Chatham, and Dover Railway Company, will take the chair in the lecture theatre of the school at 12 noon precisely, and will distribute the certificates to the successful students.

Chiswick.—The electric lighting question has created a little stir on the Council lately. The provisional order was transferred to Messrs. Bourne and Grant some years ago, and the work has not been completed. The company allege that the Council are responsible for the delay, as they had stopped the works. A side issue, alleging bribery, or, rather, the want of it, as the cause of delay, has created the stir, and some solicitors are to be instructed to look into the matter, although there are only rumours to be looked into. The Urban District Council are also trying to get the order back by arbitration.

The American Association for the Advancement of Science.—The annual meeting of the American Association for the Advancement of Science will be held this year in Boston from Aug. 22 to Aug. 27. The council will meet on Saturday, Aug. 20, at the Rogers Building of the Massachusetts Institute of Technology, and the meetings of the various sections of the association will be held in the immediate vicinity. Many foreign scientists have been invited, and foreign educational institutions are asked to send delegates to the meetings. A number of affiliated societies will meet in Boston during the same week. The headquarters of the council will be at the Copley-square Hotel.

Transhipment Saved.—We are interested to note that at the recent meeting of the Canadian Electrical Association serious attention was drawn to a plan for the standardisation of farm wagons in such a way that they could be taken aboard bodily by trolley trucks and then hauled to and from market. At first blush this looks like a rather wild project, but we confess we can see no good reason why some such plan should not be carried out in every rural region now tapped by a trolley service. The lessening of the cost for haulage and of loss from spoilage of produce would be enormous; the trolley would open up new country and a new source of income; the rates could be so low as to encourage the development of new lines of cultivation, and the ties between town and country would be closer knit than ever. These things will come, and must come soon, with electricity as the prime factor in their coming.

Continental Town-Lighting.—The city of Mannheim, an important commercial and industrial centre on the Rhine and Neckar, and which possesses the largest inland harbour in Europe, is to be lit by electricity. The firm of Brown, Boveri, and Co., of Baden and Frankfort, has obtained the contract for the installation and the working of the plant as well. The city finds the capital (£165,000). The charges per kilowatt-hour are fixed as follows for motors, heating, and chemical purposes: 1⅞d. for the town and 1½d. for the harbour district, for street-lighting 3d. (providing more than 1,500 units are used). The city is to receive out of the net profits 70 per cent. if under £5,000, 80 per cent. out of the second 5 per cent., and 90 per cent. out of all sums over £10,000. For cost of administration 15 per cent. is to be allowed on the first £5,000 of the annual expenditure, 10 per cent. on sums between £5,000 and £10,000, and 5 per cent. on any sum over the latter amount.

Wireless Messages in Use.—The proprietors of the Dublin *Daily Express* and *Evening Mail* brought off last week most successfully a series of experiments in wireless telegraphy as applied to practical journalism. Signor Marconi himself went over to Dublin to conduct the trial, which consisted in the transmission of descriptions of the yacht races sailed under the rules of the Royal Alfred Yacht Club regatta. The wireless messages were sent from distances varying from five to ten miles, and were published in successive editions of the *Evening Mail*. Not a hitch occurred, the instruments working splendidly, and not a single message had to be repeated. Signor Marconi was himself the operator in the cabin of the *Daily Express* steam-tug "The Flying Huntress," and the messages were received by his chief assistant, Mr. Kemp, at the land station in Kingstown. Thence they were telephoned to the offices of the *Express* and *Evening Mail* on a wire specially erected by the Telephone Company, who, with representatives of telegraph and cable companies, are following the experiments with marked attention and interest.

Charges for Power.—The great reduction made in the price charged for electricity for power purposes has been repeatedly noted in our columns. By reducing these charges both corporations and companies have improved the earning capacity of their electric plant and also have secured larger profit. We regret to see from the following letter that at Walsall the Irishman's rise has been adopted, and the price raised instead of lowered. The letter from Messrs. J. and W. Griffin, the proprietors of the *Walsall Observer*, is as follows: "We have gone in for electricity as our motive power for printing our weekly newspaper, but with rather bad results from a pecuniary point of view. We applied to the Corporation for their charges for electric current, and were informed that it would be 4d. per unit, but some months after we had laid down our motor, shafting, etc., we received a notice from the Corporation stating that the committee had reconsidered the matter, and had decided upon a charge of 6d. per unit, subject to a rebate on a large consumption, which we, only publishing once a week, cannot hope to reach." The course pursued by the Walsall Corporation is a futile one and will prevent motors from being used on their mains, as either a gas or steam engine is a cheaper source of power than a motor supplied at 6d. per unit.

High-Voltage Lamps.—Mr. John W. Howell's paper read at the general meeting of the American Institute of Electrical Engineers at Omaha does not add much to the facts as regards the use of high-voltage incandescent lamps. Some useful comparisons are made by the author, who has referred somewhat largely to Mr. G. B. Byng's paper on the same subject. Mr. Howell visited several stations using 220-volt lamps, and found that they were reported to be almost universally satisfactory. They were very long-lived—in fact, too long-lived, for better service would be rendered if the lamps were renewed when they began to get dull, and not allowed to remain in service after they ceased to give a first-class light. Four W.P.C. 220-volt lamps may be used for 600 hours and still give a good light, but the author thinks this is about the limit of their useful life. If not taken in they will keep on burning for a long time, and will give an average life of over double than figure before breaking. The reports concerning

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exploding were equally satisfactory. For the past year or more exploding lamps had been practically unknown; previous to that time, however, this had been one of the most serious objections to the system. All these plants have been installed with switches, cut-outs, and other appliances made for 110-volt installations, and it is remarkable how little trouble has been caused by them.

General Power Distribution Bill.—Referring to this Bill, Sir Frederick Bramwell has written a long letter to the *Times*. In it he recalls the disastrous effects of the 1882 Electric Lighting Act in hampering the industry by its stringent repurchase clause. Coming to the above Bill, he points out that the "Lords' committee passed it and all clauses unanimously. There is no purchase clause in the Bill at all. It has now to be considered by the House of Commons. It has been read a first time, and the second reading is likely to take place on Friday, or on some other very early date. The sole opponents are certain municipalities. These are using every effort to obtain the rejection of the Bill on the second reading, or failing this, they seek that an 'instruction' should be given to the committee that would be appointed to consider the Bill. That is to say, they invite the House of Commons to reject a Bill which is the outcome of the principles approved by the recent joint committee, embracing certain of its own members, without hearing (through its committee) any evidence at all; or, failing that, they ask that the judgment of the committee which would hear the evidence shall be fettered by the 'instruction' of the House that has not heard the evidence. In short, by every means in their power they hope to render the report of the joint committee a dead letter, and to continue to uphold the mischievous system of municipal trading."

A Substance Lighter than Hydrogen.—The *Times* reports a scientific discovery of great interest as announced from Italy. Prof. Nasini, of Padua, has communicated to the French Academy the result of his investigations with Signori Anderlini and Salvadori into the gases issuing from the earth in volcanic districts, among which they find coronium, hitherto known hypothetically only as a constituent of the sun. The announcement is, in the opinion of the discoverers, of the highest interest from a scientific point of view, as at once confirming the results of spectroscopic examination of the sun and adding another proof of the substantial identity of materials in the sun and the earth. Coronium would seem (says the *Times*) to be a substance with a vapour density far smaller than that of hydrogen, which is by far the lightest body with which we are familiar. Some have suggested that it is only one of the elements known to us, modified in some unknown way by conditions differing enormously from those that obtain on this planet. But against this hypothesis has to be set not only its occurrence at a distance from the sun's body, estimated at 300,000 miles, where it is difficult to believe that the vapours of the suggested elements can predominate, but also the fact that in the midst of solar disturbances in prominences or near sun spots, when the lines of hydrogen and other known elements are contorted, this coronal line remains sharp, fine, and straight.

The Bermondsey Provisional Order.—The Select Committee of the House of Commons presided over by Sir A. F. Godson, last week resumed the consideration of the Bill to confirm provisional orders granted by the Board of Trade to the local authorities of St. Marylebone and Bermondsey to enable them to set up undertakings for the supply of electrical energy in competition with the companies at present serving their respective districts. As will be remembered, the committee at its previous sitting had refused to confirm the provisional order granted to the Vestry of Marylebone, and had suggested the postponement of the order relating to Bermondsey, so that the Vestry might consider the advisability of acquiring the undertaking of the London Electric Corporation now supplying the district. It was agreed to insert a clause in the Bermondsey order by which the Vestry would only be able to exercise the powers conferred upon them after acquiring by purchase the mains and works already laid down by the company, the terms to be fixed by arbitration, and the company's powers of supply to altogether cease on the completion of the purchase. This, it was contended, would give full value to the company for the undertaking, and enable the Vestry to proceed with their scheme, which they were very desirous of doing, so as to meet the growing needs of the district. The Chairman announced that the committee had decided to confirm the provisional order in the case of Bermondsey, with the addition of the clause referred to.

An Electric Feast.—The Canadian Electrical Association held its meeting at Montreal this year. The annual dinner took place at the Windsor Hotel in that city, President Yule being in the chair. The dinner was a great success. The cover of the programme had the association's monogram and maple leaf in gold, and the covers with menu and toast list were held together by covered copper wire. The menu was as follows :

Long-Distance Transmission.
Fire Island Cocktail—50,000 volts.
Internal Resistance.
Cucumbers Radishes
Tomatoes, strain Insulators. Olives tripled Braided.
Electric Juice,
Green Turtle, a la Water Rheostat,
Cream of Asparagus, a la Ozone.
Submarine.
Saguenay Salmon, a la Hello. Potatoes, Rachel.
Shunts.
Spring Lamb Cotelettes, Sweet Breads,
Carbon Trimmed,
Asparagus—"Arrester" Points.
Joints—"Soldered and Taped." Fillets of Beef, Larded.
Relays and Sounders. String Beans.
Boiled New Potatoes, Anchors,
Cauliflower, Asparagus, Sweet Peas.
Trolley off. Punch au Champagne.
Reconstruction.
Roast Philadelphia Capon, Plants, Lettuce and Tomato Salad.
Boosters.
Cabinet Pudding "sound proof."
Gelee aux Oranges, "insulating compound."
Savarin aux Ananas, "vacuum light,"
Vanilla Ice-Cream, "self-cooler."
Sponge Cakes, "Leather Belting."
Dessert.
Fruits, "potential currents." Nuts and "wrenches."
Electric Heater, Incandescence.
Café Noir, Cigars.
Transfer. Ring off. Open Circuit. "30."

Turret-Turning.—The armoured cruiser "Brooklyn" bore a large part of the sea fight outside Santiago, and this gave a good opportunity for testing her turret-turning gear. On this vessel the forward and starboard turrets are turned by electricity, the port and after turrets by steam. The steam turning engines are double vertical engines, with cylinders 8in. in diameter and a stroke of 7in. They are capable of turning the turret at the rate of one revolution per minute, with the guns run out and the vessel heeled 10deg., with a steam pressure of 100lb. per square inch. At a recent trial, says the *Scientific American*, the steam gear worked slightly better than the electric gear, but the result of the rivalry between the steam-turned turrets and electrically-turned turrets has no doubt been beneficial, as the present steam gear is believed to work much better than any steam turning gear that has been used in the service. The steam gear is worked by a lever in the sighting hood; this lever, by appropriate mechanism inside of the ammunition tube, moves a change valve on the engine. The "follow up" gear has been abandoned, and the automatic stop, which is necessary to

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prevent the turret going too far, is provided by cams, which are fastened to the bottom of the revolving turret tube. As the turret nears its extreme position the cams are brought to against a fixed arm connected to the valve gear. These cams close the valve gradually, and the turret will stop at the right point regardless of the speed of rotation. All the ammunition hoists on this vessel are also electrical.

The X-Rays and Military Surgery.—Prof. Küttner, of Tübingen, who followed the last Greek war in connection with the German Red Cross Society, has, says the *Lancet*, made some interesting experiments with the Röntgen rays at the Constantinople Hospital. In his report, just issued, he says that while the apparatus proved of service when applied with the screen, it was rarely possible to take a satisfactory photograph on account of the difficulty of bringing the patients into the proper position. The former method proved often the only way to ascertain the site of a projectile which had entered the body and had remained there. This was applicable to all parts of the body except the stomach and head. A bullet in the brain, for instance, showed very indistinctly. (Last spring an arrangement of mirrors was exhibited at a soirée of the Royal Institution where a photograph of the brain showed in relief, thus enabling the operator not only to see the foreign body, but also to measure correctly its distance from the outer wall of the cranium.) Prof. Küttner says it is noteworthy that splinters of bullets and of bone which had penetrated into the soft parts of the body could not be distinguished from each other. Also, he says, it was proved that the opinion that deep-lying masses of pus could be located was erroneous. Injuries to the central nervous system, the spinal cord, and the peripheral nerves were solely ascertainable by the aid of the Röntgen rays. It was impossible to do this before. Furthermore, it could be seen whether a bone was totally or only partially severed—a matter of great importance as far as therapeutics are concerned. For shot wounds in the extremities he recommends that a photograph be taken. His conclusion is that the Röntgen rays are of great importance for medical aid in war, but only for fixed hospitals, such as reserve hospitals and those installed in fortresses, while for moving field hospitals their application is very limited.

Dr. Ohm's Modesty.—When a great natural law is discovered, it is as the result of careful thought and prolonged observation. It has never been the result of accident, and has never been given voice to on the spur of the moment. There are only a few great laws underlying the framework of modern science, and from these laws have sprung various ramifications which lead to a thousand and one channels of investigation. It requires a keen instinct, and those powers of observation which only occasionally appear in men, in order that they may follow out some great law or trace through a series of phenomena the influence of some predominant principle. It is somewhat surprising, says the *Electrical Age*, to realise the modesty possessed by those who have immortalised themselves in fields of science, art, and literature. Dr. G. S. Ohm, in his preface to the historical little book giving to the world the discovery and interpretation of the great law bearing his name, wrote as follows: "I herewith present to the public a theory of galvanic electricity as a special part of the electrical science in general, and shall successively, as time, inclination, and means permit, arrange more such portions together into a whole, if this first essay shall in some degree repay the sacrifices it has cost me. The circumstances in which I have hitherto been placed have not been adapted either to encourage me in the pursuit of novelties or to enable me to become acquainted with works relating to the same department of literature throughout its whole extent. I have therefore chosen for my first attempt a portion in which I have the least to apprehend competition. May the well-disposed reader receive the performance with the same love for the object as that with which it is set forth." Dr. Ohm seems to have half believed that his invaluable treatise might not be well received by his *confrères*. We can best judge of that at the present day and marvel at his wonderful simplicity in offering his great work diffidently to the scientific world.

The Telephone Enquiry.—Mr. Gaine, the general manager and solicitor of the National Telephone Company, has given some most straightforward evidence. He said that the early policy of the company had been to open call offices to subscribers free, but as the business increased this policy had to be abandoned. The call offices were found open to great abuse in practice, and there had never been any obligation on the part of the company to maintain them. He was not afraid of competition with equal powers, and would be prepared to surrender the right of giving preferences. He considered the essence of any system must be the subscriber. Call offices were a most useful adjunct, but they were nothing more. He should be very glad to leave that service to the municipalities and leave the subscribers to the company. There was no doubt, Mr. Gaine continued, that not only in this country, but in nearly all others, the telephone system was started on the wrong lines. It ought to have been payment by messages. They had tried this system in Sheffield, giving 1,000 calls for £7, and charging 1d. a call afterwards. There was a meeting of protest in Sheffield, and the company had to drop the scheme. One gentleman told him that he would have to pay £95 a year on the suggested scale. The telephone ought to have been started on that principle, but it was too late to do it now, certainly by the National Company. Mr. Goschen's evidence was even more interesting, and cleared up the vexed question of a secret understanding, as he was Chancellor of the Exchequer in 1892, at the date when the Treasury minute was issued, and when the heads of agreement between the Post Office and the National Telephone Company were signed by Sir James Fergusson. There was not, as far as he could remember, anything in the heads of agreement which limited the entire discretion of the Post Office in setting up competing licenses. The policy of the Treasury minute seemed to him to be distinct, and he did not think it would have been possible for him to lock up the discretion of the Treasury.

The Metropolitan Electric Supply.—On Tuesday a Select Committee of the House of Commons commenced consideration of the Metropolitan Electric Supply Bill, a measure promoted by the Metropolitan Electric Supply Company to enable it to establish a large station for the generation of electricity at Willesden, and to bring the current into the company's area of supply by a conduit laid along the Grand Junction Canal. The St. Giles's District Board of Works and the London County Council opposed the Bill. It was pointed out, on behalf of the promoters, that the Bill really had nothing to do with the districts in which they were authorised to supply, but was merely to enable them to procure a site at Willesden for the purpose of generating electricity. On the other hand, the St. Giles's District Board of Works have at present the absolute right of buying the Sardinia-street generating station. The company supplies the Strand and Holborn districts as well; but the persons who, under the Act, now had the right of purchasing the station, as well as the pipes and mains, were, the opponents said, the St. Giles's District Board. This point was denied by the company's counsel, who maintained that even if the

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Board had the right to purchase, the company, beyond doubt, could do away with the station altogether if it liked. Mr. F. Bailey, M.I.C.E, engineering director of the Metropolitan Electric Supply Company, gave evidence in support of the scheme. Mr. Worsley Taylor, for the London County Council, in addressing the committee, urged the insertion of clauses which would enable the County Council to purchase the undertaking at the expiration of the statutory period, and that the Bill if passed in its present form would render the right of purchase, which the local authorities at present had under the existing provisional orders, absolutely inoperative. The committee decided that the preamble of the Bill was proved after considering the question of purchase, and decided not to impose fresh conditions in regard thereto on the promoters. The Bill was read a third time and passed on Wednesday last.

Dielectric Constants at Low Temperatures.—This abstract of the paper on the "Dielectric Constants of Metallic Oxides Dissolved or Suspended in Ice Cooled to the Temperature of Liquid Air," read by Profs. J. Dewar and John A. Fleming before the Royal Society, appears in the *Journal* of the Chemical Society. The presence of cæsium hydroxide, lithium hydroxide, bismuth oxide, aluminium oxide, finely-divided sulphur, or finely-divided gold in ice was found to make little or no difference in its dielectric power when cooled to the temperature of liquid air. The presence, to about the same extent, of the hydroxides of potassium, sodium, rubidium, or the oxides of copper, iron, or lead, causes a very great increase in the dielectric power of the ice at that low temperature. The dielectric curves are, however, all seen to be tending downwards in such a way as to show that at still lower temperatures it is probable the effect of the oxides or hydroxides would be annulled and the dielectric constants of all be reduced to a value not far from that of pure ice. The exception to this tendency, so far as yet observed, appears to be in the case of the oxide of copper, which, when suspended in ice, causes it to possess the remarkably high dielectric value of 150 even at the temperature of liquid air. It is possible, however, that in this case the conductivity of the yet insulated particles of oxide may account for the result. The effect of the solvent is also exceedingly marked. Oxide of copper suspended in ice has a dielectric value of about 150 at – 185deg., oxide of lead suspended in ice has a value of about 80 at the same temperature. If, however, the oxide of copper is dissolved in ammonia and frozen, the dielectric constant of this at – 185deg. falls to 2·2, whereas if the oxide of lead is dissolved in 5 per cent. solution of potassium hydroxide and frozen, the dielectric constant rises to 170 at the temperature of liquid air. The only general conclusion that can as yet be drawn is that the presence of certain oxides or hydroxides of metals in ice, even to the extent of not many per cent., has an immense influence in raising the dielectric power of the ice when taken at the temperature of liquid air, whereas the presence of other oxides or hydroxides chemically analogous has hardly any influence at all.

Birmingham Telephones.—We understand from the *Birmingham Daily Post* that the telephone system in that town is undergoing an entire reorganisation. The erection of the new exchange in Newhall-street is now completed, and the work of fitting it up is proceeding rapidly. As the connections have to be transferred to the new building, the opportunity has been taken to reconstruct the telephone system of Birmingham and the neighbourhood. The work has now been going on for some time, and the subscribers' lines are being gradually transferred from the old switchroom to the new one. Every effort is being made in order that the service may not be interrupted. Metal returns will be used throughout in the new system. It is also proposed to do away to a great extent with the branch exchanges, and to extend by means of underground wires the lines from the suburbs into the central exchange. It will be some little time before the whole of the scheme is completed, but it is hoped that a great improvement in the service will speedily be made. When the work is finished, Birmingham will have one of the most complete and up-to-date systems in the world. The underground cables are brought along various subways under the building into a main shaft, by which they are conducted into the switchroom, and each cable contains 408 wires. The testroom is another great feature in the new building, and is now nearly completed. Four thousand five hundred wires can here be tested, and the exact position of a fault detected. The room, moreover, is so arranged that the testboard can be enlarged sufficiently for about 10,000 wires. The switchroom is not only admirably designed as regards appearance, but light, lofty, and airy. The switchboard, when completed, will for the present contain 3,600 wires, but it has an ultimate capacity for 6,600 subscribers. One of the principal features of the new system is that, although each operator only has a certain number of subscribers to attend to, every connection is within her easy reach, whereby she is enabled to immediately place the caller in connection with the number required, instead of having to transfer the order to another operator. The huge standard which is to be seen on the top of the new building, and to which a labyrinth of wires is attached, is, it may be stated, only in connection with the subscribers in the immediate vicinity, the wires from all other parts of the city and district being brought into the building by means of the underground cables.

The Losses Between the Station Meter and the Consumer's Meter.—In an attempt to fix a proper rate of payment for electric current the approximate cost per kilowatt-hour at the switchboard being known, it is highly desirable to get some idea of the ratio between the power indicated by the consumers' meters and the corresponding power at the station switchboard. In a paper read recently before the American Institute of Electrical Engineers, Mr. W. F. White points out the astonishing loss of 60 or 70 per cent. in customary practice with alternating-current systems and house-to-house transformers, and attempts to account for it largely by the transformer core losses. There are other causes for a large part of this lamentable discrepancy. Integrating wattmeters with shunt coils are now customarily used for consumers' meters, and although the loss in the shunt winding may seem at first sight very small, amounting to about 10 watts for a 100-volt meter, it must be remembered that this loss is a constant one, and amounts to about one-quarter kilowatt-hour per meter per day. If the meter measures up about one kilowatt-hour per day (this being a fair average load in private house and small store service), there is a loss right here of 20 per cent. The meter is, says the *Electrical World*, also responsible for part of this discrepancy in another way. Every service must be provided with a meter of sufficient size to carry the maximum load. In residence lighting this load may occur once or twice per year at the time of some special festivity. The daily peak of a meter-load curve may rise to one-quarter or one-third of the meter's capacity, the average load being perhaps 5 or 10 per cent. of the same quantity. At these low loads meters almost invariably run slow, and the one or two lights left on all night, or occasionally turned on during the daytime, often do not start the meter at all. In this way a meter which indicates correctly at full load may really indicate only

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about 50 per cent. of the power that passes through it in actual service, this being, it is safe to say, a reasonable estimate in residence service. This means, of course, no real loss of power. It practically amounts to giving the consumer a lower rate than that intended, and can, of course, be corrected by keeping the nominal rates up. It has the unfortunate effect, however, of giving consumers with a low consumption per lamp installed a lower rate than those with a higher consumption per lamp, thus giving exactly the reverse effect of that aimed at in the Wright demand system. It may be well also to point out the fact that both these sources of loss are as serious in direct-current systems where integrating wattmeters are used as in alternating. Unfortunately, the power factor of the meter load cannot be improved, as can that of the transformer load, by grouping services on one large instrument.

Alternating-Current Motors with Great Starting Torque.—Mr. M. Déri's valuable paper on the above subject appears in the *Zeitschrift für Elektrotechnik*. The author gives the equation for calculating the torque of rotary-field motors and discusses the characteristics graphically. He then describes his method of introducing the armature resistance necessary to obtain the great starting torque, and then cutting it out of circuit again in order to leave the armature in its simplest form—namely, of copper bars with slight insulation and without contact rings, rheostats, or switches for the armature—all that is required is a switch for the field. The arrangement appears to consist in connecting across the end of the armature two points of the closed-circuit winding which have unequal potentials by means of a wire, including a resistance. In a two-pole field the winding with these cross connections will then form a simple closed-circuit winding, a diametrical winding with a divided wire; but when the inducing field has four poles the windings short-circuit themselves, and there will be no circuit in this connecting branch. All the armature windings should therefore be provided with connections between the points of unequal potential on one end or on both ends of the armature, and the resistances in these connecting branches should be so chosen that the starting torque should be as high as possible. In the field winding there is inserted a switch which alters the number of poles. He then applies the same principle to the single-phase induction motor. The fundamental principle of these is the same as that for rotary-field motors if it is assumed that an oscillating field is the resultant of two rotary fields revolving in opposite directions, but with the same speed. The windings are illustrated, and are like those of the continuous-current machines, being connected to a commutator on which there are two brushes, which are connected together. When the field has two poles currents will be induced, which flow through the wires connecting the brushes, and this will produce an armature field which has a certain angle with the other field, thus producing a torque. For starting the motor the main field is to have two poles, and after the motor has reached a certain speed the field is changed into a four-pole field, when the current through the commutator and the brushes will cease and the armature will act like a regular short-circuited armature, the commutator and brushes being electrically inactive. The wires connecting the windings with the commutator form the necessary resistance to get the best starting torque; this will also tend to diminish the sparking at the brushes. The action is, therefore, different from that in which the resistance is usually inserted external to the brushes. When the motor has reached the desired speed the brushes may be raised from the commutator; there is a wide range of speed in which there is no fear that the motor will stop. The reversal of the motor is accomplished either by reversing the current in the field or by shifting the brushes through an angle corresponding to half the polar distance. He claims that the single-phase induction motor, then, has all the good qualities of the rotary-field motor. The above abstract is from Mr. Carl Hering's digest of current literature.

In Darkest London.—Our contemporary *London* had in its columns last week an article with the above heading, and we cannot but think that the darkness was editorial. The editor evidently uses the incandescent gas-burners, and can see no further than his own office. The article commences as follows: "London, we regret to say, continues to keep its unenviable position as the worst lighted of all large cities. Here and there electric arc lamps throw off a blaze of light, and at some corners big gas lamps have been erected, but many of our chief central thoroughfares and almost all the small streets remain with only dim flickering lights distributed by means of obsolete lamps. Such an important thoroughfare as the Strand, for instance, depends mainly for its light, not so much upon its antiquated lamps as on borrowed light from shops, public bars, and theatres. No authority has yet set a good example of street-lighting in London, if we except one or two little bits of electric lighting, and these are not by any means perfect," etc. Again, we read: "The local authorities, of course, are the greatest offenders. They make no effort to improve the light except in a fitful sort of way, and even when one district shows enterprise its neighbour lags behind. This is illustrated in Kensington, which has adopted very largely and with good effect incandescent gaslights, but one side of a main road which is in Kensington is well lighted, while the other side, which is in Westminster, has still to put up with the old-fashioned lamps and burners. It cannot be said that this desire to maintain a bad lighting system is prompted by economy. Some of the districts have a fancy for electric light lamps, which, we admit, are expensive, but no better light can be found for street purposes than the new incandescent lamps, and it actually becomes cheaper than the present system. Some attempts which have been made to establish incandescent lamps in the London streets have not been very successful owing to the short-sighted policy of the vestries. Incandescent lamp burners, to give the best effect, ought to be put in good lanterns, but the vestries expect to get the good result from this new method without going to the expense of giving it a proper installation. We frequently see attempts being made to fix up new incandescent burners in old-fashioned lanterns tacked on to standards which have lost the perpendicular," etc. After a few more paragraphs also extolling the beauties of the incandescent gas lamp and quoting figures, which read uncommonly like those in the advertisements of the company, we are rather disgusted. To treat the article seriatim would take too long, but we cannot admit that of the many vestries—such as St. Pancras, Shoreditch, St. James, etc.—not one has set a good example of street-lighting, or that the City of London, with its arc lights in all the principal streets, is behind every other city in the world. The writer of the article in question apparently knows more of incandescent gas-burners than about street-lighting, and, from his article, has not travelled beyond a 10-mile radius from St. Paul's. There is much improvement needed in our street-lighting, but that in the main streets of London will compare favourably with most cities, both as regards quality and quantity. Again, for the benefit of the editor of *London*, we may state that the vestries have found that arc lighting is both better and cheaper than the incandescent gas, and hence are extending in the cheaper direction.

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FALK CAST-WELDED RAIL JOINTS AT NORWICH AND COVENTRY.

The following details of the Falk cast-welded rail joints have been kindly supplied to us by Mr. Robert W. Blackwell:

The essential difference between tramway and railway track work is that the rails for a tramway when once laid are covered in up to the tread of the rail by paving of some sort. Therefore when the track is once laid, unless special devices are adopted, it is impossible to get at the fishplates, and the bolts holding the fishplates in position become loose in time, as they are not subjected to inspection. It has been the experience on all the tramways in this country on which mechanical power has been used, that after a very few years the joints begin to give trouble. It is evident that when heavy motorcars pass over a joint, unless the joint is absolutely solid, there will be a tendency on the part of the rails to separate while the wheel is passing from one rail on to the other. This causes what is known as "hammer blow," which is injurious to the motors on the car and bad for the track. It causes the head of the rail to wear down at joints, thus increasing the tendency to hammer. The hammering also causes the concrete, on which rails are generally laid in this country, to wear away, and water filtering through the pavement increases this difficulty.

It is evident that from the tramway manager's point of view the best possible track would be a continuous one without any joints whatsoever. For many years past, but especially since electric traction was introduced, inventors have been hard at work seeking means whereby this could be practically attained. The first idea naturally was to electrically weld the rails, and the Johnson Company of the United States spent a great deal of time and money in trying to perfect a system of electrically welding the track. As far the operation itself went it was perfectly successful. There was only one great drawback—namely, the very large cost of the plant required to do the work, and the necessity of having highly skilled labour. The price of the joints was therefore excessive, and inventors endeavoured to discover another system. The Falk Manufacturing Company finally succeeded in practically solving this problem, and since 1894 a very large mileage of track in the United States has been laid on their system, and the results obtained have been excellent.

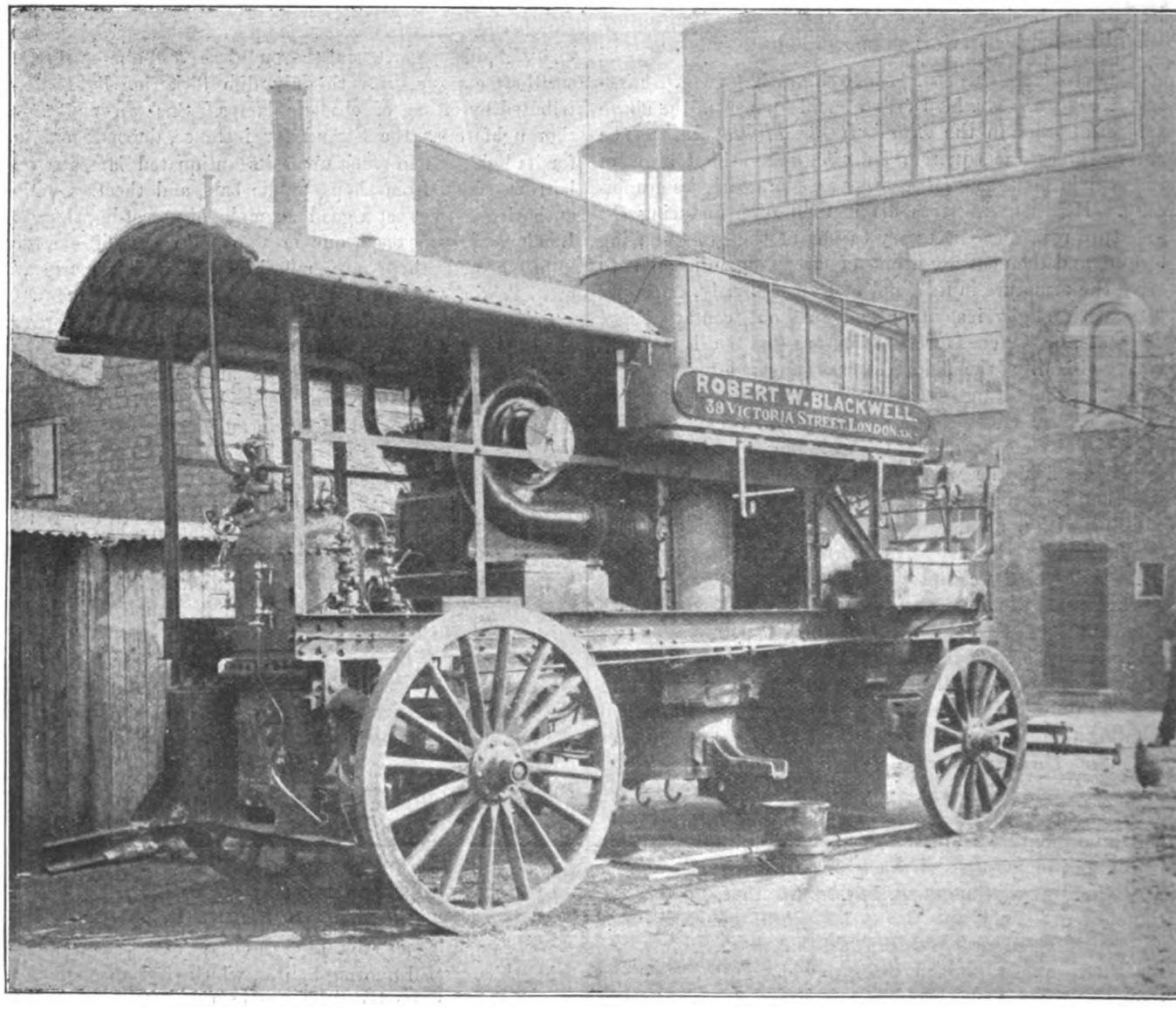

FIG. 1.—The Portable Cupola used for making Cast Joints.

There is still a great prejudice against the continuous rail, the chief reason for this being that standard *railway* practice makes special allowances for contraction and expansion at joints. It was thought that if a continuous track were laid, and the paving on the length of road removed, the track would buckle or rise up, but experience has proved that this is not the case. It was feared that with a continuous rail the paving might be damaged and torn owing to contraction and expansion of the rails, but as regards this point experience has now demonstrated that a continuous track is superior to an ordinary one, as the joints are all held so firmly that the rails are practically immovable, and differences of temperature will simply change the molecular condition of the rail and the stresses in the rail. In tramway work it must furthermore be borne in mind that variations of temperature do not affect the rails as much as one might think, owing to their being

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entirely covered in by pavement of some kind which is a non-conductor of heat.

It is easy to ascertain the strain on the rails due to the variations of temperature. Assuming a coefficient of expansion for steel of 0·0000065, and multiplying this by 75, which is a liberal figure for the number of degrees of maximum deviation from the temperature at which the welding is done, we get 0·000487, which is that part of its length which a rail would expand when exposed to a rise of 75deg., or contract when exposed to a fall of 75deg. in temperature. A steel bar will expand 0·00003 of its length, due to a load of 1,000lb. per square inch. Dividing the estimated expansion by this figure, we get for the strain 16,200lb. per square inch. As 40,000lb. per square inch is a safe value for the elastic limit of steel, it can readily be seen that the elastic limit will never be reached; and this means that these expansions and contractions may go on indefinitely, and as long as the joints remain unbroken no harm will be done to the rail, for stresses within the elastic limit work no harm. Assuming 80,000lb. per square inch as the ultimate strength of steel, we see that, so far as the strength of the rails themselves is concerned, we have a factor of safety of 5. Wherever joints have broken, in no case have they pulled apart more than 2in. This would seem to show that the pull which broke the joint was not a cumulative effort extending all all along the line, but merely the result of a local strain extending but a short distance on either side of the joint.

The Falk system is now being introduced in Great Britain for the first time by Mr. Robert W. Blackwell, of 39, Victoria-street, Westminster, at Coventry and at Norwich, where some 5,000 joints are now being cast welded. The system roughly consists in casting a cast-iron sleeve round the sides and bottom of the rail joints, the rail ends being first placed firmly together. In cases where they do not absolutely touch, the plates of steel are driven in between the heads of the rails before casting. Before fixing the moulds, which are of cast iron, the sides and bottom of the rail are cleaned, and this is generally done with an emery wheel or a sand blast. The cast iron used is of special chemical composition to give good results, and is run at a much greater heat than is used in making ordinary castings. The cast iron running into the iron moulds cools rapidly on the outside surface, thus causing a tremendous pressure to be exerted on the metal, which is still in its molten state, in contact with the web and foot of the rail. As the metal is poured in from one side, and comes in contact with the web or thinnest part of the rail at its greatest heat, this part of the rail is brought to a white heat, and owing to the tremendous pressure exerted on the molten cast iron, this is practically forced into the interstices of the steel, thus not only making a thoroughly good mechanical joint, but also ensuring a good electrical joint. The section of the cast-iron joint is so designed as to have at least the same tensile strength as that possessed by the rail. The cast-welded joints used are generally about 14in. long, and the weight of cast iron varies, in accordance with the weight of the rail, from 70lb. to 140lb. per joint. The cast iron must necessarily be melted close to where the work is being done, and for this purpose a cupola on wheels is necessary.

The apparatus used at Coventry is shown in Fig. 1, and consists of a small cupola with the necessary fan, steam-turbine, and boiler, fitted on to a truck to be drawn by horses. In the apparatus used at Norwich gearing is fixed to the wheels, so that the steam-engine which drives the fan is utilised as motive power to propel the car. Fig. 2 shows the first two cast joints ever made in England, the one on the left-hand side of the picture having had the moulds removed. The right-hand side shows a joint with the moulds and clamps still in position. In the background a set of moulds are to be seen. Fig. 3, which represents the first joint after it had been sawn in half, shows the thorough contact which exists between the cast iron and the steel of the rail.

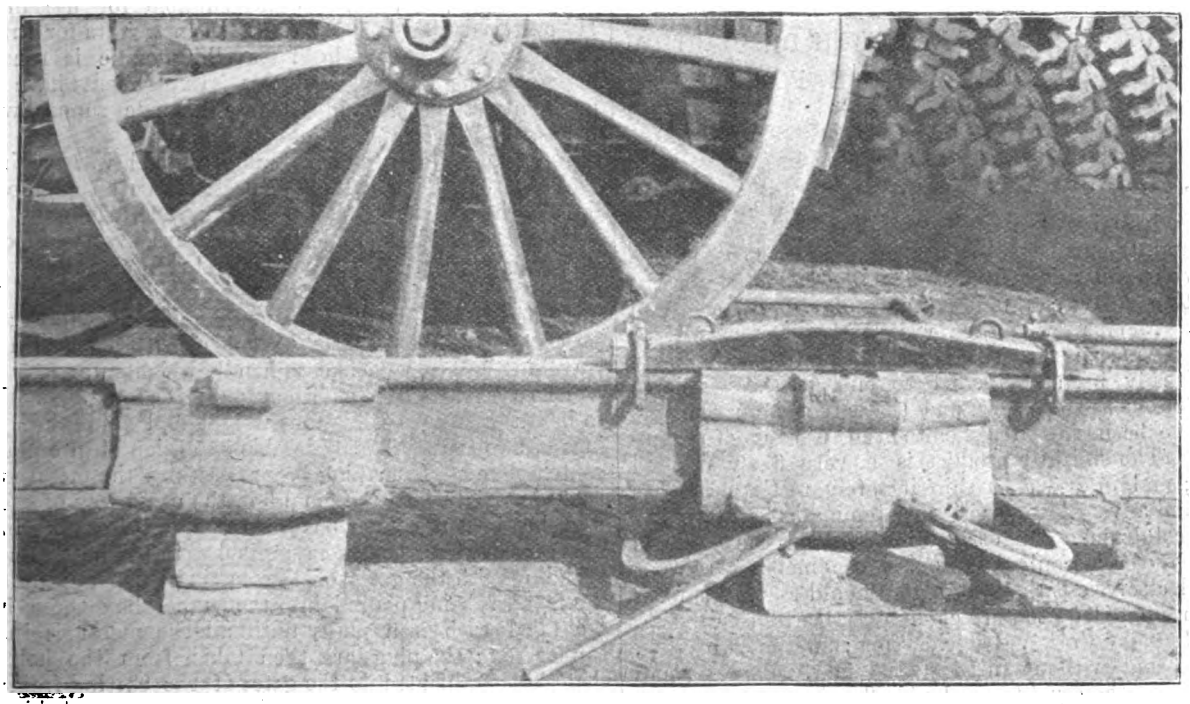

FIG. 2.

FIG. 3.

The energy of the Coventry and Norwich tramways in adopting this as yet untried system in England is to be commended, and from the portion of the work which has already been finished there is no doubt that it will be highly successful. The progress of this new system will undoubtedly be closely watched by all interested in tramway construction.

Engineers unacquainted with the good results that have been obtained by cast welding have expressed the fear that, as it would be impossible for the cast iron to be welded to

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the steel of the rail, water would get in and cause rust, which would destroy the conductivity of the joint and diminish its mechanical strength to such an extent as to cause rupture. Further doubts have been expressed that the great heat of the molten cast iron would anneal the steel rails, rendering these softer at the joints and liable to wear. In answer it may be stated, as one example among many, that in 10 miles of track which were cast welded at St. Louis in the early part of 1894, and over which there has been a very heavy traffic, the joints to-day are in as good condition as when they were first made, and so perfect that it is practically impossible to detect them. At the present moment there are some 200,000 cast joints in the United States. A large amount of work has also been done in France and Germany.

ALUMINIUM MANUFACTURE, WITH DESCRIPTION OF THE ROLLING-MILLS AND FOUNDRY AT MILTON, STAFFORDSHIRE.*

BY E. RISTORI.

On the occasion of the meeting of the Institution of Mechanical Engineers at Belfast in July, 1896, Mr. James Sutherland, the manager of the factory at Larne, read a paper which fully described the method adopted for the preparation of pure alumina (oxide of aluminium) from bauxite. Members who then visited that factory will be interested to learn that the British Aluminium Company have already been compelled to enlarge the works to nearly double the capacity, and that great improvements have since been introduced into the process of manufacture. The finished product is a very finely divided powder; and in order to ship it safely to Foyers, it has been found advisable to pack the alumina in hermetically-sealed steel drums. On arrival in Scotland, the oxide is reduced by the Héroult process, and the metal is run out of the electrolytic baths into ingot moulds. In this form the aluminium is quite pure enough for certain purposes, such as foundry work and steelmaking; and much of it is, therefore, sold without further treatment. But as small quantities of the cryolite—a double fluoride of aluminium and sodium containing 13 per cent. of aluminium—which is used as a solvent during the electrolysis, occasionally become mixed with the metal as it comes out of the furnace, the aluminium at this stage is scarcely suitable for the production of tubes, rods, etc. The original crude ingots are, therefore, sent to Milton, in Staffordshire, where they are remelted and refined until the metal attains a purity of 99·6 per cent.

Milton Works.—The site of the Milton Works, which the members will have an opportunity of visiting, is well selected in the middle of an industrial district; it is connected with the North Staffordshire Railway by a siding, and has a frontage on the Trent and Mersey Canal. The works were the first erected in the United Kingdom for the production of aluminium by electrical agency. They were erected by the Cowles Syndicate for the purpose of turning out aluminium and aluminium bronze by the well-known "Cowles" process; but before the British Aluminium Company took them over they had already stopped making aluminium, having been previously driven out of the field by the competition of the electrolytic methods, which were greatly assisted by the employment of cheap water power. It was found useful, however, to convert this factory into a rolling-mill and foundry, with the idea not only of refining the Foyers ingots, but also of working them up into sheets, rods, and large or small castings, more convenient for the different trades that use aluminium. A portion of these works which was not required for the above purpose was sublet to the Epstein Electric Accumulator Company, who have been making and charging their accumulators here for the last three years. This portion includes two tubular boilers and one engine of 650 i.h.p.

Casting-Shop.—The casting-shop, erected in 1895, is situated close to the rolling-mills, and contains a series of 11 furnaces for 500lb. pots, connected by a large flue to the main chimney 125ft. high, which gives a good draught for melting large quantities of bronze in a short time. This shop can deal with about 40 tons of aluminium per day in the shape of ordinary commercial notched bar, half-round stick for steelmakers, slabs for rolling, tube billets for drawing, wire billets, both round and shaped, for various purposes. When casting the metal it is sometimes necessary to add a little cryolite or some similar flux for assisting in the liberation of the impurities, which then rise to the surface as scum. These refining furnaces are fired with soft coke, because aluminium does not require such a high temperature as is necessary for bronze. The scum taken from the top of the pots is again remelted very slowly, in order to recover all the aluminium; it then forms a whitish power, containing practically nothing but the cryolite and some carbon; and being quite suitable for use in the Héroult reducing cell is sent back to Foyers for further employment. An overhead travelling crane is used for lifting the ingot moulds and pots. Experiments have been made in casting slabs and billets with a side runner, which seems to offer certain advantages.

Foundry.—The principal building, which was originally intended by the Cowles Syndicate to be an engine and dynamo house with outside boilers, is 200ft. long by 65ft. wide and 20ft. high under the principals. A portion of this is now used as a foundry, and contains two large core ovens, each 16ft. by 23ft., having a door 14ft. by 10ft. high, fired with coke fires under the floor; a cupola; two series of crucible furnaces to hold 500lb. pots; and two travelling cranes, sufficient to handle weights up to 15 tons, which so far have been sufficient for all the foundry work up to bronze castings of five tons weight and aluminium castings of two tons. A considerable extension of the plant is contemplated. In making bronze castings the metal is not poured straight into the mould in the usual way of casting iron, but into a runner box, or for a large casting into a number of runner boxes, having holes in the bottom corresponding with the gates of the easting. During the time the metal is being poured into the runner box these holes are filled with iron plugs until all the metal is in the runner box; the plugs are then taken from the holes, so that the metal runs into the gates of the casting from the bottom of the runner box, and leaves the scum behind in the box or in the top of the gates. In making castings of aluminium, it is not sufficient to use runners of the same size as those usually employed in making brass and iron castings. As the shrinkage of aluminium is about three times the shrinkage of ordinary gunmetal, a considerable amount of trouble is experienced if the runners and risers are not large enough to allow the casting to continue to be fed during its shrinking by the runners or risers connected with it.

Rolling-Shop.—The rolling-shop measures 130ft. by 60ft., and is covered with a weaving-shed roof having a north light. At present it contains two pairs of rolls 18in. diameter by 42in. width, one pair 18in. diameter by 48in. width, one pair 18in. diameter by 20in. width, one pair 14in. diameter by 20in. width, one pair 14in. diameter by 30in. width, and a new pair of friction rolls 22in. diameter and 60in. wide is in process of erection. All are driven by gearing from a horizontal tandem compound-condensing engine, put up in 1896. This engine runs at 60 revolutions per minute, and has cylinders of 21in. and 40in. diameter and 40in. stroke, and is capable of driving still more machinery. The steam is supplied by a Lancashire boiler 8½ft. diameter and 30ft. long, placed at the side of the house. The driving gear consists of helical-tooth wheels, 12in. wide and from 6ft. to 9ft. diameter, driving the rolls at about 10 revolutions per minute. The 14in. rolls are both fitted with a friction wind by Messrs. Jones, of Birmingham, with which strips as fine as 0·0005in. have been successfully rolled to a length of from 69ft. to 90ft. The rest of the plant required in a rolling-mill is also contained in this building. It includes a guillotine shearing machine for ½in. plates, 8½ft. wide, a crocodile machine for plates up to 1in. thick, two circular cutters, one for the manufacture of disc blanks 9in. to 24in. diameter up to 14 S.W.G. or 0·085in. thick, the second up to 4ft. diameter and ⅜in. thick, which

* Paper read before the Institution of Mechanical Engineers at Derby.

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are sold for stamping purposes; a steam-hammer, for closing the grain and for strengthening alloys before they are rolled into sheets, is in an adjacent building. A press is also being prepared for punching discs up to 12in. diameter. Two annealing furnaces or muffles, are also provided, 5ft. by 12ft. and 7½ft. by 14ft. These are a most important item in the plant for either rolling or hammering metal. Slabs 24in. wide by 1¼in. thick are broken down hot, after being heated in the muffle. They are afterwards again heated when necessary between the successive passes to reduce them from 1¼in. thick to ¼in. Most of the rolling itself is done cold; and in some cases, especially when very pure aluminium is used, even the breaking down can be done cold. Connected with the rolling-mill is a pickling-shop containing tanks 12ft. by 3ft., charged with caustic soda, water, nitric acid, sulphuric acid, etc.; the pickling process is an important step in the rolling of aluminium, and has to be carried out whenever a good polish is required on the finished sheets, while it is also equally adapted when a matt surface is desired.

Fitting-Shop, Testing Machine, and Laboratory.—The fitting-shop is subdivided into several buildings, and is provided with a quantity of ordinary lathes, circular and band saws, a nicking machine, shaping machine, and a number of small presses for cutting blanks out of sheet metal. In another building next to the rolling-mill there is a cold saw to cut metal 20in. thick, especially used for cutting heads off aluminium bronze castings which cannot be handled or cut up in any other way. If the bronze is made hot, it can be forged into any shape. Most of it has a tensile breaking strength of 30 to 35 tons per square inch, and it is useless trying to handle the heads in any other way than by sawing. The Milton factory contains also a 30-ton Wicksteed testing machine, in which the different bronzes and light aluminium alloys are constantly being tested. There is also a chemical laboratory in which the sample tappings from the furnaces at Foyers are analysed and records preserved, so that the purity of any particular delivery can always be ascertained. The whole works are lighted electrically from two dynamos, and a motor is kept ready for occasional assistance in driving the machinery.

Working of Aluminium. — With certain limitations, imposed by the chemical and physical peculiarities of the material, aluminium can be worked much like the other industrial metals handled at the present day. It is best melted in sand or in iron crucibles without the addition of any flux at a temperature not greatly exceeding its melting point, 655deg. C=1,210deg. F. On a larger scale the operation can be carried out at a dark-red heat on the bed of a reverberatory furnace lined with basic magnesia bricks of good quality. In casting, special precautions must be taken to allow for the great shrinkage during cooling. The moulds should have large risers and plenty of vents. They are preferably cooled from the bottom upwards to enable the gases to escape. Slabs for rolling must be cast in closed ingot moulds with a perfect machined internal surface, which is coated all over with graphite and water; the moulds must be very hot, and the castings cooled quickly in very cold water to make them soft. Aluminium can be forged hot or cold; preferably at a temperature which causes a hard wooden stick to smoke when pressed against the metal. In comparison with other metals it ranks third in order for malleability and sixth for ductility; sheets have been hammered as thin as $\frac{1}{40000}$in., and wire can be drawn down to $\frac{1}{250}$in. diameter. No lubricant should be used for rolling; and the aluminium requires frequent annealing at a low red heat just visible in the dark. In turning, the edge of the tool soon becomes blunt, unless only small cuts are taken; the cutting speed should be high, and both tool and metal should be lubricated with turpentine or petroleum. Filing is best done with single-cut files, because cross-cut files rapidly become choked. Spinning is easy on wooden or metal forms, the best lubricant being stearic acid dissolved in turpentine. Aluminium can be stamped or pressed, hot or cold, either dry or with soap water, for heavy work, and with tallow for small goods. Frosting is effected by dipping the articles for a few seconds in a hot 10 per cent. solution of caustic soda, containing about 2½ per cent. of common salt till the surface turns black, then brushing in cold water and dipping in strong nitric acid till the metal becomes white again, and finally washing and drying in sawdust. This process is desirable before aluminium surfaces can be efficiently painted or enamelled. For polishing a mixture of olive oil and rum is used, or emery and tallow, followed by rouge and turpentine. Burnishing is done with bloodstone or steel dipped in rum and oil, or in a solution of borax containing a little ammonia. To engrave aluminium the plate must be coated with stearic acid and turpentine, or with rum and oil as before; if this be not done the graver slips continually.

Alloys of Aluminium.—Among binary alloys especially it has been found that, as the proportion of the two ingredients becomes more and more equal, the products lose their valuable qualities, and that the industrial alloys may be broadly separated into two kinds—namely, "light" alloys, containing 90 to 99 per cent. of aluminium with 10 to 1 per cent., or even less, of some other metal or metals, and "heavy" alloys, containing 1 to 10 per cent. of aluminium with 99 to 90 per cent. of the other components. They can, therefore, be regarded either as pure aluminium strengthened by the addition of some other metal, or as one of the older metals improved physically and chemically by the addition of aluminium. A considerable amount of attention has consequently been devoted at Milton to the preparation of different sorts of alloys, some of which may be briefly referred to.

Light Alloys of Aluminium.—In its purest form aluminium is very soft, and not of great service in those arts in which much rigidity and strength are required. For this reason a metal containing only 98·5 to 98·8 per cent. of aluminium, the impurities being silica and iron in almost equal proportions, is preferred to metal of 99·6 per cent. purity. One casting alloy, having a specific gravity of 2·9, is largely used just now, and is known as "No. 6." Its composition is still kept secret. It has been found to produce remarkably clean castings, which require very little machining to finish up; it takes a high polish, and so far has given complete satisfaction. Another alloy is "No. 4," which contains nothing but aluminium and a small proportion of copper; it is not one of the materials generally recommended, though it has some good qualities. There is a strong suspicion that when aluminium is alloyed with copper galvanic action is set up between the two, especially when the alloy is exposed to salt water; therefore this is not recommended in any quantity for outside positions. The two alloys particularly recommended, as among the best yet made, are called "Wolframinium" and "Romanium." These are both ternary alloys, and next to the aluminium tungsten is the leading ingredient in each. In one of them copper is present to a small extent, in the other nickel; and both have given astonishing results as regards strength and elongation. Samples of rolled sheet or rods made of these alloys have shown as much as 20 to 22 tons tensile strength per square inch, with 5 to 10 per cent. elongation in 4in., which is remarkable when the low specific gravity of the material is taken into consideration. The above are all so-called "light" alloys—that is, alloys containing a preponderating percentage of aluminium, with only a small quantity of another metal or metals.

Heavy Alloys of Aluminium.—There are many "heavy" alloys of aluminium, in addition to the well-known bronzes; some of these have not yet reached the development to which their valuable qualities entitle them, and which they will ultimately attain when better appreciated by mechanical engineers. Aluminium bronzes are undoubtedly superior in strength to most of the copper-tin bronzes now in use, and they are especially suitable for marine engineering. Propellers of aluminium bronze have been successfully made for most of the 26 and 30-knot torpedo-catchers, also a large number for the French Government. The two classes of bronze most frequently employed are marked R 3 and R 4. The difference between them is simply in the proportion of aluminium they contain. The following tests show their maximum, minimum, and mean breaking loads and elongations, agreeably with which R 3 has a guaranteed tensile strength of 35 tons per square inch, with 25 per cent. elongation in 2in., and when cast R 4 breaks at 40 tons per square inch, with 10 to 12 per cent. elongation also in 2in. These have the advantage of being considerably

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cheaper than other bronzes, and are easily employed for any foundry work without special appliances or tools.

	Breaking load. Tons per square inch.			Elongation. Per cent. in 2in.		
Mark.	Max.	Min.	Mean.	Max.	Min.	Mean.
R 3	43·7	39·6	41·8	13·00	6·50	9·75
R 4	36·6	30·8	34·0	35·00	15·50	23·30

Uses of Aluminium.—The principal uses of aluminium are too many to be enumerated. The properties of the metal are so akin to those of copper and brass that, broadly speaking, aluminium or one of its light alloys should to a large extent replace both copper and tin and also nickel or German silver. Such a change would be followed by various advantages to all concerned. Not only would there be a considerable reduction in the weight of the articles, but they would not tarnish or turn black on exposure to air. The cost should be the same, if not actually lower, inasmuch as, bulk for bulk, aluminium is already cheaper than copper or tin, and its price will continue to fall as the demand increases. One field, however, remains, which copper is bound to maintain as its own—namely, the construction of insulated electrical conductors. Experiments have already been made on a large scale with bare conductors of aluminium for telephones, etc., and the British Aluminium Company are using it in this manner at their Foyers works with perfectly satisfactory results, its conductivity weight for weight being double that of copper. But when the mains have to be insulated, copper is absolutely unapproachable, on account of its greater conductivity volume for volume, which is 165 per cent. of that of aluminium. Besides the advantages set forth above, aluminium is not poisonous, and is pre-eminently adapted for the manufacture of cooking utensils. On the other hand, tinware is not particularly cheap in the long run, for it is constantly wearing out; cast iron is heavy and brittle; and copper requires to be frequently retinned in order to avoid all danger to health. Inasmuch as an aluminium saucepan costs no more in the first instance than a copper one, weighs much less, is perfectly innocuous, and does not periodically need a fresh inside, it is not surprising that the employment of aluminium in kitchens and canteens is spreading rapidly.

A steady demand for aluminium is springing up in various kinds of printing processes as well as in lithography. The metal appears to answer admirably for the construction of rollers used in calico printing; and when its surface is properly prepared, it is also capable of replacing the ordinary lithographic stone. It can easily be imagined that, instead of having cumbrous and heavy stones, which can be printed only on special slow-running "litho" machines, it is far better and cheaper to use thin sheets of a metal which can be bent into a circular form and printed on rotary presses. Bicycles of all kinds, electric light fittings, chains, bridles, stirrups, surgical instruments, sextants, and other scientific apparatus, keys, cigar cases, pen and pencil holders, toilet articles, plates and dishes, spoons, forks, frames, name-plates, door furniture, hat and coat pegs, boot-trees, fire-engine fittings, business and visiting cards, photographic cameras, etc., are a few of the things that are being daily made in aluminium by various firms, and all these articles should be sold at the same price as if they were composed of brass. There are other instances where aluminium should economically replace commoner metals than copper or brass. Wherever a great deal of dead-weight has to be continually moved about the cost of motive power, for which there is apparently no return, is serious, and if this unremunerative weight can be reduced to one-third of its present amount, in the course of a year or two the saving in power will more than compensate for the greater initial outlay. Thus frames for cabs and motorcars have already been made in aluminium; and though in England experiments have not yet been tried in this direction, aluminium railway carriage frames are under review in France. Especially for motorcars there should be a large field here for aluminium. A further demand for the metal will be brought about by its introduction into the military services. All parts of the soldier's equipment have practically been made already in aluminium, such as mess-tins, water-bottles, buttons, helmets, parts of rifles, cartridge-cases, fittings for guns, tents, horseshoes, portable bridges, etc. Nothing much has yet been done in England in this direction, but it is well known that Continental armies, notably that of Germany, are employing aluminium on a large scale. One of the largest uses to which aluminium has been applied is in metallurgy, where its valuable metallurgical properties were discovered and utilised. It is common knowledge among steel-makers that ingots often turn out spongy at the top; and when particularly good ingots are required, the faulty portion is cut off and melted over again. By the introduction of a very small proportion of aluminium to iron, steel, or brass, either in the mould or in the ladle, the founder can be quite certain that the ingots will be solid all through. When used in this way, aluminium has the peculiar virtue of instantly liberating all the gases contained in the metal, and of keeping it fluid for a longer period, so that by the time the casting solidifies, the gases have had an opportunity to escape. In almost all steelworks, and in all the principal foundries, aluminium is now being employed; and reports from some of these state that the result is a reduction in the wasters by 80 or 90 per cent. In this case aluminium does not actually replace any other metal, but by its own special qualities is useful as a means of improving physically and chemically some of its older rivals and friends.

Aluminium in Shipbuilding.—The use of aluminium in shipbuilding is growing rapidly, on account of the almost inestimable advantage of its great saving in weight. Four or five years ago a small canoe was made on the Thames of two sheets of aluminium stamped and riveted together. In 1892 Messrs. Escher Wyss, of Zürich, constructed a small launch entirely of aluminium, driven by a naphtha motor; and in the following year they built for Mr. Nobel another larger vessel, which has been in use ever since, and is now on one of the Swedish lakes. During 1894 and 1895 the author had on the Thames between Windsor and Maidenhead a similar vessel, which is now at work at Foyers. A much more ambitious attempt was made by Messrs. Yarrow in 1894. By request of the French Government they built of aluminium the whole of a second-class torpedo-boat, 60ft. long by 9ft. 3in. beam. This boat weighed in full working order, but exclusive of armament, only 9½ tons, and attained during a run of two hours, carrying a load of three tons and with engines indicating about 300 h.p., a mean speed of 20½ knots—an advance of 3½ knots over all previous records. Several yachts, including the "Vendenesse," were also constructed at the same time, but they do not seem to have been a real and permanent success, owing probably to the adoption of an unsuitable metal. As pure aluminium was not strong enough alone, it was thought better to use an alloy containing about 6 per cent. of copper in the construction of some of these boats. This alloy possesses a tensile strength of 14 tons per square inch; but, as already stated, this material is absolutely untrustworthy in sea-water, owing to the rapid corrosive action set up between its two ingredients. Moreover, although nobody would dream of employing any other metal than copper for plating sea-going vessels unless it were afterwards painted, aluminium has always been used bare, which the author considers a mistake. If the aluminium had been protected from direct contact with the water, it would have lasted much better. Unfortunately this comparative failure has materially discouraged the adoption of aluminium in shipbuilding; and although it is now well recognised that the pure metal, and several of its alloys which do not contain copper, stand the action of salt water better than iron or steel, some time is likely to elapse before these premature tests are forgotten. Eventually, however, when further experiments have been carried out, there is no reason why a suitable alloy should not be adopted which, when properly used and protected from direct contact with sea-water, would resist corrosion as effectually as the majority of materials now employed in shipbuilding. These remarks refer only to the keel and other parts of the vessel below water, and chiefly to such craft as are to navigate the open seas. For all internal work aluminium is perfectly safe, and it is specially suitable for adoption in the navy, where the presence of wood and other inflammable material should be discouraged as much as possible lest it lead to fires during action. In all boats

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sailing on fresh or inland waters the corrosion is less, and when portability is desired, as in the case of expeditions to little known parts of the world, even if the aluminium do suffer corrosion, this is of trifling moment in comparison with the advantage of smaller weight to be transported. For instance, Messrs. David White, of Glasgow, have recently constructed an 18ft. boat for a party going to Klondyke, weighing only 1¾cwt., which is wholly composed of aluminium, even to the rivets, nails, bolts, and nuts. It is made in sections which pack into one another; and the whole can be put into a box. Messrs. Forrestt and Son, of Wivenhoe, have also furnished a flotilla of two launches and a barge for Major Gibbons's trans-African expedition which started in May. The vessels are built in sections on the Hodgetts principle, each piece measuring about 6ft. 6in. by 3ft. 9in. and weighing less than 120lb., so that two natives can easily carry one between them by means of oars on their shoulders. The chief peculiarity of these boats lies in the interchangeability of the 20 sections composing the fleet. The different pieces can be put together in a variety of ways, forming three separate boats of such sizes as may be most convenient at the moment: it is possible to have either two 26ft. launches and one 22½ft. barge; or one 44½ft. launch and two 15ft. barges; or one 37ft. launch, one 22½ft. barge, and one 15ft. barge, etc. One launch is fitted with an awning, the other carries a mast and sail.

THE NEW ELECTRIC SYNDICATE, LIMITED.

This syndicate is exploiting the Rowbotham primary battery, and has excited such confidence in it amongst non-technical men that the shares of the syndicate are at a premium. We have inspected the battery at 23, Throgmorton-street, and gleaned from the inspection several facts, which we use below. From these we cannot but conclude that the figures published are both misleading to the general public and also incorrect. In criticising the reports on this battery given by Prof. S. P. Thompson and one by Mr. Haydn T. Harrison, M.I.E.E., we accept their quantities as to material used, but, as will be seen, the prices taken for these materials are most absurd.

The Rowbotham battery is the invention of Mr. W. Rowbotham, of Vauxhall, and from his numerous patents (19 in all) for primary batteries, we gather that he has spent a great deal of thought in developing the cell now being exploited by the above-mentioned syndicate. For this Mr. Rowbotham deserves every credit, although the product of this labour is not able to produce electricity commercially for electric lighting purposes. A full description of the cell is hardly necessary, as Mr. Harrison gives this in his report, which we print *in extenso*.

The main features are as follows. The carbon elements are contained in porous tubes, through which a strong acid is circulated. The iron elements are placed in between a series of these tubes, and water is kept running through the portion of the cells containing the iron plates. The cells are arranged on a sloping stand, so that the solution runs through a series of cells before going to waste. The use of the two circulating solutions enables both the internal resistance of the cell and the strength of the acid round the iron plates to be varied. In this way the inventor hopes to keep down local action, and consequently the waste of iron when the cell is not in use. Also, by turning off the acid solution when no electricity is required, it does not run to waste. In the iron plates there is nothing special, wrought-iron sheet being used, but we were rather amused to see that cast iron was tried in some cells. The local action between the free graphite in this cast iron and the iron itself was causing the cells in question to boil merrily. The porous sections containing the carbon rod are of more complicated construction. They consist of a series of horizontal tubes placed in a vertical plane and jointed to two end pieces. The whole is made of unglazed porcelain. The end pieces form the acid and gas chambers, which will be referred to later. A series of seven of these porcelain grids was used in each cell we saw. The carbon rods are coppered at the ends, soldered to a common terminal, and then the ends are protected by a bituminous compound. Failure of these joints necessitates skilled labour and a complete dismantlement to put the cell right. The acid solution used is a mixture of sulphuric acid, nitric acid, and water. Such is the Rowbotham cell, and about it the two following reports have been made. We regret not to have been able to obtain Prof. S. P. Thompson's earlier report.

A SUPPLEMENTARY REPORT ON THE ROWBOTHAM BATTERY, BY PROF. SILVANUS P. THOMPSON, F.R.S.

Gentlemen,—At your request I have visited the installation at 23, Throgmorton-street, and now beg to report as follows: Since the date (April, 1897) of my first report upon this battery much has been done toward the development of the invention. The cells are constructed in a similar manner to those which were submitted to me in 1896-97 for the extended tests named in my former report; but several improvements have been made in their construction, and in the arrangements for maintaining the circulation from cell to cell throughout the battery. In this particular installation there are 51 cells, designated to give out a normal current of 60 amperes with a terminal E.M.F. of 50 volts. The advantages of this battery as a generator of electric currents are most apparent in those cases where an installation is needed for a house or group of buildings not situated near any public supply of electricity. These batteries will afford an economical source of supply both for lighting and for driving small electric motors in cases where, in the absence of any supply from a central station, the only alternative has hitherto been the erection of a private installation of a steam-engine or gas-engine driving a dynamo and a battery of accumulators. As an example, take the case of a house requiring 100 lights, mostly of 8 c.p., but with such a proportion as is usual of lamps of higher candle-power. If this had to be supplied from private installation the prime cost of steam-engine, dynamo, boiler, and accumulators might be taken at £530. This estimate does not include the cost of an engine-house or accumulator-shed, and it is based on the assumption that the accumulators will not be required to furnish current for more than half the lamps at one time. The figures of cost of the Rowbotham battery submitted to me show that a battery of a size adequate to supply the same number of lights could be furnished, with ample margin of profit, at a price of £258, or less than half the prime cost of the engine installation. Larger installations may be operated by a proportionate increase in the size of the battery; and for all outputs up to 50 h.p. the capital outlay is considerably less than that which would be necessary to erect an engine plant with dynamo and accumulators to do the same amount of lighting. The space occupied by this generator is less than half that which would be occupied by an ordinary engine plant of equivalent capacity. The noise and vibration inevitable in installations where running machinery is employed, are totally avoided. Owing to the substitution of iron for zinc the cost of the consumption of metal during action is reduced much below that of any primary battery on the market. Zinc being now £17 per ton, and sheet iron of suitable quality being taken at 62s. 6d. per ton, and 1·14 tons of iron being for the purpose of such batteries equivalent to one ton of zinc, it follows that the expenditure on anodes only (for an equal electrical output) will with this battery be less than one quarter of that which there would be if zinc were used. The figures obtained in my former tests showed that with this battery the cost of generating electric energy per Board of Trade unit, exclusive of depreciation, interest on prime cost, or superintendence was 6½d. per unit, but reckoning the cost of the nitric acid on the quotations now obtainable this figure is reduced to under 6¼d. per unit. At my first tests I was entirely sceptical as to the possibility of the attainment of such a result; but the detailed figures of the repeated experiments left no room for doubt. I understand that since that date a further economy has been effected in respect of the consumption of acid, still further reducing the cost per unit. There is no wasteful local action in the battery during times when the current is not being used. There is no polarisation during normal use. The details of my former tests which establish these points are at your service.

(Signed) SILVANUS P. THOMPSON.

July, 1898.

Mr. Haydn T. Harrison, M.I.E.E., reported on July 22 as follows:

In December, 1897, I was asked to give a report on the above generator, but suggested that I should not do so until I had been afforded an opportunity of a prolonged test, in order that I might ascertain the capability of the generator to do the work for which it is intended—namely, the production of electrical energy sufficient for lighting and motive power. Since that date I have been afforded every opportunity of testing the working and thoroughly inspecting the manufacture of the generator and am now in a position to report.

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Description of Generator.—The generator primarily consists of cells divided into two compartments, one of these compartments is open to the air, and contains iron plates which form one of the electrodes of the battery; the other, a closed compartment, consists of two chambers connected together by rows of porous porcelain tubes, in which are fitted carbon rods or pencils, which are all connected together, and thus form the other electrode. The cells are arranged in rows on an inclined plane, so that each cell is about 1in. below the one above. The object of this is that the solution in each compartment may flow from cell to cell. The solution or electrolyte used is contained in a suitable tank at the top of the generator, and is allowed to flow into the closed compartment of the top cell, and from there through an inverted U connecting piece into the closed compartment of the next cell, and so on to the bottom cell and out into the exhaust or waste-pipe. Each set of three cells is provided with a supply of water from a tank connected to the cells by means of pipes. The water, after passing through each set of three cells, is allowed to run off into the waste. In each cell of the generator I tested there are six iron plates and seven rows of porous tubes containing the carbon electrodes, the iron plates being placed between the rows. The generator consisted of 51 of the cells placed in three rows of 17, all the electrodes being connected together in series.

Description of Electrolyte or Solution Used.—The solution supplied for use with the generator consists of water, sulphuric and nitric acid; the quantities in which the above constituents are mixed depends on the purpose for which the generator is intended. The solution I used contained about 30 per cent. of sulphuric acid and a small percentage of nitric acid. Where economy of space and weight is required, a stronger solution may be used.

Description of Action.—The principle on which the generator works is as follows: When the solution is allowed to flow from the tank, it fills all the closed compartments of the cells and the porcelain tubes connecting them, thus surrounding the carbon electrodes. The open part of the cell having been previously filled with water, enough of the solution percolates through the porous porcelain to slightly acidulate the water, and thus cause a potential difference of from 1·30 to 1·35 volts to be set up in each cell, but such a small quantity of solution percolates through that practically no consumption of iron takes place. Nevertheless, owing to the large surface area of the electrodes, the internal resistance of the generator is sufficiently low for 10 amperes to be taken from each cell at a pressure of one volt per cell. Directly current is taken from the generator, gas is given off from the carbon electrodes of the cells, which gas, being in the closed compartment, causes a pressure to be set up which tends to displace the solution, thus forcing it to percolate through the porous porcelain into the open part of the cell, and so lowering the internal resistance of the cell to the extent that up to 100 amperes may be taken from each cell at a potential difference of one volt per cell. When the current is no longer taken from the generator, the pressure ceases and no more solution is forced into the open compartment. The cells are then automatically flushed out with water and are again in their normal condition of rest. Despite the fact that this operation has taken many words to describe, in practice the action is very simple, as also is the apparatus. In order to compensate for sudden changes of load, simple automatic contrivances are introduced into the circuit which I need not describe here, but the function of which is to regulate the pressure while the water has time to flush out the cells, or the acid solution has time to percolate through; the same automatic contrivances regulates the supply of acid and also flush the cells out when the current drops to zero.

Results of Tests.—The results of my tests prove that a cell having six iron electrodes, having a total area of 516 square inches of iron immersed in the solution, will give a current of 100 amperes at 1·05 volts, the open circuit E.M.F. being 1·35 volts. This is the equivalent to an internal resistance of 0·003 ohm, then the internal loss in the cell is 30 watts, and the power obtained in the external circuit 105 watts. Thus we obtain for use 74·4 per cent. of the total energy produced. A battery consisting of 50 cells of this size would therefore be capable of generating over 5,000 watts at 50 volts, or the equivalent of nearly 7 h.p.

Cost of Production.—The fuel consumed in this generator is iron, sulphuric and nitric acid. The iron consumed per Board of Trade unit slightly exceeds 3·25lb. The quantity of the mixed solution used per B.T.U. is 4·3 litres, which, taking the commercial value of sulphuric and nitric acids, works out at approximately 3·75d. If we add this to the cost of 3·25lb. of iron, we obtain a total cost of under 5d. per B.T.U. These tests were taken under working conditions, under laboratory conditions even a more satisfactory result can be obtained.

Space, Weight, etc., of Generator.—The 51-cell generator above alluded to occupies a floor space of 12ft. 6in. by 3ft., or 37·5 square feet. This is less than the space required for the engine only of a generating plant of similar capacity, leaving out of consideration the boiler, dynamo, and accumulator. The weight of the whole generator complete, with acid tank, etc., is about 1⅛ tons; this is considerably lower than any other generator to produce the same electrical energy.

General Conclusions.—After my exhaustive and prolonged test, I am satisfied that a practical generator has at last been invented which will satisfy a want hitherto unprovided for. Sections of the public who have been unable to benefit by the use of electricity owing to the costly and complicated apparatus necessary for its efficient production will now be able to obtain and use this simple form of generator for lighting their houses, production of motive power, or any other purposes they may require. I am also convinced that with certain structural alterations it may be made a cheap and efficient source of energy for traction purposes, and also for the propulsion of launches.

(Signed) HAYDN T. HARRISON, M.I.E.E.

These two reports evidently inspired Lord Lurgan, the chairman of the New Electricity Supply Syndicate, in his speech at the statutory general meeting held on Monday last. Lord Lurgan, as reported in the *Financial News*, said:

It is customary at most statutory meetings for them to be of merely a formal character, and we do not propose to-day to submit to you anything in the way of accounts; at the same time, I should like to say a few words with regard to the future and present position of this syndicate. No doubt you are aware that this syndicate was formed for the purpose of acquiring Mr. Rowbotham's patents in connection with his primary generator or battery. We have acquired a contract for the purchase of all his patents for all parts of the world. So far the date for the completion of that purchase has not arrived. I do not propose personally to give you any technical details, because you will probably all have seen copies of the reports on the battery by Prof. Silvanus P. Thompson and Mr. Haydn T. Harrison. We are all aware that so far primary batteries have been tried by the thousand, and thousands of pounds have been spent in vainly trying to produce one which will supply electric light or power at a commercial price. I am glad to be able to tell you that by Mr. Rowbotham's invention the difficulty has been overcome. So far, it has only been the rich or business people who have been able to avail themselves of the luxury and utility of electric light and power. The chief reason of this was the great expense of installation, and, subsequent to that, the skilled labour or engineers' fees, and the general expenses of supervising an installation of dynamos, accumulators, etc. You will understand, of course, that I am now referring to people who are outside the area of the public supply companies. I hope you will not think I am only giving you my own humble opinion on this generator, nor the opinion of the directors, because we naturally wish to substantiate our own opinion by that of experts, and I think you will admit that Prof. Silvanus Thompson's name is sufficiently well known to inspire you with confidence. I also wish to draw your attention to the report of Mr. Harrison. He has practically had one of these generators or batteries under his control and immediate supervision for several months past, and if you study his report you will find it is quite as satisfactory as that of Prof. Thompson, if not more so. Prof. Thompson's original report on this generator, which was made months ago, contained some preliminary observations, in which he says, referring to primary cells or batteries, "I have found no cell that would give one Board of Trade unit at a lower cost than 1s. 3d. per unit." He concluded that report by bringing down his figures to 6¾d. a unit, which he certified to be the cost. I asked him the other day why he did not give the original people a report sooner? He said: "I could hardly believe the results of my own tests, and I was anxious to be perfectly certain before I issued a report on the subject." Subsequently he brought the price down to 6¼d. per unit, but we have every reason for stating that we shall get it considerably below that when certain improvements and alterations as suggested and designed by Mr. Rowbotham and also by Mr. Harrison have been perfected. If you refer to Mr. Harrison's report you will notice he says: "If we add this to the cost of 3·25lb. of iron, we obtain a total cost of under 5d. per Board of Trade unit." The advantages of this generator are so numerous that I should weary you if I went into details. I will content myself by drawing your attention to some of the most important points and facts connected with it. In the first place, the cost of the installation of this generator is less than half that of the present system of installing accumulators, dynamos, and engines. That you will see is substantiated by Prof. Thompson in his report. He goes on to say that we require less than half the space occupied by engines, dynamos, and accumulators, and I think you will admit that those are two very remarkable facts, and greatly advantageous to us. In the next place, the economy in working is obvious from all points of view. The action is automatic, and neither engineers nor skilled labour of any sort is required to supervise this battery and keep it in working order. Then there are two other important points—its simplicity and its safety. It is absolutely simple in its construction

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and working, and it is safety itself, there is nothing that can go wrong. Another great advantage over the present system of electrical installations is that when the battery is not in use there is no waste. You will agree with me that the advantages I have pointed out are invaluable. We shall possess the only generator that can efficiently generate electrical energy without the use of moving machinery. The fuel, or, I should rather say, the active materials of our generator, are cheap, and can be obtained in unlimited quantities. You, or anybody else, would be able to light your house, whether small or big, with electric light, and it will be merely like having a very large lamp, which will require renewing, instead of with oil, with a solution every month or so, less often if the generator is a big one; and instead of putting new wicks in, you will place new iron plates, which will have to be renewed two or three times a year at the most. With reference to our progress from a scientific view, I think we have every reason to congratulate ourselves. We find that by a very few simple alterations, such as reconstruction of the cells and supplying the solution in a different way, we have been able to get double the supply of energy from the generator than we anticipated. This would have been exemplified to all those who saw the battery in work in Throgmorton-street had we had a little more time, but as we were getting near the end of the season, and as we did not want to disappoint people who had been told they would see this generator, therefore we have not been able to show it in quite as complete a stage as the next one will be. A good many people have been to see it—experts, amateurs, and others—and all, including the most sceptical gentlemen, who had come with supercilious smiles on their faces, have gone away perfectly satisfied and very much surprised at the result, and they are now convinced that the problem of producing generation of electrical energy has at last been successfully solved by the primary generator. This is a bold statement to make, considering the repeated failures of all the cleverest people connected with electricity for the last 50 years. However, we believe it is none the less correct. No doubt you will realise the numberless purposes to which this generator can be applied, and the demand that is bound to ensue for it. As I said before, the poorest as well as the richest will be able to have electric light, for the smallest as well as the largest houses can be supplied with these generators; they will work equally well on a small as on a large scale. Then they are applicable to the lighting of ships, and for electric launches, in which latter respect our battery will do away with the necessity of supplying or charging stations. By a very slight alteration in the construction of this generator it will apply to the propelling of all carriages by electricity. It will come in use for electric trams just as well, and do away with the enormous expense of laying the lines with copper as at present. With regard to the future, it will be necessary for us to form a large company in the early autumn, with a large working capital, in order to carry out the manufacture and to supply these generators to the public; also to constitute agencies in the various parts of the kingdom for the supply of the irons and acids mixed ready for use. Thus there will really be no trouble or risk of any kind whatever to the consumer or purchaser of one of these generators. We have been approached by several people for the sale of the foreign patents, which, as you will naturally imagine, constitute a very valuable asset to the syndicate. In fact, it is almost impossible to compute its value at present, and we have not attempted to deal with any of these offers so far. Altogether, I think you will agree with me that the future of this company is beyond calculation.

This speech of Lord Lurgan's clearly shows that he does not understand the reservations of Prof. Thompson when the professor says that his figure of 6¼d. per unit is exclusive of depreciation, interest on prime cost, and superintendence. The *Financial News* followed this up on Wednesday by a long leader on the subject, which accepts the figures on the strength of the expert's reports. This leader concludes by saying: "Those who hereafter shall be able to say that they found electricity dear and left it cheap, found it the privilege of the few and left it the luxury of the many, will do a great public service, and—what they will, perhaps, care about almost as much—will reap a rich reward." We agree; but the directors of the New Electricity Supply Syndicate have not succeeded in this.

Our Figures.

The question of the quantities of material used per Board of Trade unit we take to be as given in the reports: iron, 3·25lb.; acid solution, 4·3 litres. Mr. Harrison informed us that the density of this solution was 1·6, and that it contained only 7 per cent. of nitric acid. From this statement, taking the density of nitric acid to be 1·42 and the density of sulphuric acid 1·84, the composition of the solution can be obtained by simple algebra. Thus we find that the 4·3 litres of solution weigh 15·2lb., out of which there are 12lb. of sulphuric acid and 1·05lb. of nitric acid.

Now as to the cost of material. Prof. Thompson says "sheet iron of suitable quality being taken at 62s. 6d. per ton." Sheet iron of the thickness used is now quoted at £7. 10s. in bulk, and to receive such iron into a factory, to cut it up, and make the connections will, after redistribution to consumers, at least double the price. Hence we treat Prof. Thompson well if we grant him iron at £12 per ton.

The price of acid taken can only be inferred, but we have ascertained that, giving an order for the quantity required per annum for a 100-light battery, we could not get sulphuric acid under ¾d. per pound and nitric acid under 2½d. The figures then read as below:

Prof. Thompson.		*Our Figures.*	
3·25lb. iron, at 62s. 6d. per ton	= 1·09d.	3·25lb. of iron, at £12 per ton	= 4·15d.
Acid	5·16d.	12lb. H_2SO_4, at ¾d.	= 9d.
		1·05lb. HNO_3, at 2½d.	= 2·62d.
	6·25d.		15·77d.

In plain words, the Board of Trade unit is said by the experts to cost 6·25d. for material, and yet will cost the consumer more than 1s. 3d., which figure Prof. Thompson says he has obtained from other batteries. Our prices are obtained from wholesale distributors who supply in large quantities, and who remind us that the cost of distribution is a large factor in the price. Mr. Harrison gets figures even lower than Prof. Thompson, which, as the battery tested was the same, must have been due to the lower prices taken.

We are not told how the test of weight per unit was conducted, but we doubt very much if Prof. Thompson tried it as the battery would be used in practice, as the value of his time would preclude this. In other words, we fancy from the report that the battery was run a definite time at constant load, and not for a long period at loads such as would be met with in practice. This affects the case very seriously. The battery giving 1·05 volts per cell used 3·25lb. of iron per unit. The theoretical iron consumption, assuming the formation of a ferric salt, is 1·5lb., so that 1·75lb. of iron was wasted in local action during the times the unit was being produced. This local action is said to be nil when the battery is not giving current. This is on the assumption that no acid exists round the iron. Hence the acid round the carbon must have all percolated out and been wasted before the condition of no local action obtains. At the same time the internal resistance will be too high to admit of a lamp being lighted. So to give a constant E.M.F. for the lamp a reasonable proportion of acid must be present, and the waste of both iron and acid will go on. These wastes will in the ordinary house be much more expensive throughout the year than the cost of quantities actually used to produce current. A comparison published in a pamphlet by the syndicate between a house requiring 100 8-c.p. lamps lighted by a gas-engine plant and by the Rowbotham battery was apparently suggested by Prof. Thompson. He confines himself to the first cost, and says that the engine plant costs £530, against £258 for the battery. The syndicate goes farther and assumes an annual output of 1,500 units. Then they say that with the gas-engine plant the cost, "including wages of attendant, interest on capital outlay, depreciation and cost of fuel, etc., would average about £105 (1s. 5d. per unit); whereas the cost of the same energy generated by the 'New Electricity Supply system,' including interest on capital, maintenance, etc., would be about £45 (7¼d. per unit). Thus the economy effected under the 'New Electricity Supply system' is apparent, the cost of lighting being considerably less than one-half."

The prices per unit we insert, and it must be remembered that the gas plant can generate at a cost of gas of not more than 1¾d. per unit, even for such small power when maximum load is on. We do not dispute, however, their average cost of 1s. 5d. per unit, as we know of cases where it has been even higher, but the high cost is due to standing charges and not to high cost of production. In the same way the primary battery may be able to produce at 1s. 3¾d. for material only as per our figures during times of regular and heavy load, but the discrepancy between this and the average cost will be about the same as between 1¾d. per unit for

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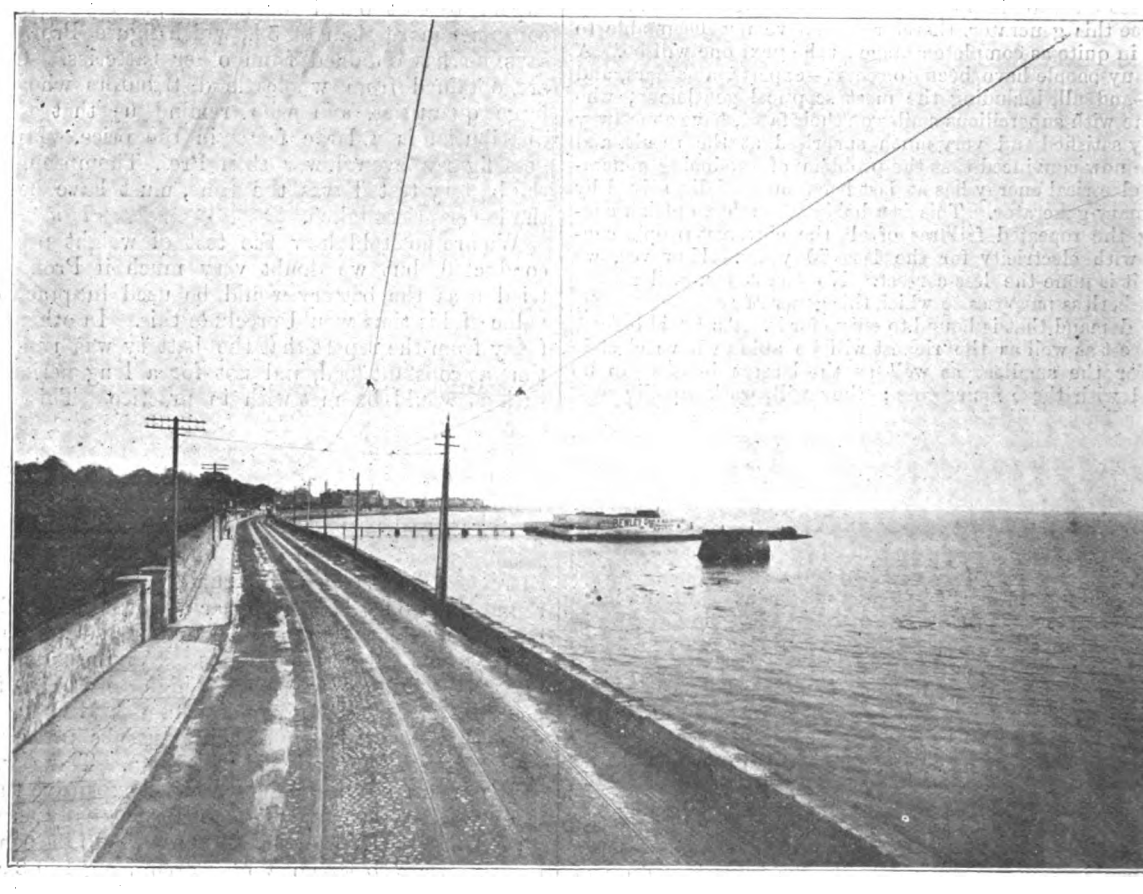
gas at heavy load and 1s. 5d. per average unit per annum for the gas-engine plant. The next point is that, by their own showing, the primary battery in question cost only £6. 5s. per annum (1,500 ($7\frac{1}{4} - 6\frac{1}{4}$) d.) to keep in order. The acid solution could hardly be mixed and put in for that, and yet the iron plates have to be replaced during the year. In fact, this sum does not represent more than $2\frac{1}{2}$ per cent. on the capital outlay, while it is supposed to cover interest and depreciation, labour and superintendence.

Coming now to the waste products, the acid is said to be almost used up before leaving the battery. Even then the acid iron solution is not a pleasant by-product to run down the drains, or, even worse, to turn into a ditch near a country house. The acid fumes are not all given off in the close cell, and the smell round the battery when we saw it was most objectionable. The fumes will at least destroy all the exposed metal work about the cells, and render the connections liable to give out at any moment. Another waste product is the half-used iron plates which have to be discarded owing to unequal action. These form a large proportion of the total iron, and are hardly worth removal in these days of cheap iron.

Perhaps the most ingenious feature of the battery on paper is the action of the gas pressure in keeping the acid supply round the iron automatically up to the requirements of the cell. This falls to the ground with the battery, as we saw it, as the arrangements of inlet and exit of the acid solution precludes an appreciable pressure being obtained in this way. The result of the pressure, if obtainable, would be to keep out fresh acid solution. Also, considering the relative density of the solution, the pressure is not required.

In regard to the originality of this battery, without wishing to detract from the credit due to the inventor, it is only fair to say that a combination essentially similar, known as Slater's battery, was invented many years ago, and may be found described in Sprague's "Electricity." Slater's battery consisted of a carbon electrode placed in a porous pot containing a saturated solution of nitrate of soda, together with two equivalents of sulphuric acid for each unit of salt dissolved. The specific gravity of the solution is 1·568. The porous pot was placed in a containing vessel. "On starting, the outer cell is charged with water, to which is added a small proportion of the solution to make it conducting and set up the action, which is then kept up by electrolysis and by endosmose, though it is to be observed that the liquid passes somewhat rapidly into the inner cell, the liquid in which stands at a considerably higher level than in the outer. . . . The action is maintained by removing a portion of the inner liquid at times and adding a fresh solution." An iron electrode (anode) placed in the outer vessel completed the cell. Sprague further says that "it may be used where it can be so placed that the fumes from it are not injurious, for though less than in other cases these are still given off, and renders it objectionable in a confined space." (Sprague, "Electricity," p. 158.)

One of the items of expense in the Rowbotham battery is the cost for nitric acid. Since sodium nitrate is much cheaper than nitric acid, whilst the resulting action of the two substances are practically identical, it is somewhat difficult to understand why the salt is not used in the present case.



The Electric Tramway to Clontarf.

To finish, we cannot let Lord Lurgan's remarks pass unchallenged. He said he thought it would be admitted "that Prof. Silvanus Thompson's name is sufficiently well known to inspire confidence." That may be so, and while we disagree with Prof. Thompson's report both as regards the uses of the battery and figures of cost, yet he does not say anything to warrant Lord Lurgan's statements that "the poorest as well as the richest will be able to have electric light," or that the batteries can be used commercially for driving launches, cabs, and tramcars. It may be necessary for the syndicate to form a large company in the early autumn, but at present they have absolutely no asset to offer to this company to warrant either a large purchase price or a large working capital.

PICTURESQUE ELECTRIC TRACTION.

The British Thomson-Houston Company, Limited, have sent us a copy of a book of views of electric lines equipped by them in England, and by the corresponding company on the Continent. These views of overhead traction as it is are the most powerful argument that could be given to those

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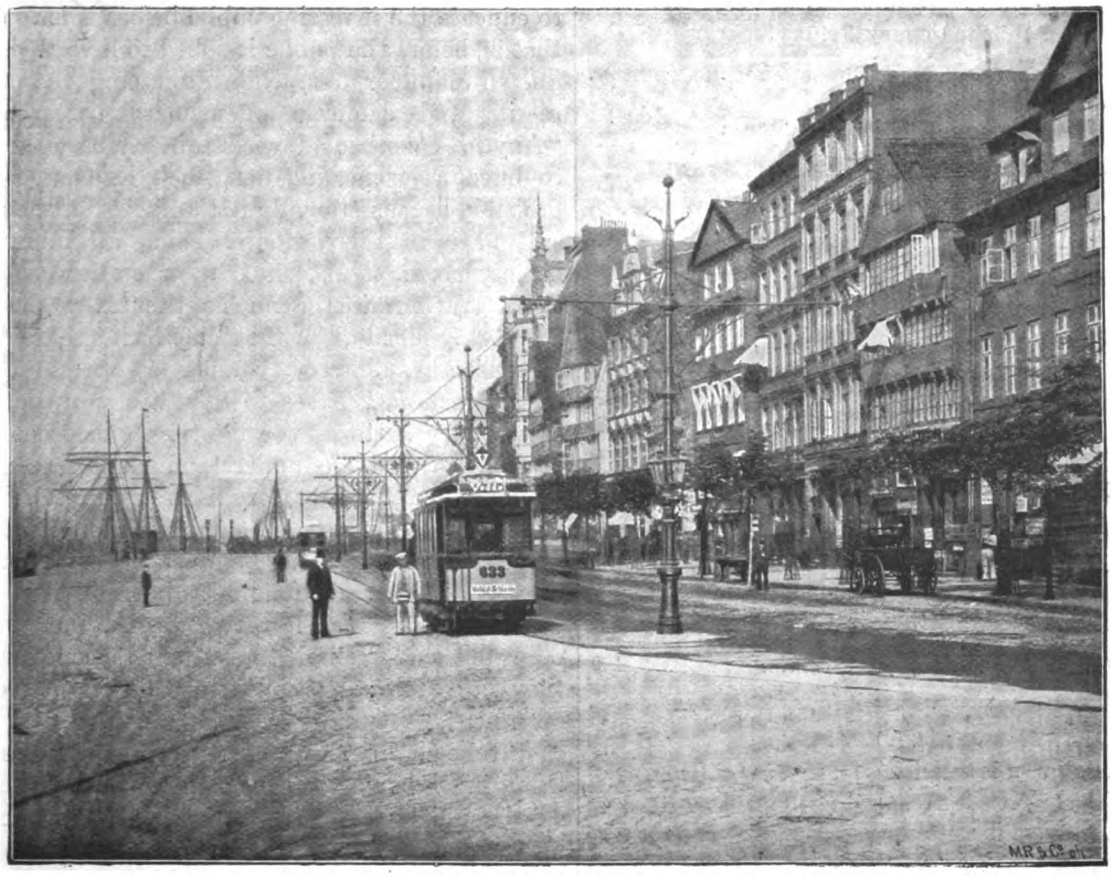
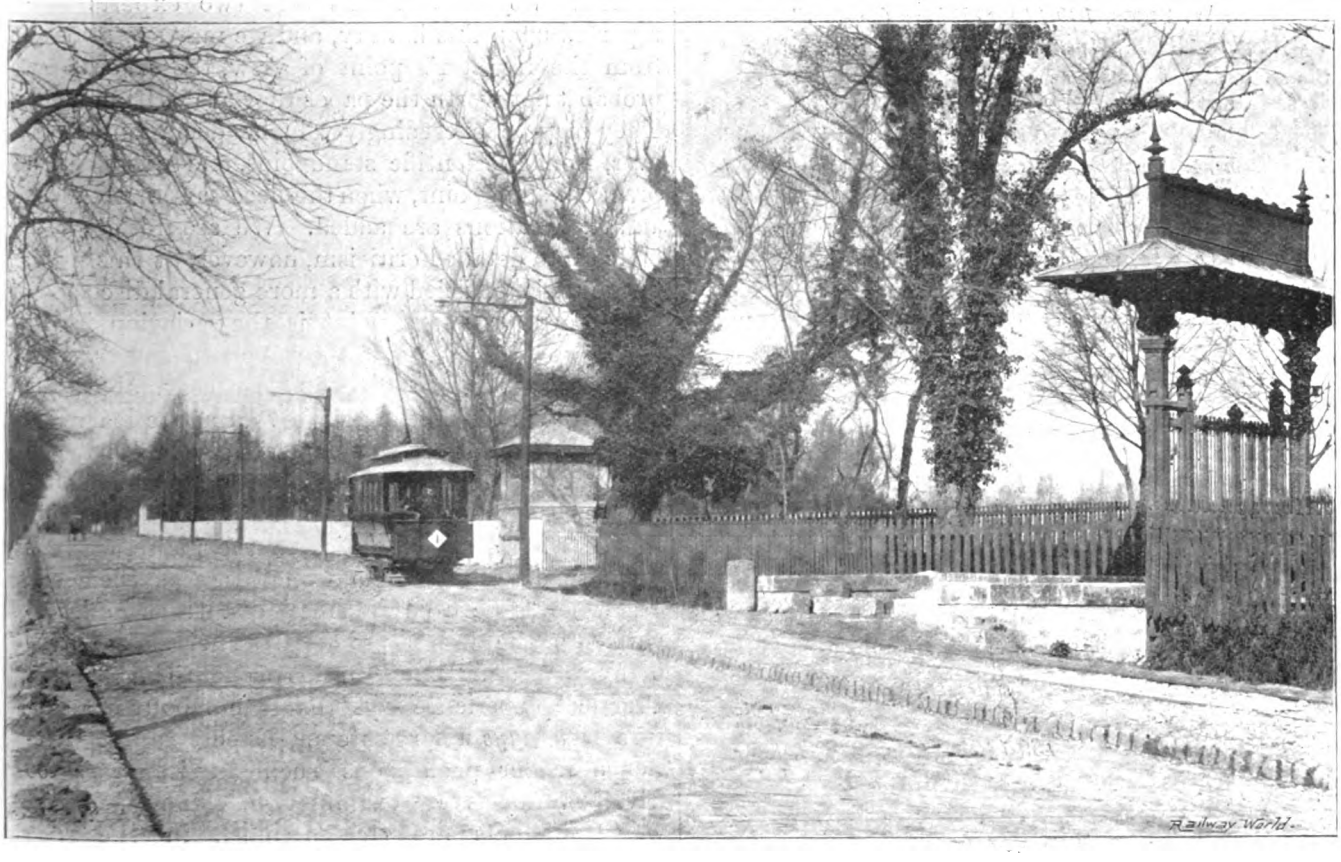
who object to electric traction on account of the unsightliness of the overhead wires. It is also curious to note that in the majority of the views the overhead wires have had to be darkened and exaggerated by the artist in order that they may be seen in the reproduction. The unsightliness, although magnified, is not appreciable. We give, through the courtesy of the company, three views from the collection of 60 or so the book contains. The first of these is of the line at Clontarf, belonging to the Dublin United Tramway Company. In this case the central suspension is used, with cross-wires to hold the trolley-wire insulator. In this the darkening of the wires by the artist is easily noticeable. The second view is of the line at Hamburg, where handsome central poles are used. The last view is from Bordeaux, showing a simple form of side-pole construction. The rest of the illustrations are equally interesting, and form a unique collection of picturesque spots on electric tramway lines.



A Street in Hamburg, showing Central Poles for the Trolley Wires.



The Electric Tramway in Bordeaux.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. XX. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

BOOMING PRIMARY BATTERIES.

We shall now have an opportunity of seeing how far the technical Press is honest in its endeavours to educate the investing public before it is too late—that is, before the public is asked to invest. A well-known manufacturer, while discussing the practical merits and demerits of primary batteries, said, "Anything connected with primary batteries seems to have a fascination for Stock Exchange folks," probably because they do not understand the subject and have in their mental being an undeveloped battery germ, latent since their earliest schoolboy days. We admire the pluck of the "New Electricity Supply Syndicate," in that they have, before issuing a prospectus, allowed a sufficiency of time to elapse for the technical Press to have a say in the matter of primary batteries for lighting purposes. As at present advised, we understand "the Press" is to be invited to see a battery next week. Our efforts to obtain more than a casual inspection have as yet met with no success. It must be said, however, that the ordinary public has been invited to see the battery for the last two weeks, but we may point out that such visitors usually accept just what they are told: they see certain lights, certain apparatus, everything is spick-and-span, the cost is said to be so much—all very pretty, and intended to bring in the bawbees without too much being known. The financial papers seem, however, to have once more met with a heartier welcome; at least, they profess to have information that is withheld from us. Why? Is the New Electricity Syndicate going to get money from a too gullible public without allowing the public to have unbiassed and unpaid-for expert advice? So far it seems that two experts have reported upon this battery, and we may say at once, from the investor's point of view, the reports are probably not worth the paper they are written upon. They may be exceedingly valuable documents, however, from a scientific standpoint, and even from a practical standpoint, when the necessary annotations and explanations are added. We are not going to be led into detailed criticism, however, at this point, but must be satisfied with a more general discussion. One most important point is the variation in the cost of materials. Is it too much to say that the cost will vary from 100 to 500 per cent. above the prices quoted by the syndicate? In practical work the cost of materials will depend very largely upon the quantities purchased, and the geographical position of the point where purchased. Estimating the cost in large quantities at the manufacturer's premises does not come out the same as the actual cost when purchased in small quantities and conveyed to the user's premises. There are far too many "ifs" and "buts" in this matter to be pleasant. Practical experience says that the labour expenditure is *always* a large item. Expert report experience rather pooh-poohs such an item as too frivolous for real examination. Then, again, waste products are treated much in the same way, but in practice they *always* give considerable trouble, and lead to proportionate expense. We might lay considerable stress upon the point that the cost of iron in bulk is quite different from

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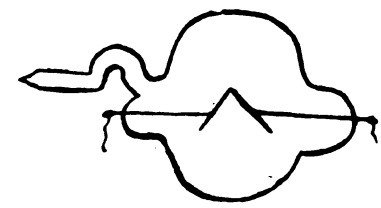
the cost of iron in plates of the size required for this battery. It is principally with the report of Prof. Thompson that we have to deal, because he is the better known of the two experts, and undoubtedly his report will be made the most prominent of the two. Now, Prof. Thompson is an old hand at such reports, and he cannot escape from the position that he does and must know his report will be used to influence an investing public. How, then, can he reconcile some of his statements with what may be termed his duty to those whose money is to be subscribed because of those statements? Is it the part of an expert to take promoters' or inventors' figures? Yet Prof. Thompson says, "the figures of cost . . . submitted to me." Ought he not to verify these figures from independent sources? Take the point previously mentioned—the iron plates. If our contention is correct—that these plates cannot be obtained at the cost quoted—what becomes of the truth of his estimated capital outlay? Further, we contend that an expert whose report is to be used to influence subscriptions should not stop short of the figures required by the public for just comparison. The user does not want to know the estimated cost per unit for generation; he wants to know the cost per unit as used. To the cost of generation, even if this be correct—which in this case for the ordinary consumer it is not—many other costs have to be added before the real cost per unit is ascertained. Suppose all these costs bring the real total to five shillings, ten shillings, or twenty shillings per unit (these are merely figures for argument), it might be possible that many people would still install the apparatus, but it is absolutely certain that an investing public would not run so eagerly to invest as when the generating cost is given as something not over sixpence halfpenny or under fivepence. The ordinary run of readers will—thoughtlessly, it may be, yet still it will be done—compare this fivepence to sixpence halfpenny with the charges made by central stations, varying from, say, fourpence to eightpence, and this comparison, we say, is wholly misleading.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

SOME FACTS ABOUT THE X-RAYS.

SIR,—Ever since the Röntgen X-rays were accidentally discovered we have had many experiments carried on in connection with them, but the progress has been comparatively small, and being in possession of what I think to be a little information in connection with the X-rays, I propose to lay it before your readers for their use and consideration. I take it that we are all of one mind—that we like to see progress made in scientific investigation and experiment. The sum total of all experiments, so far as I have read them, is that the rays emitted from the platinum anodes and cathodes are yellow green. We will ask ourselves first of all what is the best kind of focus tube giving the greatest volume of X-rays, and I would in reply suggest the tube shown in the accompanying illustration, as I think it a great improvement on the present style. As will be seen, the anodes and cathodes are alike, and must be made of the same material. Every element or combination of elements gives off a certain defined ray or tint according to its composition and density. If we put a pane of glass of one particular tint in a window frame, and put another similar pane immediately at the back of it, the light passes through unimpeded; but put a darker-tint glass behind the first mentioned pane of glass, and you get light in the room according to the tint of the second glass.



It is not that the light of the first pane of glass does not pass through the darker one, because it really does, but it is because of the composition of the glass containing a darker element or solid. This is a law of the earth: a like element or light ray has an affinity for a like element or ray. The same principle is equally applicable to the X-rays. If you get a piece of platinum wire and put it in a Bunsen flame you get, I think, a yellow-green tinted light or vapour ray from it. Call it a vapour ray or tinted light just as you like, but it means the same thing. Now if we put platinum wire anodes and cathodes in the focus X-tube and pass an electric current through it, we note the fact that we get a similar yellow-green ray as was produced by the Bunsen burner. Kindly note that similarity. It is the same with all other elements and metals, etc. Whatever the tint or ray is given by the Bunsen burner, you can depend upon it the same ray will be given off in the X-ray tube. The best guide-book which I can advise the student of the X-rays to take up is Tait's "Properties of Matter." He can see at a glance in that book what is the vapour ray of almost every metal. Now, after adjusting our focus tube, we ask ourselves why do the platinum rays penetrate flesh and not bone also. The answer to that question is simplicity itself, *i.e.*, the vapour ray given from flesh is yellow green, and it follows that the yellow-green ray of the platinum must pass through the flesh, but it will not penetrate bone, for the simple reason that bone contains a great proportion of phosphates of lime, which gives off a darker ray or tint. If it is necessary to penetrate only the bones, I advise that the anodes and cathodes be made of pure carbon and a sheet of compressed phosphates of lime or a wide clean bone be placed at right angles to the rays near the tube, or a very flat bottle filled with ground bones will do equally as well. I think if that experiment were tried, it would be found to answer well, but I am not quite so sure if the present fluorescence screen would be suitable. I expect that the screen would have to be altered according to the tint or ray photographed. The screen composition or coating would probably have to possess the same ray or tint as that focussed. If we wished to see through steel, we should use steel anodes and cathodes, brass for brass, aluminium for aluminium, gold for gold, silver for silver, and so on *ad infinitum*. If we wish to find flaws in steel and iron, I suggest that carbon anodes and cathodes alone be used. If the above ideas were carried out I have no doubt but that considerable progress would be made.—

Yours, etc.,
GEO. H. SMITH.

Daniel-street, Cardiff, July 25.

ALUMINIUM AS AN ELECTRODE IN CELLS FOR DIRECT AND ALTERNATE CURRENTS.*

BY E. WILSON.

(Continued from page 111.)

In Figs. 1 and 2 the Siemens dynamometer in the circuit registered the same current—namely, 3·97 amperes—but the frequencies are 16 and 98·5 respectively. We see that $\frac{1}{16}$ second is too short to allow the effect we are looking for to fully develop, since the ratio of the maximum coulombs

* Paper read before the Royal Society, May 26. Communicated by Dr. J. Hopkinson, F.R.S.

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is 1·47. On the other hand, if we examine the two sets of curves we see that at 98 periods per second the potential difference between the exploring electrode and aluminium has a maximum value of 3·63 volts during the half period when the coulombs have the smaller maximum, whereas at 16 periods per second the same maximum current is

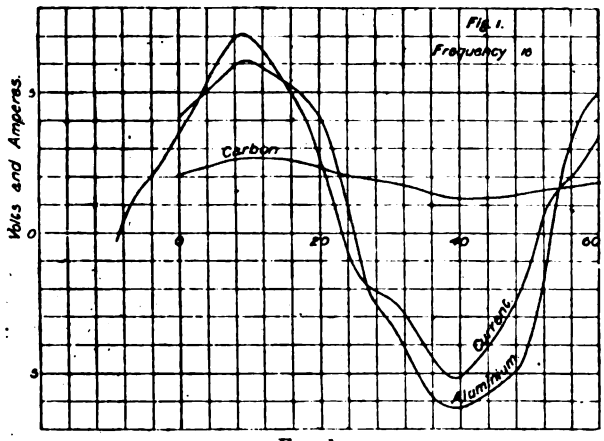

FIG. 1.

produced with a larger maximum potential—namely, 6·27 volts. That the aluminium plate was an anode during the half period when the maximum coulombs were a minimum, was proved by noting the direction of the electrometer deflection, when the positive pole of a Clark's cell was connected to the insulated quadrant, and examining

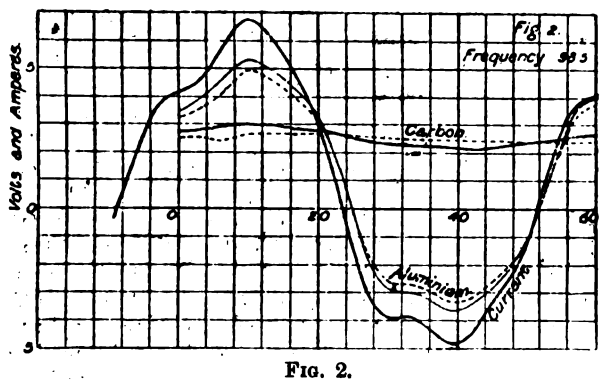

FIG. 2.

the observed direction of the deflection during the experiment. Experiments made upon the resistance of the electrolyte with two exploring electrodes employing alternate currents show that at the temperature at which these experiments were made—namely, 13½deg. for the 16 frequency and 11½deg. C. for the 98·5 frequency—the resist-

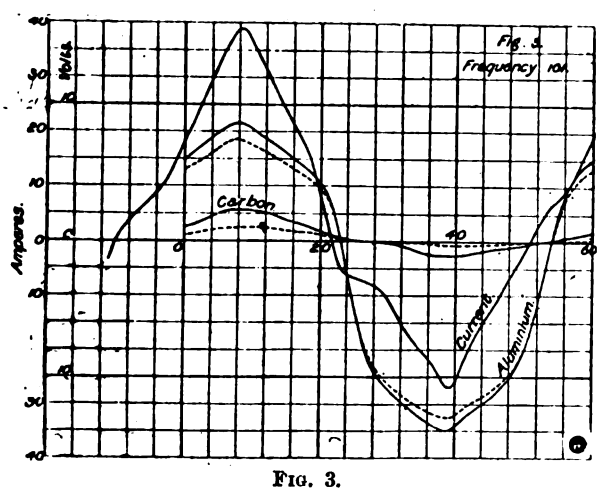

FIG. 3.

ance of a layer of the electrolyte of area equal to the area of the plate submerged, and length equal to the distance between the electrode and the plate has a resistance of about 0·063 ohm. The curves of potential in Fig. 2 have been corrected for this, and the dotted lines show the results. The average watts dissipated by electrolytic hysteresis at the carbon and aluminium plates at 98·5 periods per second (Fig. 2) are 0·69 and 4·5 respectively. This takes no account of the resistance of the electrolyte, and has been obtained by taking instantaneous products of potential and current at 20 equal intervals during the period. During the first half period work is supplied at the carbon plate on the average at the rate of 4·1 watts; during the second half period the plate does work on the system at the average rate of 2·7 watts. The aluminium plate returns practically nothing to the system.

In Fig. 3 the frequency is 101, the ratio of the maximum coulombs in the two halves of the period is 1·7, and the Siemens dynamometer in the circuit registered 20·6 amperes. The average temperature during this experiment was about 55deg. C., but had a maximum of 64deg. C. at the end of the test. Under these conditions evaporation of the electrolyte was rapid. The experiments on the resistance of the electrolyte at this frequency and temperature give 0·033 ohm, and the potential curves have been corrected, the result being shown by the dotted lines. The average rate of dissipation of energy due to electrolytic hysteresis at the aluminium plate during the period is 153 watts, whereas at the carbon plate this rate is only 9·8 watts. We see that the maximum volts during the half period when the maximum coulombs are a minimum have risen to 13, whereas during the other half period the maximum volts are only 7½.

The paper by Graetz already alluded to deals with alternate currents; and two groupings of cells with aluminium plates as the one electrode are given, whereby he proposes to rectify alternate currents. He gives 22 volts as the potential an aluminium cell is capable of opposing, and states that the current could not be measured with a delicate galvanometer. The first grouping of these cells consists of placing between the poles of the alternator two

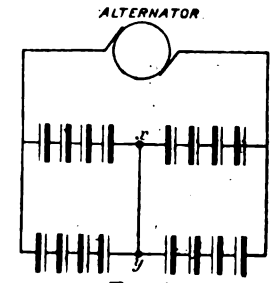

FIG. 4.

circuits in parallel, in each of which he places four cells in series. The poles are reversed so that in the one circuit the predominating current will be positive, whereas in the other it will be negative. The other grouping of these cells is shown in Fig. 4, and the author states that he gets a unidirectional current in the circuit $x\ y$. In this circuit he has operated a direct-current motor, and deposited copper. By superposing one of the current curves in Figs. 1, 2, or 3 on the same curve, but with reversed phases, one can form an idea as to what the resulting current would be in the circuit $x\ y$. Curves in Fig. 5 were obtained by

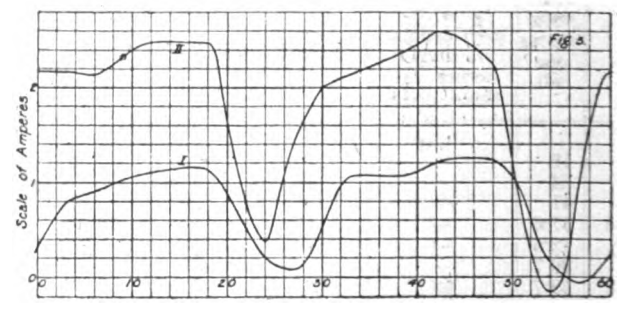

FIG. 5.

observing the instantaneous value of the potential difference between the ends of a non-inductive resistance of 0·349 ohm, forming the circuit $x\ y$, Fig. 4. Four small cells were used, each one taking the place of the group of four in the diagram. Each of these consists of a thin aluminium sheet and a carbon plate, the opposed surfaces in a saturated alum solution

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having each 10 square inches, separated by a distance of $\frac{5}{32}$in. In Fig. 5, Curve I. is the current in $x\ y$ when the current from the alternate-current machine through the system was 3·96 amperes, as given by a Siemens dynamometer. Curve II. is the current in $x\ y$ when the Siemens dynamometer read 10·4 amperes. The frequencies were 74 and 73·3, and the temperatures of the cells 25deg. C. and 44deg. C. respectively in the two experiments. Graetz states that with cells of sufficient size 95 to 96 per cent. of the energy of the alternate current can be changed into direct current. The efficiency of such a system as shown in Fig. 4 will obviously be the ratio of the rate at which work is done on $x\ y$ to the rate at which work is done on the whole system by the alternate-current machines. If this is to be 95 per cent., then only 5 per cent. must be dissipated in the cells.

An important point in connection with the working of these cells is the wearing away of the aluminium. The thin metal used in the small cells above alluded to is perforated with small holes, but I have not noticed so much deterioration in the thicker sheet. The evaporation of the electrolyte is another matter which needs consideration if the temperature is raised fairly high in working.

Two Aluminium Plates in Alum Solution.

These experiments were undertaken to find what effect as a condenser this metal with its film has with varying frequency, temperature, and current. The aluminium plates in the two large cells above experimented upon were opposed to one another in a saturated alum solution. The distance between them was $\frac{1}{8}$in., and the opposed areas in the solution are 36 square inches on each plate.

TABLE V.

Experiment.	Frequency.	Max. volts across one cell.	Max. amperes.	Current $\sqrt{\text{mean}^2}$, as given by Siemens dynamometer.	Temperature.	Ratio of energy returned to energy supplied per period per cent.	Average phase difference 360deg. = one period.	Average rate of dissipation energy in cell.	Plates.
				Amperes	Deg. C		Deg.	Watts	
(*a*)	96	25·0	30	21·6	82	—	12	—	Al
,,	,,	3·35	,,	,,	24	—	9	—	Fe
(*b*)	17	46·0	8	3·93	53	0·72	12	150	Al
,,	,,	1·3	,,	,,	11	—	60	—	Fe
(*c*)	100	52·5	2·6	1·3	14	16·0	54	42	Al
,,	,,	0·25	,,	,,	9	—	—	—	Fe
(*d*)	92·4	21·0	1·48	—	11	11·2	60	9·24	Al
(*e*)	92·4	8·0	0·51	—	13½	16·6	57	1·11	Al

The important data have been collected in Table V. As a comparison, two plates of ordinary sheet iron of the same area and the same distance apart as in the aluminium cell were placed in a saturated solution of alum and placed in series with the aluminium cell. As before, the circuit included a Siemens dynamometer and non-inductive resistance, and potentials were observed for different positions of the phase across the non-inductive resistance, and each cell, by aid of a Kelvin quadrant electrometer and revolving contact-maker. On account of the irregular wave form of the curves of potential and current, the ratio per period of the energy returned to the system by the cell to the energy supplied to the cell is given as a percentage. If the electrolytic process were perfectly reversible, we should expect the curves of current and potential to have a phase difference of one-quarter period if they were sine curves. An examination of Table V. shows that maximum phase difference develops with the smaller currents at lower temperature. In experiment (*c*) the maximum amperes are 2·5, the maximum volts 53. The curve of potential difference has a maximum rate of change of about 57·5 volts in $\frac{1}{600}$ second, so that an ordinary condenser with maximum current 2·5 amperes would have a capacity of about 72 microfarads. We see, therefore, that aluminium is suited for the plates of condensers. The average watts in Table V. have been deduced from the instantaneous product of potential and current at 20 equal intervals during a period.

The foregoing experiments employed saturated potash alum solution as electrolyte. The following experiments deal with soda, ammonia, and potash alums—first, when the solutions were saturated, and, second, when non-saturated. In each of the non-saturated solutions the proportions were 13 parts of saturated solution at about 12deg. C. by volume and 70 equal parts of distilled water. Three cells were constructed, each containing two aluminium plates of 99·5 per cent. purity, separated $\frac{1}{8}$in. apart, and each having 33 square inches of surface in the electrolyte opposed to the other. The results of the experiments are given in Table VI.

With regard to the saturated solutions, one may say that at the low frequency 7·5 (Table VI.) the results are not so good as at the high frequency 92·4 (Table V.). The non-saturated solutions also show a better result with regard to efficiency at the higher frequency.

These plates were not specially formed with direct currents and carbon cathodes before starting the above experiments. In a preliminary experiment of about one hour's duration before the first series at frequency 33 in Table VI. were made, and starting with clean polished plates, the maximum volts for the soda, ammonia, and potash were, a few minutes after starting, 4·4, 21·5, and 32. The maximum current was 0·48 ampere, and the phase differences in each case about 70deg. The frequency was 23 and the temperature of each cell about 14deg. C.

An experiment was tried in which two aluminium discs, 6in. diameter and separated $\frac{3}{16}$in. on an ebonite spindle, were submerged to within $\frac{3}{4}$in. of the centre in a saturated potash alum solution, and rotated at 108 revolutions per minute by a small electric motor. In this manner more

TABLE VI.

Frequency.	Max. volts across one cell.	$\sqrt{\text{Mean}^2}$ as given by multicellular voltmeter across the three cells.	Max. amperes.	$\sqrt{\text{Mean}^2}$ as given by Siemens dynamometer.	Temperature of cell in degrees Centigrade.	Ratio per period of energy returned to energy supplied to cell per cent.	Average phase difference, 360° = 1 period.	Average rate of dissipation of energy in cell.	Alum solution in cell.
		Volts.		Amperes.			Deg.	Watts.	
33	16	—	1·73	0·79	15	25·5	78	3·6	Soda, saturated solution.
,,	34	—	2·17	1·03	19	2·5	31	26·2	Ammonia ,,
,,	41	—	,,	,,	19½	2·7	31	25·3	Potash ,,
54·6	37·6	—	1·87	1·12	25½	8·7	44	22·0	Soda ,,
,,	42·5	—	,,	,,	19	17·3	36	24·0	Ammonia ,,
,,	39·7	—	,,	,,	19	4·3	30	28·0	Potash ,,
7·5	39·7	90	0·525	—	14	7·6	57	9·1	Soda ,,
,,	48·5	91	0·95	—	15	2·8	48	23·0	Ammonia ,,
,,	42·9	,,	,,	—	15½	1·9	36	21·0	Potash ,,
10·5	31·3	88	0·66	—	13½	3·2	41	5·0	Soda, non-saturated solution.
,,	49·1	92	0·685	—	15½	4·0	48	10·3	Ammonia ,,
,,	44·4	,,	,,	—	16	2·6	36	10·0	Potash ,,
43·2	35·0	89	0·894	—	15	26·0	70	6·0	Soda ,,
41·3	47·6	,,	,,	—	17	22·0	71	9·6	Ammonia ,,
,,	45·0	,,	,,	—	17½	14·0	65	11·1	Potash ,,
18·5	57·8	120	2·61	1·25	16½	2·0	36	42·4	Soda ,,
18·1	55·7	117	,,	,,	21	2·1	33	39·4	Ammonia ,,
,,	48·8	,,	,,	,,	20½	1·4	28	37·6	Potash ,,

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than half the discs were continuously exposed to the atmosphere. Two brushes bearing on copper discs, pressed into good contact with the aluminium discs, served as a means of transmitting current through the electrolyte between the discs. The frequency was 73, the temperature 18deg. C., and square root of mean square value of current about one ampere. No perceptible difference was observed in phase difference between potential and current when the discs were rotated and at rest in the electrolyte.

The conclusion is that the effect investigated in this paper takes time to develop, and is not fully developed with alternate currents of frequencies 16 and 98 complete periods per second. It can be increased by increasing the current density for a given film, and is greatly influenced by temperature. The metal aluminium with its film is suitable for use as the plates of condensers, if due regard be given to current density and temperature. It might in some cases be found useful as an equivalent to a metallic resistance.

Messrs. Simpson, Greenbank, and Davy, student demonstrators in the Siemens Laboratory, King's College, London, have given me valuable assistance in the experimental part, and in the working out of results. To these gentlemen I tender my thanks.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE I.

(Continued from page 116.)

The composition of the specimen from Palaq. Borneense was found to be intermediate between that of Palaquium (Dichopsis) gutta and Palaq. oblongifolium from Perak, as it contained 85·3 per cent. of gutta and 14·7 per cent. of resin in the guttapercha proper. The specimen from Payena Leerii agreed fairly well in composition with that from Perak, giving 54·8 per cent. gutta and 45·2 per cent. resin, the difference between the two being negligible for practical purposes.

The author proceeds to give the results of analyses of several materials which were described either as Getah taban or merah, or both, and for comparison that of a small piece of homogeneous pinkish material, which he picked out from a large commercial lot of first-class as resembling in appearance this class of guttapercha, and observes that, as far as quality is concerned, there is not much difference between the four materials, so that we may consider the average as representing the guttapercha known as Getah taban merah.

The second part of Table II. affords a similar comparison for various specimens received under the name of Getah mantah, sundek, sondek, or soondie. Here, again, the mean of the figures fairly represents the average composition of this particular kind of second-class guttapercha.

Table III., which follows, is particularly interesting as showing the composition of some historical specimens of guttapercha, one sent to Sir Wm. Hooker by Lobb in 1846, and the second by Oxley in 1847, both being described as having been obtained from the same tree as the botanical specimens which they accompanied. The third specimen is the one collected in 1887 by Sérullas at Bukit Timah from an offspring of Oxley's tree, as already mentioned, the corresponding botanical specimen being also here to-night. The comparatively large amount of resin in Oxley's specimen is noteworthy, as is also the marked difference between this and Sérullas's specimen, which latter contains an exceptionally low amount of resin. It may be that the great age of Oxley's specimen and its long exposure to air and light in the museum has something to do with this, as it is bady oxidised on the surface, whereas the older specimen from Lobb, which had been protected from light in the herbarium, is still in an excellent state of preservation.

The specimen collected at Johor about seven years ago contains even less resin than that from Sérullas, showing that excellent trees must have existed at that time, and probably still exist in that district.

But we must now leave the specimens of scientific interest and consider the commercial materials. These are mostly designated according to the names of either the producing countries, or the places whence they are exported. Examples of the former have such designations, for instance, as Pahang, Bulongan, Sarawak, etc., and of the latter, Bagan, Serapong, Macassar, etc. Of the numerous sorts which appear on the Singapore market, I can only deal with the principal ones, and I have selected the following 12 brands as typical of the rest of them, and divided them into four groups for convenience in comparison and reference, as follows :

First group, comprising the three best kinds of guttapercha, probably all derived from some species of Palaquium closely related to Pal. gutta and Pal. oblongifolium—

1. Pahang, from the Malay Peninsula.
2. Bulongan red, from Borneo.
3. Banjer red, from Borneo.

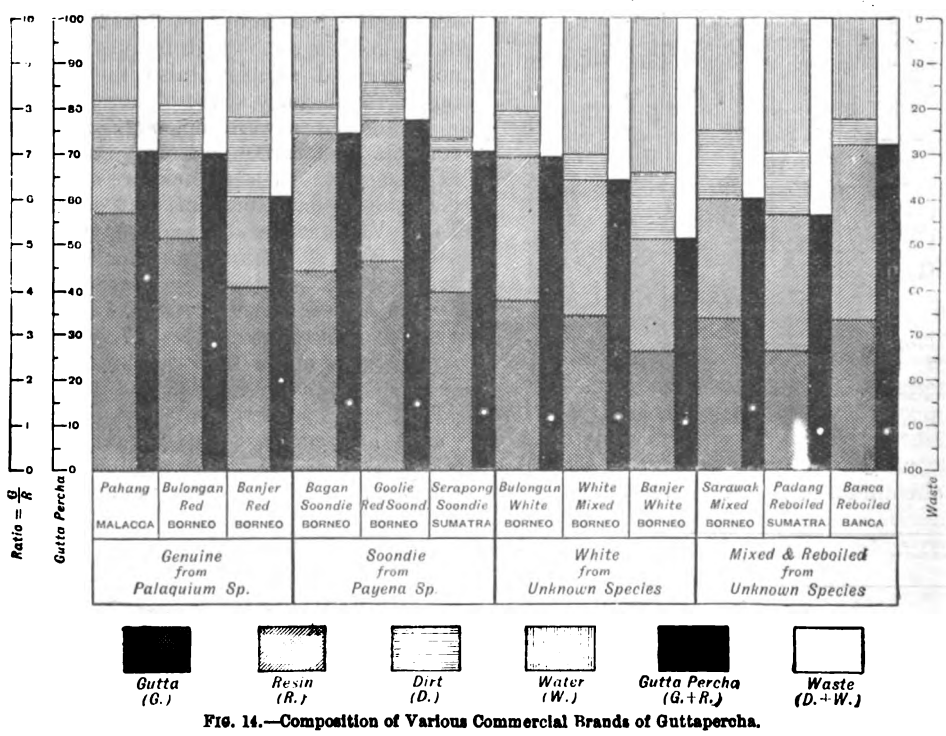

FIG. 14.—Composition of Various Commercial Brands of Guttapercha.

The name of "Pahang" guttapercha is now applied to any first-class material, irrespective of its geographical derivation.

Second group, comprising three kinds of guttapercha of the second order, probably all derived from some species of Payena, possibly from Payena Leerii :

4. Bagan goolie (and gutta) soondie, from Borneo.
5. Goolie red soondie, from Borneo.
6. Serapong goolie soondie, from Sumatra.

[NOTE. — Goolie red soondie is identical with Kotaringin goolie soondie.]

Third group, comprising three kinds of so-called "white gutta" of second and third class from unknown trees, possibly partly from Dichopsis polyantha or pustulata, and partly from some species of Payena :

7. Bulongan white, from Borneo.
8. Mixed white, from Borneo.
9. Banjer white, from Borneo.

* Cantor Lectures delivered before the Society of Arts.

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Fourth group, comprising three "mixed" materials, two of them being what is termed "reboiled" (an operation performed by the Chinese, who buy up odd lots, soften the materials in hot water, and make them into a more or less homogeneous average mixture):

10. Sarawak mixed, from Borneo.
11. Padang reboiled, from Sumatra.
12. Banca reboiled, from Banca.

[NOTE.—The mixed Sarawak lots mostly represent a very useful second-class material. The two reboiled are decidedly inferior.]

The average composition of the various commercial brands is graphically represented by diagram (Fig. 14), each value being deduced from the analysis of a great number of individual lots, taking into account their relative weights. Altogether 2,282 tons of raw guttapercha are represented by the figures in this diagram, and 751 analyses of individual lots.

The calculation of the mean values from the percentage composition of each lot was, as you may imagine, a rather laborious task.

bined being the essential factors for estimating the value of a sample.

For a comparison of different materials it suffices, therefore, to observe the length of the black column, and the height of the white dot above the datum line. The division of the different brands into four distinct groups is also shown on the diagram, and you observe at once that the members of the first group, although not remarkable for great length of the black column, are yet distinguished from all others by the greater elevation of the white dot, indicating a favourable ratio between pure gutta and resin. Other materials, on the contrary, are conspicuous by their comparatively large yield of guttapercha proper, but the ratio between gutta and resin, as indicated by the position of the white dot, is unfavourable—*e.g.*, Goolie red soondie, and Banca reboiled. One of the least favourable materials is Banjer white; it contains 33⅓ per cent. water and about 15 per cent. of dirt, making in all nearly 50 per cent. of waste; the position of the white dot is pretty low, although not quite as low as in the two reboiled materials. The cleanest kind is the Serapong soondie, which contains only 3⅓ per cent. of dirt, but it is rather wet, having more than 25 per cent. of water. When a raw material is very dirty and wet, it is of course already noticeable on cutting the blocks open, and this is now mostly done by the dealers at Singapore. The blocks are then sorted out into several grades (two or three, sometimes more), according to their appearance, and valued separately.

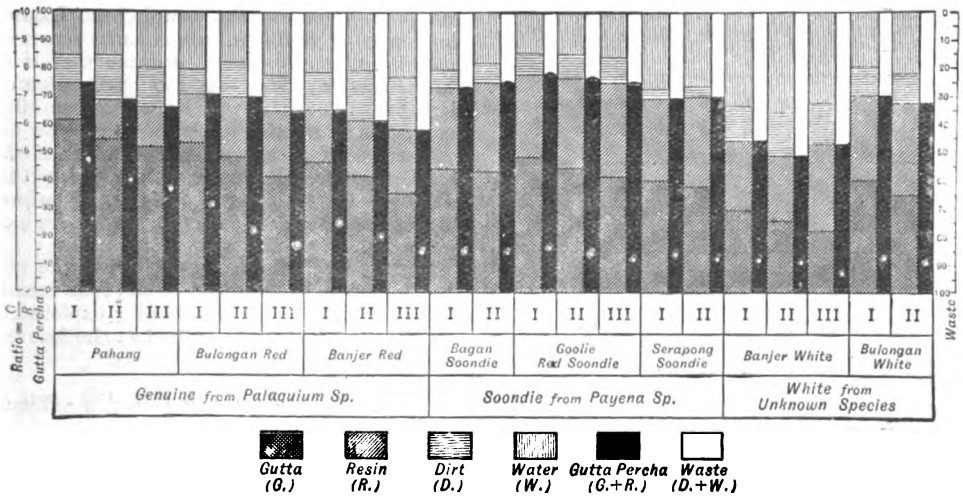

FIG. 15.—Composition of Different rades of Commercial Brands of Guttapercha.

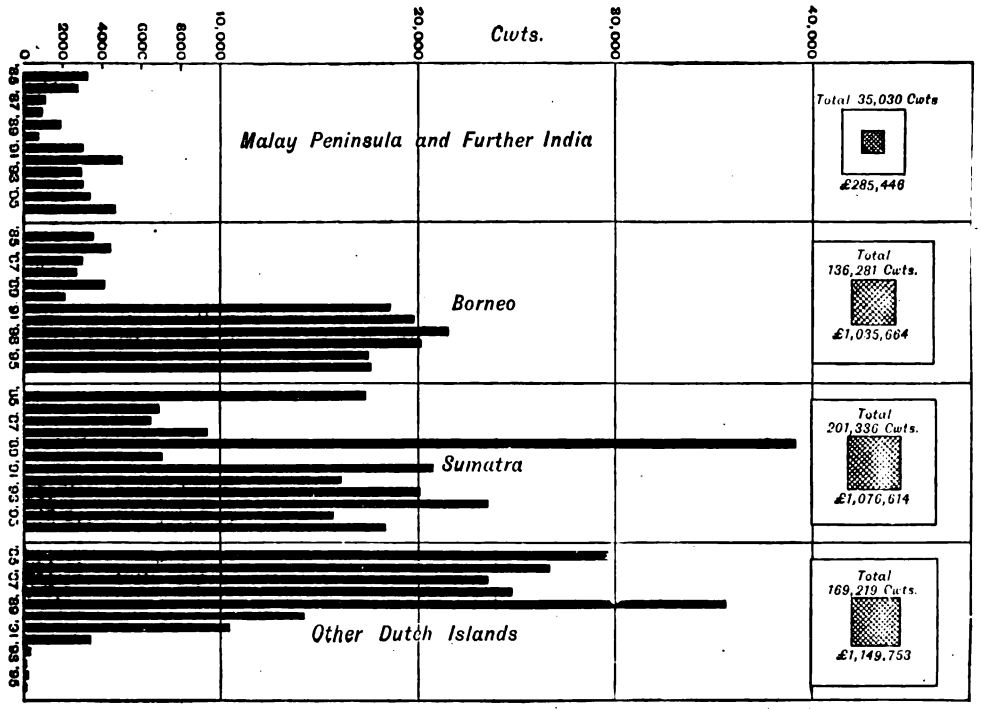

FIG. 16.—Importation of Guttapercha into Singapore from Producing Countries.

The diagram is so arranged that the components are, as it were, piled one on top of the other: first the gutta, indicated by cross shading; next the resin, shown by oblique lines; then the dirt, by horizontal; and finally the water, by vertical lines. The height of the black column at the side represents the percentage of "guttapercha proper" contained in the raw material, and, consequently, the empty space above the "waste." The small white dot indicates by its elevation above the datum line the ratio between pure gutta and resin—*i.e.*, the character of the guttapercha—quantity and character com-

The results represented by the diagram (Fig. 14) have been worked out without taking these grades into consideration, but in the next diagram (Fig. 15) average values are given for different grades of each particular brand. This diagram shows that not only the amount of water and dirt increases, as a rule,

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TABLE IV.—Analyses of Commercial Samples from Localities on Boundary of Geographical Area of Growth of Guttapercha Trees.

Number of sample.	Geographical position on boundary of area.	Material as received.									Guttapercha proper.				
		District and territory.	Appearance, etc.	Percentage composition.				Totals.		Ratios.	Percentage composition.		Quality.	Appearance of components.	
				Gutta. G.	Resin. R.	Dirt. D.	Water. W.	G.P. (G.+R)	Waste. (D.+W.)	G.P./Waste.	Gutta. g.	Resin. r.	$\left(\frac{r}{10}\right)$ q.	Gutta.	Resin.
1	N.N.E. (on).	British North Borneo	Light brown, little fine bark.	68·5	18·1	11·9	1·5	86·6	13·4	6·5	79·1	20·9	2	Light brown, strong.	Light brown, hard.
2	E. (within.	Coti, Borneo.	Brown, grey, woody.	42·0	14·4	16·9	26·7	56·4	43·6	1·3	74·5	25·5	2b	Brown, very strong	Yellow, hard.
3	S.S.E. (well within).	Banjermassin, Borneo	Light pinkish-brown, woody.	50·4	12·9	12·6	24·1	63·3	36·7	1·7	79·6	20·4	2	Brown, very strong.	Yellow, hard.
4	S.S.W. (within).	Lampong, Sumatra.	Brown, woody.	31·7	26·0	22·3	20·0	57·7	42·3	1·4	54·9	45·1	4b	Brown, very strong.	Light yellow, hard.
5	W. (without).	Achin, Sumatra.	Light brown, dense, clean.	72·8	13·6	9·5	4·1	86·4	13·6	6·4	84·2	15·8	1b	Light brown, very strong.	Brown, soft.
6	N.N.W. (within).	Penang, Malacca.	Brown, much fine bark.	41·5	19·5	14·0	25·0	61·0	39·0	1·6	68·0	32·0	3a	Dark brown, strong.	Yellow, hard.

from one grade to the next, but also the relative proportion of resin and gutta; consequently the line connecting the white spots of the various grades of any particular brand is more or less inclined and not horizontal, as would otherwise be the case.

The analytical results in Table IV. refer to a set of six samples chosen from localities lying as near as possible to the boundary limiting the growth of guttapercha plants, shown by the rectangular space on the map (Fig. 7). The samples are derived from the following territories and districts—viz.: (1) British North Borneo; (2) East Borneo (Coti); (3) South Borneo (Banjermassin); (4) South Sumatra (Lampong); (5) North-East Sumatra (Achin); (6) North-West Malacca (Penang). They thus represent the N.N.E., E., S.S.E., S.S.W., W., and N.N.W. parts of the boundary line. In each case the best specimen hitherto obtained from the respective district was selected, the object being to demonstrate that good class guttapercha is actually produced there, though commercially it may be in unimportant quantities.

The result of the analyses of these samples bears this out, except in the case of the sample from Lampong, the southernmost part of Sumatra, which only represents a second-class material, so it may just be possible that the southern limit of the area—viz., 6deg.—is too great, although, of course, no definite conclusion can be drawn to that effect. On the other hand, it is interesting to observe that the sample from Achin, situated beyond the western boundary of the area, yielded an excellent material, and although the quantity imported into Singapore from Achinese ports during the last 12 years was only 15cwt., yet the price paid for it was a high one—viz., over 2s. per pound.

Here it is, therefore, possible that the western boundary of the area ought to be extended, and considering that the northern part of Sumatra is as yet hardly explored, it is not unlikely that it will have to be shifted in the future to the dotted line shown on the map.

Imports into and Exports from Singapore.

I have now arrived at the last section of my programme for to-night, the statistical and financial part of the subject. Here I can be very brief, as the more generally interesting particulars have been represented by diagrams, whilst the detailed information will be given in the supplement.

The diagram (Fig. 16) shows the quantity and value of raw guttapercha imported into Singapore, the chief market place of this article, for each year from 1885 to 1896 from the principal producing countries, and you will observe the extraordinary fluctuations. Look, for instance, at the quantity imported from Sumatra in 1889, amounting to over 39,000cwt., and compare it with that in the following year, which is only little more than 7,000cwt. Also look at the import from "Other Dutch Islands" in 1889, which is over 35,000cwt., whereas five years later it is reduced to only 63cwt. The shaded squares on the diagram represent the total imports into Singapore during the 12 years from each particular country, and the larger unshaded squares the corresponding values. The largest amount during this period came from Sumatra, but the total value of the import from Borneo is only about 4 per cent. lower than that from the first-named island, whilst the quantity is 20 per cent. lower, which is significant of the respective qualities of the materials.

Table V. gives the imports into Singapore for the last five years (1892 to 1896) from the various districts of Borneo and the Malay Peninsula; it also shows the values per pound in pence. This enables you to form an opinion about the relative quality of the materials produced in the various districts. Compare, for instance, the values per pound for Penang, Johor, and Kelantan.

Table V.—Imports into Singapore during last Five Years (1892-1896).

Country.	Quantity. Cwts.	Value. £	Value per lb. Pence.
Borneo —			
British North Borneo	4,201	26,240	13·4
Brunei	279	2,279	17·5
Sarawak	14,232	115,842	17·5
Borneo proper	76,688	560,145	15·7
Labuan	1,443	11,162	17·3
Sulu Archipelago	255	1,347	11·3
Malay Peninsula—			
Penang	11,298	120,560	22·9
Perak	344	2,378	14·8
Selangore	776	5,756	15·9
Sungei Ujong	189	1,454	16·5
Malacca	336	2,206	20·0
Johor	646	5,342	17·7
Pahang	2,389	15,911	14·3
Tringganu	2,088	12,645	13·0
Kelantan	1,254	7,030	12·0

The total export of guttapercha from Singapore up to the end of last year, exclusive of Asia, is 82,714 tons, and that during the last 12 years (1885-1896) alone 30,757 tons, of which 23,539 tons, representing a total value of £3,810,624, were sent to England.

(To be continued.)

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CITY AND GUILDS OF LONDON INSTITUTE.

MAGNETISM AND ELECTRICITY.

SECOND STAGE OR ADVANCED EXAMINATION.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1898 :

Magnetism.

21. What is the magnetic moment of a magnet? Show how the magnetic moments of two magnets may be compared by the use of the torsion balance. (25 marks.)

22. The centres of two short magnets, A B and C D, are at a distance, r, apart. A B lies along the line joining their centres and C D is at right angles to it. Show that the couple due to A B tending to make C D twist round is $2 M M'/r^3$, where M and M' are the magnetic moments of the magnets. (25.)

23. Describe and explain the way in which a dipping needle is adjusted so that the needle may swing in the magnetic meridian. (25.)

24. Two magnets are placed horizontally on a large sheet of white paper. You are supplied with a small compass, a pencil, and a watch. Assuming that the earth's field may be neglected, how would you trace the lines of force due to the magnets and determine points at which the intensity of the magnetic field was equal? (25.)

Frictional Electricity.

25. Eight equal metal cubes are placed at a distance from each other and given equal charges. Without being discharged, they are then placed on an insulator and built up so as to form a single cube. Compare the original density at a given point on one of the small cubes with the final density at a corresponding point on the large cube. What would the result have been if one of the small cubes had been accidentally discharged? (25.)

26. An insulated conductor, placed at some distance from other conductors, receives a charge of positive electricity. Is its potential altered when another conductor, uninsulated and uncharged, is brought near to it? Give reasons for your answer. (25.)

27. A gold leaf electroscope is placed upon an insulated metal stand. State and explain the indication of the leaves when the stand receives a positive charge. How would the indication be modified if the leaves were earth-connected? (25.)

28. Two similar deep metal jars are placed on the caps of two similar electroscopes at some distance apart and the caps are connected by a fine wire; a positively electrified ball is lowered into one of the jars without contact. Explain the effect as to potential and divergence on both sets of leaves, and also that which occurs on breaking the wire connection by means of a silk thread and then removing the ball without allowing it to touch the jar. (25.)

29. Describe an experiment for comparing the specific inductive capacities of two non-conducting liquids. (25.)

Voltaic Electricity.

30. A Leclanché cell is connected by long thin wires to a galvanometer the needle of which is deflected. The poles of the cell are then bridged across for a short time by a piece of thick copper wire. After the removal of the thick wire the galvanometer deflection is much less than before, but gradually rises to its former value. Explain this. (25.)

31. A thermopile is joined up in series with a Daniell cell, and the current allowed to flow for a short time. The thermopile is then removed from the circuit and connected to the terminals of a galvanometer, the needle of which is thereupon considerably deflected but gradually returns to its undisturbed position. Explain this. (25.)

32. How would you proceed to show experimentally, without using an electrometer, that there is an increased difference of the electrical conditions of the terminal wires of a battery as the number of cells is increased, taking into account the possibility of the cells being unequal both in E.M.F. and resistance? (25.)

33. What would be the magnetic effect produced on a straight steel tube by the passage of a strong current through a straight wire placed along the axis of the tube? and how would you prove your statement? (25.)

34. A vertical hoop of wire, at right angles to the magnetic meridian, is quickly but with uniform speed turned through 180deg. about a vertical axis, its originally eastern half moving northward at first. State the direction in which the induced current passes round the wire, and determine the position of the hoop in which the induced E.M.F. is the greatest. (25.)

HONOURS EXAMINATION.—PART I.

41. Explain how a large and a small resistance may be compared by means of a differential galvanometer. Prove any formula you make use of. (60.)

42. Describe an experiment for comparing the specific inductive capacities of two non-conducting liquids. (60.)

43. What experiments and calculations are necessary for the determination of the total characteristic of a shunt dynamo? (60.)

44. Describe some method by which a quantity of electricity measured electro-statically may be compared with the same quantity measured electro-magnetically. (60.)

45. Describe some method of determining the coefficient of mutual induction of two coils. (60.)

46. Write a short essay on the source of E.M.F. in a galvanic cell. (60.)

47. Discuss any mode of determining the difference of potential between the earth and a point in the air. (60.)

HONOURS EXAMINATION.—PART II.

51. Describe and give the theory of Lord Kelvin's absolute electrometer. (40.)

52. Investigate the attractive force between an electrified point and an insulated conducting sphere. Find what charge must be given to the sphere in order that no force may be exerted between it and an electrified point placed at a given distance from its centre. (40.)

53. Prove that the production of heat in a network is a minimum when the currents are distributed according to Kirchhoff's law. (40.)

54. Show that in a circuit of two metals whose junctions are kept at the absolute temperatures T_1, T_2 respectively, the E.M.F. is $\int_{T_1}^{T_2} \frac{\Pi \, d\,T}{T}$, where Π is the Peltier coefficient of the two metals. (40.)

55. Determine the effect of rotating a coil of wire at a constant speed in a magnetic field of uniform strength. (40.)

56. Write an essay on Poynting's theory of the transfer of energy in an electromagnetic field. (40.)

57. Discuss the best form of galvanometer for the production of a uniform magnetic field. (40.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

84. What is the cause of "hunting" in electric lighting engines, and how may it be remedied?—S. J. M.

85. In power distribution what are the relative advantages and disadvantages of a direct-current system and a multiphase-current system as far as speed regulation only is concerned? P. T.

ANSWERS.

Question No. 78.—In a three-wire system having a pressure of 120 volts across the middle and outer wires, the positive, middle, and negative wires are each in turn connected to the earth through an ammeter. If C_1, C_2, and C_3 represent in each case respectively the currents flowing to earth through the ammeter, deduce formulæ which will enable the insulation resistances, A, B, and C, in ohms, of the respective wires to be determined. Show fully how you arrive at the result'

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and, if possible, graphically illustrate each stage of your reasoning?

Best Answer to No. 78 (*awarded* 10*s.*).—In Fig. 1 let V_1, V_2, and V_3 be the three mains and let C_1 be the ammeter.

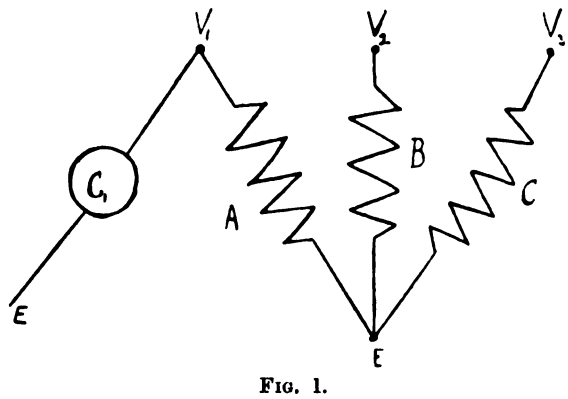

FIG. 1.

In practice this ammeter would need to have a resistance in series with it. We shall denote the resistance of the ammeter plus the added resistance by R. Now let V_1, V_2, and V_3 be the absolute potentials of the three mains before the ammeter is connected on to any of them, then by Kirchhoff's law

$$\frac{V_1}{A}+\frac{V_2}{B}+\frac{V_3}{C}=0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let V denote the potential difference of supply, so that

$$V_1=V_2+V, \text{ and } V_3=V_2-V.$$

Substituting in (1) for V_1 and V_3, we find that

$$V_2=V\,F\left(\frac{1}{C}-\frac{1}{A}\right) \quad . \quad . \quad . \quad . \quad (2)$$

where $\frac{1}{F}=\frac{1}{A}+\frac{1}{B}+\frac{1}{C}$, so that F is the insulation resistance to earth of the network. Hence also

$$V_1=V_2+V=V\frac{\frac{2}{C}+\frac{1}{B}}{\frac{1}{F}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and

$$V_3=V_2-V=-V\frac{\frac{2}{A}+\frac{1}{B}}{\frac{1}{F}} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now, when V_1 is connected to earth through the ammeter of resistance R_1, its fault resistance is changed to $\frac{A\,R}{A+R}$, and hence the new potential, V_1^1, is given by

$$V_1^1=V\frac{\frac{2}{C}+\frac{1}{B}}{\frac{1}{F}+\frac{1}{R}} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Similarly if V_2^1 be the potential of the middle wire when connected to earth,

$$V_2^1=V\frac{\frac{1}{C}-\frac{1}{A}}{\frac{1}{F}+\frac{1}{R}} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

And, similarly,

$$V_3^1=-V\frac{\frac{2}{A}+\frac{1}{B}}{\frac{1}{F}+\frac{1}{R}} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Now, $C_1=\frac{V_1^1}{R}$; $C_2=\frac{V_2^1}{R}$; and $C_3=\frac{V_3^1}{R}$.

Writing $\frac{V}{R}=X$, equations (5), (6), and (7) become

$$\frac{2X}{C}+\frac{X}{B}=\frac{C_1}{F}+\frac{C_1}{R} \quad . \quad . \quad . \quad . \quad (8)$$

$$\frac{X}{C}-\frac{X}{A}=\frac{C_2}{F}+\frac{C_2}{R} \quad . \quad . \quad . \quad . \quad (9)$$

$$-\frac{2X}{A}=\frac{X}{B}=\frac{C_3}{F}+\frac{C_3}{R} \quad . \quad . \quad . \quad . \quad (10)$$

Adding (8) and (10) together we easily deduce that

$$C_1+C_3=2\,C_2.$$

This shows that if we determine C_1 and C_3 it is unnecessary to determine C_2, as it must equal $\frac{1}{2}(C_1+C_3)$.

Equations (8), (9), and (10) are thus equivalent to only two equations, and it is impossible to determine A, B, and C individually from them, although we could determine their ratios.

Subtracting (10) from (8),

$$\frac{2X}{F}=\frac{C_1-C_3}{F}+\frac{C_1-C_3}{R}.$$

Hence,

$$F=R\,\frac{2X+C_3-C_1}{C_1-C_3}=\frac{2V}{C_1-C_3}-R \quad . \quad . \quad . \quad . \quad . \quad (11)$$

We thus deduce a very simple method of determining the insulation resistance of a three-wire network.

If we wish to determine A, B, and C individually, we would have to vary the voltage between the mains slightly so as to enable us to get another equation connecting A, B, and C, but this leads to long mathematical calculations, and as the insulation resistance of the whole network is all that is wanted in practice, formula (11) is quite sufficient. J. C. R.

Question No. 79.—How would you find out the saving effected by the use of hot air and exhaust steam feed-water heaters, giving data of experience with either?

Best Answer to No. 79 (*awarded* 10*s.*).—Apart from the question of saving in fuel, it should not be forgotten that very serious damage may be done to boilers under high-pressure steam if a cool feed be used, and almost any means adopted for heating the feed water is bound to effect a saving if in no other direction than in lengthening the life of the boiler. A little consideration will suffice to show that there is as much difference in temperature between feed water at 180deg. F. and steam at a pressure of 180lb., as there is between melting ice and water boiling at the pressure of the atmosphere. Any tables showing the properties of saturated steam will make this quite clear, and, if thoroughly grasped, may give one some indication of the importance of using a very high temperature feed. Feed-water heaters may be divided into three classes: (1) Live steam spray feed-water heaters; (2) exhaust steam feed-water heaters; (3) hot gas feed-water heaters.

Of these, Class 1 is used almost exclusively for marine purposes. Class 2 may be of two kinds: (*a*) where the exhaust steam passes on its way to the atmosphere through a receptacle or drum partially filled with continuous lengths of brass or copper tubing which are bent backwards and forwards, or "cork-screwed," and through which the feed water is forced on its way to the boiler (such a type is the "Compactum"); or (*b*) the steam and water may change places, the steam passing through the coiled pipes and the water to be heated filling the drum. Such a type is the Brown-Berryman feed-water heater. Heaters of the latter type (*b*), unless carefully designed, are often not at all economical, for although the water is well heated, the fact of the steam being *forced* through the pipes causes the back pressure in the cylinders to be unduly raised, and much more heat is thus often lost in the engine than is gained by raising the temperature of the feed water. The third class is confined to the well-known fuel economisers of Messrs. Green and Son and Messrs. Babcock and Wilcox, both of which types are in reality low-pressure tubulous boilers, and consequently should be fitted with safety valves.

To obtain a thoroughly accurate knowledge of the saving effected by means of feed-water heaters, it would, of course, be necessary to compute the power used in driving the tube scrapers, etc., and make allowance for this power in the results, but where it is only desired to ascertain the percentage gain at any pressure by increasing the temperature of the feed water, the following rule will be useful.

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TABLE A.

Particulars of test, etc.	A. Economiser in use.	B. Economiser not in use.	C. Economiser in use.	D. Economiser not in use.
1. Duration of test ..... hours	11·5	11·5	11·5	11·5
2. Weight of dry coal consumed ..... lb.	8,743	9,694	7,856	10,282
3. Percentage of ash and refuse ..... per cent.	7·5	7·7	8 0	8·4
4. Weight of coal consumed per hour per square feet of grate surface ..... lb.	15·2	16·8	7 6	9 9
5. Weight of water evaporated ..... lb.	84,078	82,725	72,002	72,959
6. Horse-power (taken at 30lb. steam) ..... per horse-power hour	247·0	243 5	210·3	213·6
7. Average boiler pressure (absolute) ..... lb.	82·9	81·9	72·7	72·1
8. Average temperature of feed water entering economiser ..... deg. F.	84·2	—	88·0	—
9. Average temperature of feed water entering boilers ..... deg. F.	196·2	82·0	225·2	85·2
10. Number of degrees heated by economiser ..... deg. F.	112	—	137·2	—
11. Average temperature of flue gases entering economiser ..... deg. F.	435	—	618	—
12. Average temperature of flue gases entering chimney ..... deg. F.	279	452	364	645
13. Number of degrees flue gases were cooled by economiser ..... deg. F.	156	—	253	—
14. Pounds water evaporated per pound coal as observed ..... lb.	9·617	8·533	9·165	7·096
15. Equivalent evaporation per pound coal from and at 212 ..... lb.	11·204	9·955	10·613	8·235
16. Percentage gained by using economiser ..... per cent.	12·5	—	28·9	—
17. Total area of heating surface in the economiser ..... square feet	3,126	—	2,804	—
18. Number of pipes in economiser ..... No.	160	—	160	—

In tests A and B the steam contained 1·3 per cent. of moisture. In tests C and D the steam was superheated 50deg. and 52deg. F. respectively.

$$\text{Gain per cent.} = \frac{100\,(T - t)}{H - t},$$

where H = total heat of steam at absolute boiler pressure;
T = temperature of feed water *after* heating;
t = temperature of feed water *before* heating.

As an example. A boiler working at a pressure of 105lb. per square inch is fed with water from a condensing engine, which water has a temperature of 100deg. F. On passing this water through a feed-heater the temperature is raised to 250deg. F. What is the gain per cent.? The absolute steam pressure will be – 105 + 15 = 120lb.; total heat in steam at 120lb. absolute = 1,217·4 B.T.U. = H; temperature after leaving heater = 250 = T; temperature before entering heater = 100 = t. Then

$$\frac{100\,(T - t)}{H - t} = \frac{100\,(250 - 100)}{1{,}217{\cdot}4 - 100} = \frac{15{,}000}{1{,}117{\cdot}4} = 13{\cdot}4 \text{ per cent.}$$

Another and more accurate rule is the following:

If u_1 = heat in B.T.U. required to raise 1lb. of steam from temperature of cold feed;
u_2 = heat units used in raising temperature of 1lb. of feed water from t_2 to t_1;
t = temperature of steam in degrees Fahrenheit;
t_1 = temperature of feed water (hot) Fahrenheit;
t_2 = temperature of feed water (cold) Fahrenheit;
W = water to be heated in pounds per hour;

then $$\text{saving per cent.} = 100\,\frac{u_2}{u_1}.$$

But $u_1 = 1{,}082,\ 0{\cdot}305\,t - (t_2 - 32)$; and $u_2 = t_1 - t_2$,

therefore $$\text{saving per cent.} = \frac{(t_1 - t_2) \times 100}{1{,}082 + 0{\cdot}305\,t - (t_2 - 32)}.$$

$$\text{Saving per hour} = u_2 \times W.$$

A little consideration will show that exhaust steam feed-water heaters cannot give such a high temperature feed as hot-air feed-water heaters. In the former case the feed can never be equal in temperature to the exhaust steam. In the same way the feed water in a Green's economiser can never be equal in temperature to the hot gases. But there is this very important difference, the temperature of exhaust steam is not very high, whereas the temperature of the hot gases entering a fuel economiser on the boiler side is very frequently 670deg, which temperature will probably be lowered to 350deg. after passing over the stack of pipes. It will readily be understood, then, that an economiser is capable of giving a very much hotter feed than an exhaust feed-water heater. By economiser is meant one of the Green type.

The following particulars of the percentage saving in fuel by heating the feed water to the temperature of evaporation are given by Mr. E. Tremlett Carter.

The results given in Table A were obtained with a Green's fuel economiser, which was used without any preparation whatever to ascertain the saving in fuel under ordinary everyday working conditions. The results may be relied upon, as they were obtained by Messrs. Green and Son's staff in the presence of the engineer-in-charge.—F. STOTT.

Temperature of water entering feed heater (Fahrenheit).	Steam pressure in pounds per square inch above atmosphere at which evaporation takes place in the boiler.			
	80	100	150	200
	Percentage economy in fuel.			
32	24·7	25·8	28·0	29·6
50	23·2	24·3	26·4	28·2
100	19·0	20·1	22·2	24·0

LEGAL INTELLIGENCE.

DISPUTE BETWEEN ELECTRICAL ENGINEERS.

In the Westminster County Court, on Monday, his Honour Judge Lumley Smith, Q C., had before him the case of White *v.* the Headlands Patent Electrical Storage Battery Company, in which the plaintiff, a dealer in electrical goods, sued the defendant company to recover payment in respect of a quantity of "litharge" supplied to them, and also a share of profits on the sale of certain electrical lamps.

It appeared that judgment had been obtained in the High Court in respect of the litharge, and it was further admitted that there was something due in respect of the profits on the sale of the electric lamps, but the defendants set up a counterclaim in respect of the alleged defective quality of the litharge.

In support of the counterclaim a number of witnesses were called with a view to proving that the litharge in question, which was used for filling battery cells, was defective in quality, and that as a result no less than 102 of the cells were totally spoilt. These were valued at 2s. 6d. each, and it was in respect of that item that the counterclaim was raised.

On behalf of the plaintiff it was contended that the litharge was as pure as it was possible to get it, and that if it did not act properly it must have been improperly applied.

In the result his **Honour** said he thought the defendant had cause of complaint, and the result would be that there would be judgment for the plaintiff on the claim, with costs, and judgment for the defendant on the counterclaim, with costs.

SELLING ELECTRIC FITTINGS ON COMMISSION.

In the Westminster County Court, on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Glenny *v.* Cook, in which the plaintiff, a traveller on commission, sued the defendant, a dealer in electrical fittings, to recover payment of the sum of £6. 12s. as commission on certain orders obtained.

The plaintiff's case was that his commission was payable monthly, and that the amount now claimed was due to him when he left the defendant's service.

For the defence it was alleged that, although the commission was payable monthly, the plaintiff was not entitled to payment in any case until orders had been paid for. At the present time there was only £1. 5s. due to him, and that sum had been paid into court.

His **Honour** thought plaintiff had brought his action before he was entitled to payment, and gave judgment for the defendant, with costs.

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COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The ordinary general meeting of this Company was held at Winchester House on the 26th inst., under the presidency of Mr. E. M. Underdown.

The Chairman, in moving the adoption of the report and accounts, published in our last issue, said the revenue was £8,340 more favourable than in the corresponding half of last year, no doubt owing in part to the war. Repairs had been considerable during the last year, but the reserve fund account had been debited with £8,260 for cost of cable repairs, and with £2,000 written off the Ballinskilligs buildings account, the balance of the reserve fund now amounted to £351,455.

The report was adopted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

An extraordinary general meeting was held on the 27th inst. at Winchester House, Mr. J. Denison Pender presiding, to consider an agreement dated the 14th inst. between the Western and Brazilian Telegraph Company, Limited, the London Platino-Brazilian Telegraph Company, Limited, and the Company, and an agreement of the same date between the Company and Mr. William Stratford Andrews, and to consider resolutions for increasing the capital of the Company by the creation of 120,000 new ordinary shares of £10 each, and for altering certain of the articles of association of the Company.

The resolutions were unanimously agreed to.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on the 27th inst., at Winchester House, to sanction an agreement, dated the 14th inst., made between the Company, the London Platino-Brazilian Telegraph Company, and the Brazilian Submarine Telegraph Company.

Mr. William Andrews, who presided, said that the object of the proposals was more closely to identify the companies, and to avoid conflicting interests.

The resolution was carried, and a series of resolutions for altering the articles of association were also unanimously passed.

GLOBE TELEGRAPH TRUST COMPANY, LIMITED.

The ordinary general meeting of the Globe Telegraph and Trust Company, Limited, was held on the 26th inst. at Winchester House.

The **Marquis of Tweeddale** presided, and in moving the adoption of the report said their receipts, after deducting all expenses, amounted to £196,974, an increase of £10,392 over the previous year. The ordinary expenses were £50 less than last year. As a result of the year's working the ordinary shareholders had received 6d. per share by way of an interim dividend, and now there was sufficient to pay 4s. 3d. per share, or a total dividend for the year of 6 per cent. on the preference shares and a dividend of 5½ per cent. upon the ordinary shares, against 4½ per cent. for the preceding year, leaving a balance of £2,225 to be carried forward to the next account. The market price of their investments had increased from £3,602,690 to £4,703,436, and stood higher than they had ever done in the history of the Company.

Sir J. Pender, M.P., seconded the motion, which was carried unanimously.

EASTERN TELEGRAPH COMPANY, LIMITED.

The fifty-second half-yearly ordinary general meeting of the shareholders of this Company was held at Winchester House on the 22nd inst., the Marquis of Tweeddale presiding.

The Chairman, in moving the adoption of the report and accounts, said the gross revenue for the half-year of £472,734 showed a decrease of £7,088. They had received more messages and more words in the corresponding half of last year. The falling off of the traffic between Greece and Turkey, which was abnormally high last year, alone was more than the total reduction of £7,088 in their revenue. The total ordinary expenses of £118,402 showed an increase of £8,293, which was principally due to the increase in the number of their staff. The automatic system of signalling had proved to be of very great benefit both in the matter of speed and accuracy. Their ships had been very fully engaged in effecting repairs of cables, and the amount of cable used had been considerably in excess of the corresponding half of last year. Their ships had earned £24,299 while employed in the repair of cables of other companies, as against £20,885 in the corresponding period of last year. It had been decided to lay down additional cables from Porthcurnow to Gibraltar and from Gibralta to Malta, and another one from Malta to Alexandria.

Mr. J. Denison Pender seconded the adoption of the report, which was agreed to.

An extraordinary general meeting was then held, when the following resolution was adopted: "That the 400,000 shares of £10 each in the capital of the Company which have been issued and fully paid up be converted (as and when the directors determine) into stock."

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

The fifth annual general meeting of this Company was held at Winchester House on the 22nd inst.

Sir Daniel Cooper, who presided, stated that the volume of their business had during the past year greatly increased, but the profit had not increased in equal proportion. They had earned enough to pay a dividend of 6 per cent. and to add something to the reserve, paying the full dividend on the preference shares. They had orders for extension of recently completed central stations, and for the electrical equipment of the City and South London Railway extensions sufficient to keep their works employed as long ahead as they cared to engage themselves. They did not think that the Workmen's Compensation Act would involve the Company in serious expense. They did not propose to meet their liability by insurance with any company, but to be their own underwriters. After providing £5,000 for depreciation, they proposed to unite the depreciation and reserve accounts into one general fund. Much the larger proportion of the shares and debentures which they held in other companies, amounting to £124,494, consisted of their interest in the Electrical Power Storage Company, which was organised by the Electric Construction Corporation to take over the latter's accumulator business. The Electrical Power Storage Company had proved a success, having paid a regular dividend of 5 per cent. in each of the last seven years, but when more capital was required by the growth of their Bushbury business, they contemplated to offer a portion of their holding in the Electrical Power Storage Company to their shareholders. The 6 per cent. debentures due in 1901 had, by the payment of a moderate premium, been converted into a 4 per cent. debenture stock. The cost of the conversion had been paid out of the premiums received on the preference shares issued last year, and the conversion would save the Company about £3,000 per annum in interest.

Sir Henry C. Mance seconded the motion, which was carried.

BRITISH ALUMINIUM COMPANY, LIMITED.

The third ordinary general meeting of this Company was held at the Westminster Palace Hotel yesterday.

Mr. R. W. Wallace, Q.C., who presided, moved the adoption of the report and accounts, from which it appeared that during the year a profit of £10,811. 5s. 4d. had been made, which, together with £1,243. 4s 1d. carried forward from the previous year, amounted to £12,054. 9s. 5d. available for dividend. An interim dividend amounting to £1,128. 9s. 11d. was paid on July 21 last year, leaving a balance of £10,925. 19s. 6d. The directors recommended the payment of the cumulative 7 per cent. dividend on the preference shares up to July 1, 1896, and that the balance be carried forward. He said that having been their own contractors a large profit had been made that way. The water rights at Foyers which were completed were worth £200,000 more than appeared in the balance-sheet; they represented 5,000 h.p. per year. The dividend was small because they found they could employ their available balance to better purposes at present; the value of this proceeding would be felt in the course of the next year or two. The sale of metal was increasing, the 1897 output being double that of 1896, and that of the last six months equalising that of the whole of 1897. The demand in Germany, owing to the increasing use of the metal for army purposes, exceeded the supply, and they had been approached by the Neuhausen Company to supply them. It was of advantage to have the metal made in the district where it was required, in consequence of which Glasgow shipbuilders had formed a company to manufacture aluminium at Greenock, the British Aluminium Company receiving 10,000 shares in that company for the concession.

Mr. A. S. Bolton, J.P., seconded the resolution, and said that there were two causes they had to contend with. Firstly, they wanted about four times the present output; and, secondly, there was still a difficulty about the soldering of the material. Once that were overcome an increased demand would ensue, and as they were turning out the metal in as good a quality as any other factory their success was assured.

Mr. Spencer asked that the third debentures should be converted into preference charges, and the **Chairman,** in reply to various questions, said that the Carbide Calcium Company paid them £5,000 per year for the use of one dynamo.

Mr. Wallace was re-elected as a director, and Messrs. Crewdson, Youatt, and Howard were re-elected auditors.

A vote of thanks to the chairman closed the meeting.

NATIONAL TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of the National Telephone Company, Limited, was held on the 27th inst. at the Cannon-street Hotel.

Mr. J. S. Forbes presided, and, in moving the adoption of the report (already published by us) and the payment of the dividends, said that he feared that they were in ill-favour with some of their more critical subscribers, but the irregularities complained of arose from causes beyond the Company's control—causes for which the authorities (Parliament itself) were to blame. At the right moment he intended to show that all the charges which were made respecting the inefficiency and extravagant cost of the telephone service in England were quite unfounded.

The motion was then carried unanimously, the proceedings terminating with a vote of thanks to the president, the directors, and staff.

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CITY AND SOUTH LONDON RAILWAY COMPANY, LIMITED.

The half-yearly general meeting of this Company was held at the head office, Monument Station, on the 26th inst.

Mr. C. G. Mott, who presided, moved the adoption of the report and accounts, already published by us. He said the expenses of working their line were no larger this half than when they opened it, although their actual receipts had increased very nearly 50 per cent. Although a large number of passengers was carried last half-year, they had an increased number again of 41,167, although the receipts showed a decrease of £54. The circumstances of the line would be to some extent altered when their extensions were carried out, which would still further augment the mid-day service. The working expenses had decreased since the line was opened from 79·7 to 56·7, which was, he thought, a gratifying result.

Mr. S. Hanbury seconded the motion, which was agreed to.

An extraordinary meeting was subsequently held for the purpose of sanctioning the creation and issue of the additional capital authorised by the Company's Act.

CROMPTON AND CO., LIMITED.

The annual general meeting of the shareholders was held on the 21st inst. at Cannon-street Hotel.

Mr. John Trotter presided, and moved the adoption of the report, already published by us. The chairman, referring to the loans, said the Board were proposing to dispose of their interest in the Chelmsford Electric Lighting Company, and he believed they would be able to do so at such a price as would enable them to reduce the loans to a figure that need not give the shareholders any anxiety in future. He also mentioned that at the beginning of the year they had orders in hand amounting to more than the whole of the turnover for the previous year.

Mr. R. E. B. Crompton (managing director) seconded the motion, and, after a short discussion, the report was adopted.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING COMPANY, LIMITED.

The seventeenth ordinary general meeting was held at Winchester House on the 22nd inst.

Mr. C. L. W. FitzGerald, who presided, said that at the date of last year's meeting the Company was fairly full of orders, yet within a short period afterwards they were practically without any. The rentals from private wires continued to increase, but they did not yield the Company any profit so far because during the first part of the time the cost of manufacture had to be written off. Eventually, however, the income would become profit. The total revenue for the year amounted to £2,547, and after deducting the ordinary expenses there was a balance left of £1.713, from which it was proposed to pay a dividend of 1½ per cent. The income for the year from their investments was £2,450.

The report was adopted, and the proposal of the Board to convene an extraordinary general meeting next month agreed to.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The report of the directors for the half-year ended June 30 last, to be presented at the general meeting to be held to-day, states that the total receipts for the six months amounted to £196,196. The traffic receipts show an increase of £24,305 as compared with the corresponding half of 1897. The total expenses of the half-year, including the repair of cables, etc., amounted to £61,616, being an increase of £8,315 The directors have set apart the sum of £12,000 to the renewal fund, leaving a balance of £122,580. One quarterly interim dividend of 15s. per cent. on the ordinary stock, and of £1. 10s. per cent. on the preferred stock, absorbing £52,500, has been paid, and a second quarterly dividend of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 2. This leaves a balance of £17,580 to be carried forward.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Directors: James Staats Forbes, Esq. (chairman); the Earl of Lichfield; Major Samuel Flood Page; Joseph Wilson Swan, Esq., F.R.S.; Ernest Villiers, Esq.; W. P. James Fawcus, Esq.

Fifteenth annual report of the directors to be presented to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel, E C., to-day (July 29) at 1 p.m.:

The profit and loss account shows a credit balance of £43,040. 17s. Providing for the interest upon the debenture stock there remains a balance of £35,587. 7s. 7d. available for distribution. An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the half-year ending December, 1897, a further payment at the rate of 7 per cent. per annum for the second half is recommended, making the dividend for the book year 6 per cent. per annum, the balance of £12,578. 14s. being carried forward, as against £8,493. 7s. 6d. in the preceding year. The business of the Company has continued to develop, and besides the large extensions of premises and plant at the Ponder's End works, it has been found necessary to make others. The factory at South Benwell, which has been unoccupied for a considerable time, has been refitted with machinery of the latest invention and reopened as a lamp factory. A brass-finishing factory at Walsall has been acquired for the manufacture of electrical fittings. The Broadheath factory (taken over from the Manchester Edison-Swan Company) is now turning out dynamos, motors, and other machinery used for electrical plant. In order to meet the expenditure consequent upon these large extensions, and to make provision for much larger stocks of lamps, fittings, and appliances at the numerous depôts of the Company, it has been determined to issue shortly a further £100,000 of the Company's 4 per cent. debenture stock. Ernest Villiers, Esq., and Major Flood Page retire by rotation from the Board, and offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1898.

Dr.	£	s.	d.
Stock on hand, July 1, 1897	115,562	7	3
Wages, purchases, etc.	198,276	10	2
Salaries, directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	11,063	12	10
Depreciation on plant, etc.	6,699	5	7
Balance	43,040	17	0
	£374,642	12	10

Cr.	£	s.	d.
Balance brought forward	8,493	7	6
Sale of lamps, fittings, royalty on holders, etc.	214,168	15	1
Interest, etc.	3,870	8	6
Stock on June 30, 1898	148,110	1	9
	£374,642	12	10

Dr. BALANCE-SHEET, JUNE, 30, 1898.	£	s.	d.
Share capital—17,139 A shares of £5 each, fully paid	85,695	0	0
99,261 A shares, £5 each, £3 paid	297,783	0	0
	383,478	0	0
23,564 B shares, £5 each, fully paid	117,820	0	0
4 per cent. debenture stock	194,023	0	0
Sundry credit balances	100,326	18	10
Reserve fund	82,748	10	7
Profit and loss, as per appropriation account, £43,040. 17s.; less interim dividend paid, £9,586. 19s.; and interest on debenture stock, £3,573 0s. 3d.	29,880	17	9
	£908,277	7	2

Cr.	£	s.	d.
Cost of establishing the business, goodwill, remaining patents, etc, as per last balance sheet	322,815	1	2
Further expenditure thereon	2,816	6	11
	325,631	8	1
Amount of B shares of this Company, issued as *per contra*	117,820	0	0
	443,451	8	1
Altrincham Electric Supply, Limited, shares	23,146	0	0
Freehold and leasehold property	79,459	12	10
Plant and stock	252 463	11	0
Sundry debtors and debit balances	86,442	1	1
Investment National Telephone Company, Limited, 5 per cent. non-cumulative third preference shares at cost	15,500	0	0
Cash at bankers and in hand	7,814	14	2
	£908,277	7	2

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Melbourne (Victoria).—The Town Council invite tenders for a supply of arc lamp carbons. Particulars may be obtained of, and tenders addressed to, the Town Clerk by Aug. 16.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns. Tenders by Aug. 10.

Tiflis (Russia).—Tenders are invited by the Municipal Authorities, from whom particulars may be obtained, for the electric lighting of the central part of the town. Tenders by Aug. 1/13.

Barking Town.—Tenders for electricity supply meters, main cut-outs, columns, and free wiring must reach the Clerk to the Council not later than 5 p.m. on Wednesday, Aug. 10, instead of Aug. 3, as previously advertised.

Stavelot (Belgium).—The Municipal Authorities invite tenders for the installation and working of an electric plant for light and power for 30 years. Conditions, etc., may be obtained for 2s. 8d, from the Town Clerk, at Stavelot. The deposit is £120. Open until Aug. 2.

Hendon.—The Managers of the Central London Sick Asylum District invite tenders for supplying the necessary plant and for installing the electric light at their new asylum, Hendon, Middlesex. Further particulars appear in our advertising columns. Tenders by Aug. 15.

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Hapton (Padiham, Lancs.).—Tenders are invited for lighting the Hapton township with electricity from Sept. 1, 1898, to April 30, 1899. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, St. Anne's-terrace, Padiham, by Aug. 1. Full particulars on application.

Stanford-le-Hope (Essex).—Tenders are invited by the Parish Council for the erection of 30, 40, and 50 lamps in different parts of the village, to be lighted either by electricity, gas, or oil, and for lighting same until March 25, 1899. Sealed tenders, marked "Lighting Tenders," to be sent to Mr. John Reeve, clerk, by 29th inst.

London.—Tenders are invited by the Vestry for the erection of a new battery-room, boiler-house, and extension of offices at the electric light station, Coronet-street, Shoreditch. Specifications, etc., can be obtained and the drawings can be seen on and after Aug. 2 at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders, endorsed, by Aug. 15.

Pemberton (Lancs.).—Tenders are invited by the Urban District Council for suitable schemes for carrying out the electric lighting in their district. Schemes must be sent to Mr. Paul Partington, clerk, before Aug. 14. They should be accompanied by explanatory details, and must be such as will satisfy the requirements and comply with the regulations of the Board of Trade. Information as to the area and population of the district and other essential particulars may be obtained on application to the Clerk.

Alderley Edge.—The Alderley and Wilmslow Electric Supply Company, Limited, invite tenders for the erection of a generating station and electric lighting works at Belmont, Alderley Edge. Drawings and specifications may be inspected and bills of quantities obtained at the office of Mr. W. E. Rowcliffe, secretary, 30, Cross-street, Manchester, upon payment of a deposit of £1. 1s., which will be returned to people sending in a bona fide tender. Tenders, addressed to the Secretary, to be delivered by 12 noon on Aug. 2.

RESULTS OF TENDERS.

Watford.—Mr. Wilkinson's revised tender for the electric light buildings, at £3,322. 8s., has been accepted.

Wimbledon.—The Urban District Council have accepted the tender of Messrs. Parsons and Townsend, at £2,117. 17s. 8d., for wiring the depot buildings.

Belfast.—The tender of Messrs. J. and W. Stewart, Adelaide-street, has been accepted by the Belfast Harbour Commissioners for the extension of their electric lighting station, Abercorn Basin.

Hammersmith.—The Vestry have decided, with reference to further electric lighting works, that the pipes required for extensions shall be obtained from Messrs. Spencer and Co. for £618. 9s. 9d. (approximate), the erection and fixing to be done by the Vestry's own workmen; also that an engine be purchased from Messrs. Marshall and Co., of Gainsborough, for £760, less 2½ per cent. discount.

BUSINESS NOTES.

Paisley.—The Council intend to borrow a further £25,000 for extensions at the electrical works.

Fleet (Hants).—An electric lighting scheme is being prepared for this district. Mr. F. J. Warden-Stevens is the consulting engineer for the scheme.

Taunton.—A Local Government Board enquiry was held on the 28th inst. into the Council's application to borrow £11,500 for electric lighting purposes.

British Electric Traction Company.—The transfer books and register of members of this Company will be closed from Aug. 2 to Aug. 15, 1898, both inclusive.

Salford.—Colonel A. C. Smith held an enquiry on the 28th inst. into the application of the Council for a loan of £33,000 for extension of the electricity works.

Yarmouth.—A Local Government Board enquiry was held on the 23rd inst. into the Council's application for power to borrow £4,800 for electric light extensions.

Bradford.—Major Cardew, Board of Trade inspector, inspected the Bolton-road section of the Bradford electric tramway last week. Trial trips were also made, which were a complete success.

Llanelly.—Arrangements are being made for the lighting of Messrs. Buckley's brewery by electricity. It is probable that the contract will be locally let. Other concerns in the town are likely to follow suit.

Hackney.—The Duke of Newcastle, who is an energetic student of the manipulation and possibilities of the Röntgen rays, is presenting to the North-Eastern Hospital for Children a complete and valuable X-ray outfit.

Leatherhead.—A resolution that applications be invited for carrying out the electric lighting under the Council's provisional order is under consideration by the General Purposes Committee of the Urban District Council.

Norwich.—An extraordinary general meeting of the electric tramways company will be held to-day for the purpose of authorising the borrowing by the company on mortgage of the sum of £6,000 at interest at the rate of £4 per cent. per annum.

Cable-Making Plant.—We have received from Mr. Thomas Barraclough, of 20, Bucklersbury, E.C., and of Manchester, his lists of machinery for wire-stranding and ropemaking. Several of the machines in question are adapted for electric cablemaking.

Aberdeen.—The names of Messrs. J. A. Bell, Blackpool; J. R. Dick, London; Charles M. Johnston, Lancaster; and H. Turner, London, are now before the committee as the most eligible candidates for the office of electrical engineer to the Corporation.

Paddington.—At the last meeting of the Vestry it was decided to refer to the Electric Lighting Committee to consider the advisability of applying for a provisional order for Paddington forthwith, and that the borough members, with General J. W. Laurie, M.P., be asked to support the case.

Heaton Norris.—The District Council have decided to apply to the Board of Trade for a provisional order authorising the Council to supply and light the district of Heaton Norris with electricity. It is stated that the Council intend to sign an agreement with the Manchester Corporation for electric lighting.

Woking.—The Woking Electricity Supply Company, Limited, although they cannot give any reduction in the price of the unit at present, or enter into any binding promise to do so in the future, have given all customers a scale of discounts, probably thinking that even a small part of a loaf is better than no bread.

Glasgow.—Notice of a motion has been given to the effect that a special committee be appointed by the Corporation to co-operate with any similar committees of other departments of the Corporation to consider and report on the expenditure by the Corporation in respect of telephone connections, and to make a recommendation thereupon.

W. T. Henley's Telegraph Works Company.—The directors have declared the following interim dividends, payable on Sept. 1, 1898, for the half-year ending June 30, 1898: on the preference shares at the rate of 7 per cent. per annum (less income tax); on the ordinary shares at the rate of 8 per cent. per annum (less income tax).

Watford.—At the last meeting of the Urban District Council the Clerk reported that the Local Government Board had sanctioned the proposed loan of £21,000 for the purposes of electric light, to be repaid within a period of 25 years, and also gave formal sanction to the appropriation of the necessary piece of ground for a station.

London Electric Supply Corporation, Limited.—Letters of allotment and regret in connection with the issue of £200,000 4 per cent. first mortgage debenture stock of the London Electric Supply Corporation, Limited, have been posted. The issue was offered to the shareholders of the Company only, and was very largely over-subscribed.

Alnwick.—At the last meeting of the Urban District Council, it was mentioned during a debate on the cost of gas that probably if the question was taken up by the Lighting Committee some scheme or something might come out of it by which electric light or some other might be devised, that was if the gas company would not come to any other terms.

Marylebone.—The report of the Baths and Wash-houses Committee, presented to the meeting of the Vestry yesterday, contained a recommendation to the effect that the committee be empowered to make enquiries as to the cost of providing plant at the baths and wash-houses establishment to enable the Vestry to generate electricity for the lighting of the establishment.

Wrexham.—At the meeting of the Town Council on the 26th inst., another long discussion took place respecting the proposed purchase of the Willow Brewery from the trustees of Peter Walker's estate for £8,000 for the purpose of erecting baths, electric light station, stables, etc. Finally it was decided to give the Local Government Board the assurance they required.

Appointments Vacant.—An electrical engineering draughtsman and designer, to take charge of design class in electrical engineering and instrument making and to assist in the general work of the department at the Northampton Institute, Clerkenwell, E.C., is wanted for the winter session. Particulars of this and various other vacancies will be found in our advertising columns.

Stanmore.—The North London Electricity Company have notified the Rural District Council under the Act of 1882 that they are going to apply for an order to supply the whole of the North London district, and have asked the Council to support it. The proposal would embrace the whole of the parishes in the Hendon rural district. No action has been taken by the Council so far.

Shoreditch.—At the last meeting of the Vestry the Lighting Committee reported that they had considered plans drawn up by the consulting engineers for the new boiler-house and battery-room. They recommended that the plan be approved and instructions given to the consulting engineers to prepare the specification and quantities, and to advertise for tenders forthwith. This was agreed to.

Personal.—We are informed that Mr. H. M. Salmony has resigned his position as managing director of the firm of H. M. Salmony and Co., Limited.—Mr. H. E. Mitchell, who has for many years past held the position of chief assistant and secretary to Prof. George Forbes, F.R.S., has recently been offered and accepted the post of manager to Mr. Francis Hastings Medhurst, B.Sc., M.I.E.E.

Chester.—The recommendations of the Electric Lighting Committee, which were adopted by the Town Council last week, included the extension of the main from Liverpool-road to Brook-lane railway bridge, at an estimated cost of £227. 10s.; the laying of mains along Liverpool-road to the end of Lumley-road, at an estimated cost of £236; and the appointment of an assistant electrical engineer.

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Fenton.—At a meeting of the District Council on the 26th inst., a letter was received from the Potteries Electric Traction Company, Limited, giving notice of their intention to apply to the Board of Trade for a provisional order authorising them to supply electrical energy for public and private purposes within the area of the Fenton urban district. It was decided to postpone the consideration of the subject.

Charing Cross and Strand Electricity Supply Corporation.—The directors, after paying interest on debentures, making provision for dividend on 4½ per cent. cumulative preference shares, have declared an interim dividend for the half-year ended June 30, 1898, at the rate of 6 per cent. per annum on the ordinary share capital of the Corporation, and have carried forward £7,400. The interim dividend will be paid on Aug 15 next.

Theatre-Lighting.—The new Princess's Theatre, Kennington, the foundation-stone of which was laid by Sir Henry Irving on the 25th inst., and the new Empire Theatre, Bradford, are to be lighted by electricity, each installation consisting of about 1,200 lights. Complete plant for generating the current will be put in at the former, while it is proposed to light the latter from the Bradford Corporation's mains. Messrs. Owen Lucas and Pyke are now preparing the specifications.

Tipton.—In moving the adoption of the annual financial statement of the gasworks at the Council meeting on the 26th inst.. Mr. D. Hipkins remarked that a satisfactory feature of the year's working was that the net profit had been £1,390, or £182. 5s. more than for the preceding year. Seeing the possibility of competition by the introduction of electric light and other illuminants, he suggested that if they continued to make profits they ought to establish a reserve fund sufficient to meet emergencies.

Metropolitan Railway.—The half-yearly report of the Metropolitan Railway contains the following paragraph: "The directors state that the time has now arrived when electrical traction can be introduced with success and advantage, and they have agreed with the District Company for an experimental working by electricity of a piece of line on their system between High-street, Kensington, and Earl's Court Stations at an estimated cost of £20,000, to be borne in equal proportions by the two companies."

Stirling.—A special meeting of the Stirling Police Commissioners was held on the 22nd inst. for the purpose of considering letters from Sir Alan Seton Steuart and other proprietors between Touch and Stirling, and also from the Water Commissioners, in connection with Mr. Yorke's scheme for the electric lighting of the town. Sir Alan Steuart and Colonel Murray, of Polmaise, anticipated no difficulty in giving their consent, and the Board of Trade reported that they saw no reason to object to the scheme detailed in Mr. Yorke's report. After some discussion it was agreed to remit the letters to the Lighting Committee for consideration and report.

Newington.—At the last meeting of the Vestry it was decided to undertake by direct labour, under the supervision of the surveyor of roads, the removal of pavements, excavation of trenches, etc., in connection with the laying of the electric mains, and the Finance Committee was authorised to draw cheques during the recess for wages for this work as required. In consideration of the National Telephone Company bearing a moiety of the expense of taking up the footways, excavation of trenches, etc., the company is to be permitted to lay in the same trench their pipes and wires, under the supervision of the consulting engineers of the Vestry.

General Power Distributing Company's Bill.—The Sheffield Chamber of Commerce and Manufactures, and the ratepayers and inhabitants of Normanton-on-Trent, have deposited petitions in the House of Commons in favour of the General Power Distributing Company's Bill, but the Corporations of Glasgow, Aberdeen, Chester, Rotherham, Derby, Mansfield, Nottingham, Luton, Bakewell, Lincoln, Ilkeston, and Doncaster, the Great Northern Railway Company, the Riddings District Gas Company, and ratepayers, traders, and owners of property of property at Doncaster are opposing the Bill. The Wigan Coal and Iron Company and the East Retford Rural District Council have petitioned against alterations in the Bill.

Fleetwood.—A public meeting was held in the Free Library on the 22nd inst. in connection with the electric lighting scheme for the district. Mr. A. Davies, who presided, explained how the local authority came to get the provisional order and disposed of it to the present promoters. Mr. Bailey, one of the directors of the new company, addressed the meeting, and proceeded to explain that the method which would be introduced was similar to that at Shoreditch. Mr. Medhurst, consulting engineer, said that five lights, 8 c.p. (with wiring), would cost 35s. per annum, and emphasised the point that 7d. per unit was equivalent to 3s. 6d. per 1,000ft. of gas; also that it was probable that this company, in two or three years, would supply lamps free of cost. No resolutions were submitted. Votes of thanks to the chairman and the two speakers closed the meeting.

Colwyn Bay.—At the last meeting of the District Council the Clerk read correspondence which had ensued since the enquiry held by the Local Government Board to obtain sanction to borrow £5 000 for the promenade electric lighting scheme and the purchase of a site for a town's depôt. The Local Government Board now wrote sanctioning £1,564 for the electric light works, repayable in 25 years. The letter suggested that the machinery at the generating station should be duplicated at the end of one year. They could not authorise the costs of the Act being paid out of the loan, as they were not authorised to do so in the provisional order. The terms upon which the trustees of Messrs. P. and H. Lewis were prepared to let the Council have the use of certain property in the depôt forthwith, so as to be able to light the promenade early in August, were approved.

Sevenoaks.—The Lighting Committee's report, adopted by the Urban District Council last week, states that they had considered a notice from the Electrical and General Engineering Company referred to them, and they recommended that the company be informed that in the event of their applying for a provisional order the Council should not assent to the same. A letter from Mr. H. E. McKrell, of Edenbridge was read, asking if the Council would reconsider their decision, recently arrived at, with reference to the question of electric lighting, and asking to be allowed an interview with the Council, but the committee recommended that Mr. McKrell be informed that the Council saw no reason to alter their former decision in the matter, and that no useful purpose would be gained by an interview.

Stourbridge.—The conversion of the Stourbridge and Dudley tramway for working by electric power has now been started in earnest. A good deal of the work has been done in Brierley Hill, which was outside the scope of the disputed part of the order. The British Electric Traction Company, in pursuance of the powers already granted, will extend their line from the present terminus in Lower High-street, Stourbridge, to the centre of the town, and if the assent of the Stourbridge Council is granted they will further continue it to Hagley-street. This would give an opening for its ultimate extension to Clent, and a point of departure, from the junction of Foster-street with High-street, for a branch to the Lye and Cradley district and places beyond. The construction of branches, starting from other points, to Netherton and Cradley Heath and to Kingswinford are also parts of the scheme of the company.

Huddersfield.—The usual monthly report of the Electric Lighting Committee, adopted by the Council last week, showed that the number of consumers had increased during July from 695 to 698, and the number of lamps connected from 46,014 to 46,857. In June 27,019 units were metered, as compared with 14,929 for the corresponding period of last year, this increase of 12,090 representing 81 per cent. During the half-year ending June the number of consumers had increased from 598 to 698, the number of lamps connected from 41,702 to 46 857, and the units metered from 192,708 to 292 654, the latter being equal to 52 per cent. Six thousand pounds was ordered to be taken up on loan from the borough fund. The mains are to be extended to Longroyd Bridge, and upon the application of Mr. W. D. Shaw, J P., a subcommittee was appointed to consider a proposed extension to Longwood. The accounts amounted to £762. 13s. 4d.

Wimbledon.—At the meeting of the Urban District Council last week the following report of the Electric Light Committee was adopted: "Mr. A. H. Preece informed the committee that he was going to South America on business and would be absent two months, and that his brother, Mr. W. L. Preece, would be able to carry on the arrangements in connection with the electric light scheme during his absence. Recommended that this arrangement be agreed to. The committee recommend that an underground station be constructed, as an extension of the underground convenience. Wiring depôt buildings: Mr. Preece reported on the tenders received. Recommended that Messrs. Parsons and Townsend's tender of £217. 17s. 8d. be accepted, and that the clerk prepare an agreement for sealing at the next meeting of the Council. Boiler-house: That the extra accommodation in the boiler-house required for the dust destructor be provided if necessary without waiting for the sanction to a loan for the dust destructor."

Hornsey.—At the last meeting of the Urban District Council, the Lighting Committee reported that they had had before them a letter received from the North London Electricity Company, of Prescot, Lancashire, giving notice that it was their intention to apply to the Board of Trade and to Parliament in the ensuing session for a provisional order to supply electricity within the area of the Hornsey Urban District Council. The committee added that the company were informed that the Council had themselves obtained a provisional order, and the company then wrote that it was their intention to put down large electricity works for the supply of a number of districts in the North of London, and that they would probably be in a position to offer electricity to the Council wholesale—at least as low a price as they could generate it themselves. The committee recommended that the company be informed that the Council will object to the granting of the order, and that notice of the Council's intention be given to the Board of Trade. This was agreed to.

Tunbridge Wells.—We hear, says the *Kent Courier*, that the Electric Lighting Committee have approved of the following scheme for further profit sharing with the consumers of electric energy, which will no doubt be adopted by the Council. The sliding-scale system will be continued, but the charge reduced from 4d. to 3d. per unit. This will mean that those who are the largest consumers will, in proportion, have the largest reduction in their bills, according to the number of the hours which their lamps are in use, and the minimum in this respect will also be lowered. These technical details may best be illustrated by mentioning that had the system been in force last year, the consumers' bills would have been reduced by £900, so that a material benefit may be expected by those who use the electric light. As 6d. per unit is equivalent to the present price of gas in the borough, it is estimated that those who get the fullest benefit under the sliding scale will be supplied with electricity at exactly half the price of gas, assuming that the candle-power is in each instance the same, and those who make the most use of the light will get the largest benefit.

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Parliament.—The Telegraph (Channel Islands) Bill has passed through committee in the House of Lords.—The Electric Lighting Provisional Orders (No. 12) Bill has been read a third time in the Commons.—The Clontarf and Hill of Howth Tramroad Bill has been ordered for third reading.—Lord Ribblesdale's committee in the House of Lords has passed the preamble of the Bill promoted by the London United Tramways Company, Limited, by which power is sought for the extension of the company's existing lines from Kew Bridge to Hounslow, through Brentford, along the Chiswick High-road, and from Brentford along the Boston-road to Hanwell, and for the application of electricity throughout the whole system The only opposition to the Bill, as amended by the House of Commons Committee, was on the part of the Middlesex County Council. The committee have decided that any contributions received by the local authorities from the tramway company should be handed over to the Middlesex County Council, but that in the case of Chiswick an apportionment should be agreed between the District Council and the County Council.

Newmarket.—The surveyor has submitted to the Urban District Council three alternative schemes, all of which necessitated pumping, and all of which would keep the sewage within the Newmarket area. The first provided for the pumping of sewage by gas-engines at Newmarket and at Exning; the second substituted electricity as the pumping power; and the third, which was apparently viewed with most favour, differed in that a refuse destructor should be erected near the present outfall, that the steam generated by it should supply the motive power for pumping at Newmarket, and that compressed air by pumping should be transmitted from the Newmarket station to Exning. About 3,000 tons of refuse per year was accumulated at the depôt, and the surveyor thought that such a method of combining the destruction of refuse and the pumping of sewage would be both practicable and cheap. The details of his three schemes have been sent to the Council's consulting engineers, Messrs. Beesley and Son, and it has been decided to await their report. Regarding the new electric light generating station, it was resolved to adhere to the Council's decision as to the erection of a chimney shaft.

Stourbridge.—At the monthly meeting of the Urban Council the Consulting Committee reported that they had had under consideration the notice under the Electric Lighting Act, 1882, given by the Midland Electric Corporation for Power Distribution, Limited, of their intention to apply for a provisional order to supply electric light and power in the urban district. The committee were informed that two similar notices had been served by other companies. The committee recommended that the Council apply to the Board of Trade forthwith for a provisional order to enable them to supply electric light and power in the urban district, and that the Council oppose any applications for similar powers from outside corporations. It was stated that the application for powers by the Council would involve more expense than the application not proceeded with last year, apart from the cost of opposing the applications of other bodies for similar powers. After a discussion, the recommendation of the committee was adopted. On the recommendation of the Railway Committee it was resolved to grant the British Electric Traction Company, Limited, permission to erect poles in connection with the conversion of the existing tramline to electric traction.

Dewsbury.—The *Batley Reporter* says: "The communication from the electric traction company, copies of which were received by the three local authorities in the Spen Valley—Heckmondwike, Liversedge, and Cleckheaton—was in each case dealt with in committee, but we have ascertained that the disposition of the respective authorities is to place no obstacles in the way of the company's project, provided certain clauses are inserted in their powers protecting the districts through which the company proposes to run. One of the clauses will probably stipulate the period within which the works must be completed, so that the scheme will not be everlastingly hanging fire; whilst another clause which will probably be insisted upon will be one enabling the local authorities to take over the undertaking if they wish to do so, and prevent its becoming a private permanent monopoly worked for the benefit of those financially interested instead of for the public good. Failing these concessions, the project would doubtless meet with fierce opposition from the Spen Valley. The Dewsbury Corporation have not discussed the question yet, the letter having been referred to the Parliamentary Committee. They are certain, however, to welcome the company to the town, and to render what assistance they can."

Beckenham.—At the ordinary meeting of the Urban District Council the following report of the enlarged Electric Lighting Committee was adopted after an amendment to refer the same back to the committee had been defeated: "The committee further considered the electric lighting question, particularly in connection with the report by the clerk and surveyor on applications to and replies from electric lighting firms as to undertaking the electric lighting for Beckenham. These replies were now read, and of the 10 firms communicated with, four—namely, Messrs. Siemens, the British Thomson-Houston Company, Messrs. Crompton and Co, and the Brush Electrical Engineering Company—are prepared to tender for the erection and equipment of the works, and in the alternative, for the working of the same as a business. Of the remaining six firms, five would tender for machinery and construction only—namely, the Electrical Construction Company, Messrs. S. Z. de Ferranti and Co., Mather and Platt, John Fowler and Co., and Easton, Anderson, and Goolden. The Westinghouse Company made no reply. It was resolved to recommend that alternative tenders be invited (*a*) for the construction only, and (*b*) for construction, maintenance, and working as a business, the contractor taking all risks, and provision being made for transfer to Council on payment of a graduated fine."

Hampstead.—At the usual fortnightly meeting of the Vestry the Lighting Committee's report, which was adopted, stated that there were at present in force in Hampstead two systems of charging for electric current—viz., the discount system and the maximum demand system—and that each consumer was entitled to be charged by which system he preferred; that it was the unanimous opinion of the committee that the maximum demand system should be adopted throughout; and therefore they recommended that maximum demand indicators be fixed upon the premises of all new consumers, and that on or before Jan. 1, 1899, maximum demand indicators be fixed upon the premises of all consumers, and that every consumer be charged on that system as from the above-mentioned date. The Vestry also decided to strongly oppose the application proposed to be made to the Board of Trade by the Metropolitan Electric Supply Company, Limited, for a provisional order to authorise the supply of electricity by them within this parish. It was further resolved to inform the London County Council that the Vestry are prepared to take up the loan of £16,700 (part of the sum of £17,700 applied for) for further extension of plant at the electric lighting station, to be repaid within 42 years, interest at 3 per cent. being repayable quarterly.

Bermondsey.—At the last meeting of the Vestry Mr. T. Cox (chairman of the Electric Lighting Committee) reported that the Bermondsey Provisional Order Bill had been before a committee of the House of Commons, who, after hearing the evidence, decided not to give their decision until after they had heard the opposition to the Marylebone order, in which case the conclusions were exactly the same, except that in Marylebone the company in possession had expended a very much larger sum of money in providing electricity than the one in Bermondsey. The committee gave their decision on the 15th inst., refusing to confirm the Marylebone provisional order. So far as the Bermondsey order was concerned, the committee expressed the opinion that the Vestry should consider the question in the light of purchase, adjourning the matter until the 21st inst. to enable the Vestry to see what could be done. The vestry clerk had drawn up a clause which would be submitted to Mr. Littler, Q C., for approval, for insertion in the Bill, agreeing, on behalf of the Vestry, to purchase the mains at present laid down in the parish at a sum to be agreed upon by arbitration. According to the evidence, the total amount expended by the company on laying distributing mains was £5,000. He moved that the Vestry agree to the insertion of this clause, but at the same time he could not help saying that the action of the Parliamentary Committee, in compelling the Vestry to buy out the London Electric Supply Corporation, was not in accordance with the spirit of the resolution passed in the House of Commons that local authorities should be allowed competing supplies. This was carried unanimously.

Fulham.—The Vestry have received a letter from the Kensington and Knightsbridge Electric Lighting Company intimating that their principal object in sending the notice of their intention to apply for a provisional order had been to provide for the contingency of their desiring to establish a generating station or connecting mains within the district, but that this notice must not be regarded as an intimation that they will not, if so advised, prosecute their application for an order of the ordinary character. The Electric Lighting Committee's last report stated that they had received a report from Mr. F. Hastings Medhurst, B.Sc., M.I.E.E., who had, in company with the surveyor, made an inspection of the Town Mead Wharf site, and considered the same the most suitable for the erection of the proposed combined scheme. Mr. Medhurst produced a plan showing approximately the ground necessary for the work in the first instance, and also that required for future extensions. He suggested that the latter portion might for the present be utilised as a store or stone yard. As, however, the preparation of the necessary plans and specifications would entail an enormous amount of work, he did not think he would be in a position to submit anything very definite for consideration for the next three or four months. The Vestry have adopted the plan presented by the engineer, and have instructed the surveyor to prepare an amended plan, the same to be placed in the committee-room for inspection when required. Having received intimation from five electric supply companies of their intention to apply for provisional orders in respect of the parish, it has been decided that the applications be opposed, and that the Board of Trade be informed that the Vestry are now proceeding in the matter. An application from the directors of the Granville Theatre of Varieties for permission to open up the road for the purpose of laying the mains to supply the theatre with electric light has been refused.

Chelsea.—At the last meeting of the Vestry the Lighting Committee reported that they had elected Mr. Irons chairman for the ensuing year. They had considered the desirability of the Vestry obtaining a provisional order authorising them to supply electricity for public and private purposes within the parish of Chelsea, and had been in communication with the Board of Trade on the subject. That authority stated that in view of the fact that there were already two companies under statutory obligation to supply electricity in the parish, for all public and private purposes, the Board would not, as at present advised, be prepared to grant further powers in respect of the parish. The committee therefore recommended that a further communication be addressed to the Board of Trade, urging them to reconsider their decision, and pointing out that, although two companies are authorised to supply electrical energy in the parish, the supply is practically a monopoly in the hands of the Chelsea

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Electricity Supply Company, and that the Board had recently granted provisional orders to the Vestries of St. Marylebone and Bermondsey, notwithstanding that private companies are already supplying those districts; and transmitting copies of the notices received from the Kensington and Knightsbridge Electric Lighting Company and the Metropolitan Electric Supply Company, Limited, of their intention to apply for powers authorising them to supply electricity within the parish. The committee further reported that with regard to the preliminary notices received from these two companies no action was at present necessary with respect to them. The committee had been informed by the clerk that in the event of the Vestry desiring to oppose the Chelsea Electricity Supply Bill in the House of Commons it might be necessary, in order to secure a *locus standi*, to prepare and deposit a petition against the Bill before the next meeting of the Vestry. The committee had, under the circumstances, authorised the clerk to continue the Vestry's opposition to the Bill. This was agreed to.

The Wenlock Electrolytic Company.—This Company has been formed, with a capital of £120,000, to acquire a process for the manufacture of chlorate of soda and potassium, and to establish the business of manufacturers of various commercial products capable of being manufactured by electricity or electro chemical means. The company has acquired a lease granted by the Right Hon. Lord Forester of a coalfield situate at Little Wenlock, in the county of Shropshire, which yields a coal of very high quality, for the purpose of producing electricity, either by the use of steam or gas engines. The works will be erected on the coalfield, where there is a good water supply available. The sidings of the Great Western Railway Horsehay Station are within a mile, on a good road. The Company intend to put down at once a plant of 2,000 h.p. for the production of electricity, and to put down further plant up to 3,000 h.p. as the industry progresses. In addition to chlorate of soda and potassium the Company will be able to manufacture such other articles of commerce, yielding a substantial profit, as may from time to time recommend themselves to the management. The services of Mr. Thomas Parker, F.R.S.E., etc., have been obtained as consulting engineer and electrician, and the services of Dr. Readman, F.R.S.E., of the firm of Messrs. R. R. Tatlock and Readman, of Edinburgh, as consulting chemist. Mr. A. H. Preece, in his report on the coalfields, says: "The coal is about 30ft. from the surface. I saw the coal being worked. It is quite clear that its continued working and delivery in the electro-chemical works can be maintained at a cost not exceeding 3s. per ton. The calorific value of the coal is unusually high—viz., 16,000 B.T.U. With such fuel, and at such a price, electrical energy with modern apparatus can easily be produced at a cost of 0·15d. per unit. This can be done either by steam or by gas. I prefer the former in the pioneer stage of the industry, for gas-engines of large power are in an experimental stage, and are not yet sufficiently well developed to justify their adoption. Electrical energy can thus be produced in a coalfield cheaper than by a waterfall, even at Niagara. The estimated cost of erecting works and putting down a plant of 4,000 h.p. to work the process is £78,000, but a first instalment of the 1,000 h.p. could be put down for £25,000, with means to add additional power as the industry progressed at £18,000 per 1,000 h.p. These figures are given me as those at which a responsible firm is willing to carry out the work, and they are fair and reasonable. It appears to me that everything indicates the wisdom of utilising this coalfield to inaugurate in this country a new and lucrative industry, and that there is every prospect of extending the operations, so as to add considerably to the population of the district and to the value of the adjoining property." Messrs. C. F. Kemp, Ford, and Co., Mr. William Ramsay, LL.D., F.R.S., Mr. T. Vaughan Hughes, F.I.C., F.C.S., etc., and Mr. William Grove, mining engineer and surveyor, have reported favourably on the matter.

Dudley.—The following report of the Railway, Tramway, and Electric Lighting Committee was adopted at a recent special meeting of the Town Council: "Your committee appointed the following four gentlemen—the Mayor, the Deputy-Mayor, and Councillors Haynes and Hooper (members of your committee)—to attend the hearing of the appeal by the Corporation against the amended draft order before the Board of Trade and to represent the interests of the borough on the tramway question. The hearing took place on the 14th inst. at the Board of Trade, before Sir Courtenay Boyle, when all the before-named gentlemen attended, with the town clerk, deputy town clerk, borough surveyor, and Mr. R. P. Wilson (electrical engineer). Mr. G. M. Freeman, Q.C., of the Parliamentary Bar, appeared as counsel, and most ably conducted the case for the Corporation. After considerable argument a suggestion came from the chair that a private conference between the parties might be desirable. This took place, with the result that an agreement was finally come to, the heads of which were put into writing and were signed by Mr. Freeman on behalf of the Corporation, and Mr. Sydney Morse on behalf of the company, and which is as follows: 'Heads of agreement made between the British Electric Traction Company (herein called the promoters), their successors and assigns, and the Corporation of Dudley (hereinafter called the Corporation). Order to pass. Subject to agreement. No. 5 to be constructed by promoters to reasonable satisfaction of Corporation. All roadwork, other than laying and electrically equipping tramway, to be executed by Corporation at cost of promoters; any differences to be settled by Board of Trade. Corporation at end of four years to purchase existing tramways under Tramways Act and Railway No. 5, sanctioned under this order at the same time, at price to be settled in case of difference by Board of Trade. Corporation to lease existing tramways and No. 5 to the promoters for 21 years from date of purchase on terms to be settled by lay arbitrator to be appointed by Board of Trade, including a supply of electrical energy to the promoters for tramways within Dudley boundary by the Corporation at a price, failing agreement to be settled by such arbitrator. Price to be open to revision every five years, subject to arbitration of an arbitrator to be appointed by Board of Trade. Corporation to submit plans of electrical station and works to promoters, who are to reasonably approve same and execution of works and plans. Any difference to be referred to arbitrator appointed by Board of Trade. The fact of this agreement to be recited in order.—G. M. Freeman (for Corporation), Sydney Morse (for company), July 14, 1898.' It is considered by your committee that these terms carry out the views of the Council, and obtain for the Corporation all the advantages and preserve all the rights to which they are entitled. (1) The line of tramway No. 5, which will run from present main tramway at Queen's Cross to the borough boundary at Mouse Sweet Brook, will be made as soon as practicable, the promoters laying and electrically equipping the tramway, all the other work being done by the Corporation at the expense of the promoters. This will ensure there being a good vehicular road, also an electrical equipment uniform with the districts beyond the borough boundary. The tramway No. 5 is also to be purchased at the end of four years by the Corporation, which will ensure a unity of ownership of the main line in the borough and of the branch line, a matter of great importance in the opinion of your committee. (2) The rights of purchase of such part of the main tramway between Dudley Station and Stourbridge as lies within the area of the borough, and which right is vested in the Corporation, is guaranteed at the end of four years upon the terms of the Tramways Act, 1870, and which, without doubt, are advantageous to local authorities. Your committee, however, have every reason to believe that no delay of four years need occur, and that when a formal agreement carrying out the 'heads of agreement' has been executed the work of constructing and electrically equipping the main line all the way from Dudley Station to Stourbridge will be carried out without delay. (3) The supply of electrical energy for traction purposes required for the working of the tramways within the borough boundary is secured to the Corporation, which your committee regards as a most important factor in the profitable working of the electric order obtained by the town in the session of 1897, and the supply to the borough of electricity for lighting purposes. (4) Your committee are convinced of the absolute necessity of having an unbiassed tribunal of unexceptional weight and authority to settle points important in themselves, but nevertheless minor to the main issues involved which inevitably arise in the working out of the numerous and varied arrangements between the Corporation and the company, and they have therefore provided that the Board of Trade shall be the ultimate appeal in all cases of difficulty and difference of opinion, and your committee feel no hesitation in recommending the Corporation to leave the interests of the town to the arbitrament of so high and impartial an authority. Your committee further recommend that the town clerk be instructed to carry out the agreement proposed, to be at once executed with all such necessary clauses and provisions requisite to carry out and complete the 'heads of agreement' before mentioned, and that the adoption of your committee's report by the Council be deemed sufficient authority from the Council to the carrying out of the above-mentioned agreement, and for the town clerk to attach the corporate common seal thereto."

PROVISIONAL PATENTS, 1898.

July 18.

15674. Improvements in electrical communication between passengers and guards in railway trains. William Edward Langdon, Electrical Department, Midland Railway, Derby.

15682. An improved mouthpiece attachment for telephones. Nicholas Walter Harper, 9, Benson-street, Liverpool.

15686. New or improved means for electrical incandescent luminous advertisements. Emily Sophia Böhm, 306, High Holborn, London.

15703. Improvements in primary batteries. Edgar Giglio, 6, Lord-street, Liverpool.

15724. Production of chromic acid by electrolytic oxidation of solutions of chromium oxide salts. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Farbwerke vormals Meister, Lucius, und Brüning, Germany.)

15733. Improvements in electric telephone transmitters. Alfonso Maria Massari, 45, Southampton-buildings, London. (Complete specification.)

July 19.

15736. An improved electric arc lamp. Henry Vincent James, Westhill, Higher Broughton, Salford.

15765. Improvements in gratings or supports for electrical accumulator plates. Frederick William Golby, 36, Chancery-lane, London. (Cambier et Cie., France.)

15785. Improvements in switches for electric circuits. Reginald Belfield, 322, High Holborn, London. (Charles F. Scott, Harry P. Davis, and Gilbert Wright, United States.)

15792. Improvements in electric motors. Léon Marie Joseph Clément Levavasseur, Birkbeck Bank-chambers, Chancery-lane, London.

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15797. **Improvements in or relating to means for ensuring a constant charge in electric traction stations or for transmission of power to generating dynamos.** Alfred Julius Boult, 111, Hatton-garden, London. (La Société Française de L'Accumulateur "Tudor," ———.)

15801. **Improvements in electric accumulators.** Ewald Leiner, 45, Southampton-buildings, London. (Complete specification.)

15802. **Improvements in electric accumulators.** Ewald Leiner, 45, Southampton-buildings, London. (Complete specification.)

15803. **Improvements in electric accumulators.** Ewald Leiner, 45, Southampton-buildings, London. (Complete specification.)

JULY 20.

15879. **Improvements in or in connection with contact boxes for electrical railways or tramways with underground conductors.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alfredo Diatto, Italy.)

15881. **A construction of dynamo-electric machines in combination with flywheels of motors.** Léon Marie Joseph Clément Levavasseur, Birkbeck Bank-chambers, Southampton-buildings, London.

15885. **Improvements in electromagnetic ore separators.** Hugo Erich Langguth, 1, Queen Victoria-street, London. (Complete specification.)

15886. **Universally-adjustable reflector or screen for electric glow lamps.** Paul de Kilduchevsky, 53, Chancery-lane, London.

JULY 21.

15944. **Improvements in or relating to electricity meters.** Jean Villey, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 11, 1898, being date of application in France.) (Complete specification.)

15967. **Improvements in cells applicable for the production of chlorine and alkali metal amalgams by electrolytic decomposition of solutions of alkaline chlorides.** Josiah Wyckliffe Kynaston, 6, Lord-street, Liverpool.

15972. **Improvements in electricity meters.** George Hookham, 18, Southampton-buildings, Chancery-lane, London.

15976. **Improvements in electric arc lamps.** Walter Claude Johnson and Adolph Wunderlich, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

JULY 22.

16029. **Improvements in and relating to electric furnaces.** George Llewellyn Palmer and Ernest Williams, 7, Southampton-buildings, London. (Complete specification.)

JULY 23.

16057. **Improvements in or relating to electric light installations.** Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, Charing Cross, London.

16064. **An electric jib crane or hoist.** John Dugdill, Firs House, Failsworth, near Manchester.

16070. **Method designed to facilitate the passage of electric wires into or out of brake pipes or other pipes which are to or which may be coupled on railway trains.** George Rennie Powell, Rosebank, Ashley Down, Bristol.

16114. **Improvements in connection with telephones for recording the number and duration of telephonic conversations.** Joseph Frank, 47, Lincoln's-inn-fields, London.

16120. **Improvements in or in connection with prepayment apparatus suitable for use in connection with electricity and other meters.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

16129. **Improvements in the electrolysis of solutions of alkali salts, especially alkali chlorides.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Oesterreichischer verein für chemische und metallurgische production, Bohemia.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

7958. **Electric batteries.** Jahncke.

15328. **Apparatus for operating two or more electric current switches simultaneously or periodically.** Lucas.

15472. **Electric furnaces and processes of treating ores.** Burton.

16788. **Alternating-current motors.** Langdon-Davies.

18176. **Electrical accumulators or storage batteries.** Heil.

20316. **Electric fire-engines.** Dymond. (Cox and Smull.)

20325. **Electric light fittings.** Salt.

23623. **Process of manufacturing electric incandescent lamps.** Howard and Mayer.

1898.

11153. **Electric arc lamps.** Siemens Bros. and Co., Limited. (Siemens and Halske—Aktien-Gesellschaft.)

11783. **Conductors for electric railways.** Lake. (Willard.)

12350. **Electric alarums.** Siemens Bros. and Co., Limited, and Ebel.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended July 24 were £1,652, as compared with £1,472 in same week of 1897, being an increase of £180.

Birmingham Tramways.—The traffic receipts for the week ending July 23 were £3,854. 7s. 9d., as compared with £3,763. 6s. 9d. for same week in 1897, being an increase of £91. 1s. 0d.

Dover Tramways.—The traffic receipts for the week ending July 23 were £203. 2s. 4d. The total receipts for the year 1898 are £3,834. 0s. 10d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending July 22 were £3,047. 7s. 2d., compared with £2,707. 14s. 11d. for same period of last year, being an increase of £339. 12s. 3d.

South Staffordshire Tramways.—The traffic returns for the week ending July 22 were £628. 11s. 11d., as compared with £656. 7s. 3d. in same week of 1897. The aggregate receipts for the year are £17,746 3s. 10d., as against £18,037. 19s. 3d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended July 24 were £935, compared with £889 for same week of 1897, being an increase of £46. The total receipts for the half-year amount to £3,763, compared with £3,666 for the same period last year, being an increase of £97.

Dublin S.D. Tramways.—The traffic receipts for the week ending July 22 were £1,264. 14s. 0d., as compared with £912 16s. 10d. in the corresponding week in the previous year, being an increase of £351. 17s. 2d. The number of passengers carried was 173,563 in 1898 and 127,687 in 1897. The aggregate returns for the half-year are £3 261. 15s. 2d., as compared with £2,648. 16s. 7d. last year, being an increase of £612. 18s. 7d. The mileage open is 9 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	£	10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
——— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1¾-2⅛
——— Non. Cum., 6 per cent. Pref.	2	2¼-2⅜
——— 4½ per cent. Debenture Stock	100	110-114
——— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	108-111
——— Ordinary	5	10-11
Central London Railway, Ordinary	10	9⅞-10⅛
———	6	5⅞ 6⅛
——— Pref. Half-Shares	1	1⅛-1⅜
——— " "	5	4¼-4½
Charing Cross and Strand	5	12½-13½
——— 4½ per cent. Cum. Pref.	5	5⅞-6⅛
Chelsea Electricity Company	5	9-10
——— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	25½-26½
——— Prov. Cert. 90,001-100,000	5	25½-26½
——— 6 per cent. Cumulative Pref.	10	16½-17½
——— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-71
——— Ordinary	3	2¾-3¼
——— 4 per cent. Debenture Stock	100	136-138
——— 5 per cent. Pref. Shares	10	15-16
——— " " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
——— " " " "	6	9½-10½
——— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞ 2⅛
——— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	127-132
——— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	2	2⅛-2⅜
——— 5 per cent. Debentures	5	4-5
——— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	4-5
Electric Construction, Limited	2	2⅛-2⅜
——— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
——— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅜-½
Elmore's Wire Company	2	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
——— 7 per cent. Preference	10	18½-19½
——— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9½-10½
——— 7 per cent. Preference	5	9½-10½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
——— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
——— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3⅜-4⅛
Metropolitan Electric Supply, Limited, Ordinary	10	15-17
——— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5⅞-6⅛
——— 6 per cent. Cum. First Pref.	10	15-17
——— 6 per cent. Cum. Second Pref.	10	15-17
——— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅞
——— 3½ per cent. Deb. Stock, Red.	100	101-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-1⅜
——— £5 Shares	5	7¼ 7⅝
——— £4½ shares	4	6-6½
Oriental Telephone and Electric Company	1½	⅝-¾
Royal Electrical Company of Montreal	—	142-145
——— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	3	3-3½
St. James's and Pall Mall, Limited, Ordinary	5	16-17
——— 7 per cent. Pref.	5	9-10
——— 4 per cent. Deb. Stock, Red.	100	103-108
Telegraph Construction and Maintenance	13	36-39
——— 5 per cent. Bonds	100	110-113
Waterloo and City Railway, Ordinary	100	116-121
Westminster Electric Supply, Ordinary	5	15½-16½
Yorkshire House-to-House	5	5⅜-5⅝ xd

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NOTES.

Paris Exhibition of 1900.—We are authorised to state that applications for space should be sent to the secretary of the Royal Commission, St. Stephen's House, Westminster, not later than Aug. 20, 1898.

Errata.—In our "Questions and Answers" columns last week, p. 153, the following errors have been noticed by Mr. F. Stott: Line 35 from bottom, for "gain per cent. 13 4," read "13·4 per cent." Line 24 from bottom should read: "But $u_1 = 1{,}082 + 0{\cdot}305\ t - (t_2 - 32)$," etc., as it appears in the equation immediately after.

Personal.—Mr. W. Worby Beaumont is leaving England on a visit to the United States on the 12th inst., which he is visiting to inspect and report on a special class of machinery, electrical working of machine tools, and on certain manufactures. He will at the same time make use of his opportunities with regard to motor tramcar and carriage questions.

Our Japanese Representative.—We understand that Dr. Ichisuka Fujioka, the local honorary secretary for Japan of the Institution of Electrical Engineers, and consulting engineer to many Japanese electrical undertakings, has come to this country to study the position of the British electrical industries in general, and is now making a short stay at the Hôtel Métropole.

The Dover Trams.—The electric trams in Dover, in spite of their present limited length, are more than paying their way, and have fully justified their installation. On Monday last a record was established, as £71 was taken in penny rides. The average cost of working, including interest and repayment on loans, only works out at little over £17 per day. The average daily takings is over £30. Over 17,000 persons used the trams.

Presentation.—Mr. George C. Sillar, who, as already announced, has recently been appointed general manager of the Otis Elevator Company, Limited, was presented last Wednesday evening at Falcon Works by his late fellow employés in the employ of the Brush Electrical Engineering Company, Limited, with a silver salver, two silver goblets, and an illuminated address containing over 300 signatures. Mr. R. Percy Sellon, the general manager of the Brush Company, presided, and good speeches were made during the ceremony.

Telephones in Costa Rica.—There is a notice on the wall of the telephone exchange in Costa Rica requesting the lady operators to "abstain from smoking" while on duty. It is said the service in the exchange is fairly good, although no one seems to be in a particular hurry. The operators are, says the *Electrical Review* of New York, leisurely in their movements, and vary their professional duties with cheerful conversation. Unfortunately, the cheerful conversation of the telephone operators in England does not make up for the annoyance of the "engaged" reply.

The North-East Coast Institution.—We have received Parts 6, 7, and 8 of the fourteenth volume of the *Transactions* of the above institution. These contain the following items: Mr. H. E. J. Camp's reply to the discussion on his paper on "The Transverse Framing of Ships"; discussion on Mr. A. E. Long's paper on "Some Points of Interest in the Designing of Cargo Steamers"; paper on "Cylinder Ratios," by James Andrews, and discussion; paper on "The Effects of Different Arrangements of Crank Angles upon the Economy of Quadruple-Expansion Engines," by A. L. Mellanby, B.Sc., and also the discussion.

Competing Provisional Orders.—We must admit that it is somewhat difficult to follow and give reasons for some of the decisions arrived at by the Houses of Parliament this session. Thus, while neither the Marylebone Vestry nor the Bermondsey Vestry have been allowed to establish works to compete with the electric lighting companies in their districts, the Charing Cross and Strand Electricity Supply Corporation have been allowed to extend their area. Thus we learn that the provisional order granted to the above corporation by the Board of Trade, enabling the corporation to supply electric energy in that part of the St. Giles and Holborn districts lying to the south of New Oxford-street and High Holborn respectively, has now been confirmed by Parliament, and only awaits the Royal assent to become law.

Electric Groomers and Clippers.—The electric motor has become a necessary adjunct to every well-appointed modern stable in the States, whether livery or private, and horses are now both groomed and clipped by electricity. In the latest type of these gears a 1-h.p. motor and its rheostat are bolted to the ceiling of the stable. In this case no floor space is occupied by the motor, the countershafting is eliminated, and the belting is reduced to a single belt from the motor pulley to the pulley attached to the flexible driving shaft of the groomer and clipper. This clipping and grooming outfit is singularly compact and simple, and requires almost no attention beyond an occasional oiling. With the electric motor-driven groomer and clipper a horse may be thoroughly brushed in about 2½ minutes and clipped in about 35 minutes.

Shunting.—Trials have been made at the Koenigstein railway station in Saxony with an electric locomotive made by E. Klemm in Dresden. The *Zeitschrift für Elektrotechnik* says the car has the form of a close lorry, and carries a battery of accumulators. The trial included 16 shuntings of a different number of cars. The locomotive was able to move two to three fully-loaded wagons at the necessary speed, while a train of six to eight wagons could be shunted somewhat less quickly. The speed during the actual shunting equalled the walking pace of a strong horse; that of the locomotive without train was equal to that of a horse while trotting. When fully at work 40 amperes were used. The average horse-power was 3·4; the highest 6. The trial showed that in places where horses are used for shunting the motor-wagon is more useful and is also cheaper, provided that the arrangements for charging the accumulators already exist on the spot.

Finsbury Technical College.—The council of the City and Guilds of London Institute has accepted the following list of students who have regularly attended a complete course of instruction for day students (extending over a period of two years for mechanical and electrical engineering students and three years for chemical students) at the institute's technical college, Finsbury, and have satisfactorily passed the several class examinations: N. L. Ablett, J. A. Anderson, F. M. Attwood, B. F. Browne, S. Cazeaux, R. H. Collins, W. G. Davis, J. Denham, A. W. M. Dickins, J. H. Fennell, A. P. M. Fleming, H. W. Fyson, C. L. Gray, H. C. Hastings, P. A. Jones, F. C. Kidman, C. J. Lockyer, D. Ockenden, V. C. Phillips, A. R. Powell, J. F. M. Roberts, W. G. Royal-Dawson, L. H. Rugg, C. G. Saunders, O. J. Silberrad, G. Taylor, W. H. Taylor, O. A. Tuxen, A. V. Venables, H. L. Wall, F. P. Whitaker, A. Wilkes, W. A. Williams, C. E. Young.

Novel Advertising.—The *Electrical World* is publishing with the first issue of every month, in its advertising columns, three pages of most interesting and valuable information in connection with incandescent lamps for the Bryan-Marsh Company, of New York City. This latter company has adopted this novel and attractive manner of not only advertising its own excellent product, but in con-

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nection therewith gives a current discussion of timely topics on the incandescent lamp, the manufacture of which is in itself an enormous industry. It is called the *Imperial Lamp Gazette*, and will certainly be looked forward to by every one interested in the incandescent lamp from any standpoint with the greatest interest. Thus in fact a journal within a journal is obtained, over which the advertiser has complete control. This is a great advantage, and the lamp company is able by giving useful information to ensure that its three page advertisements are read, as they certainly are not when they consist of catalogue matter only.

A New Kind of Transition Cell.—Ernst Cohen describes in the *Zeit. für physikal. Chem.* an electrical cell in which an E.M.F. is produced by means of electrodes placed in saturated solutions of the two forms of a compound capable of undergoing a transition change, and an element where the temperature coefficient changes abruptly at the transition temperature (Abstract, 1894, ii., 407). Another class of cell is of the following type: electrode reversible with respect to the anion | saturated solution in presence of stabile solid phase | electrode reversible with respect to the cation. Such a cell is the Clark cell, consisting of mercury in mercuric sulphate, | saturated solution of zinc sulphate, | zinc, and in this cell the temperature coefficient should change abruptly at the temperature of transition from $ZnSO_4+7H_2O$ to $ZnSO_4+6H_2O$. Callendar and Barnes (Clark cell's abstract) found this temperature to be 38·75deg.; solubility experiments gave the value 39·3deg., and by the dilatometric value the temperature 38·5deg. was obtained. The above is abstracted from the *Journal* of the Chemical Society.

Institution of Mechanical Engineers.—The Derby meeting of the above institution was concluded last week by a series of excursions to various works in the surrounding districts. One of these commenced by a trip to Loughborough by a special free train provided by the directors of the Midland Railway. At Loughborough the works of the Brush Engineering Company were visited, and a large number of the members availed themselves of the opportunity to see over the electrical works. The fact that a large number of tramway motors were to be seen in the shops is a sign that this firm is not succumbing to the American competition in this department. After leaving these works the company proceeded by contractors' train over the new Great Central Railway to see the new Swithland waterworks of the Leicester Corporation, where light refreshments, by invitation of Mr. Alderman Wood, chairman of the Waterworks Committee, were provided. Other members of the institution went over the British Aluminium Company's works at Milton. The Corporation's electricity works at both Derby and Nottingham were open for inspection. On Friday a social trip to the Dukeries concluded the pleasure outings.

Professional Ethics.—If good professional ethics in relation to one another were the rule among consulting electrical engineers, while the conditions of practice would be more conducive to doing good work, the total result in the distribution of employment would be much the same as if the "get there" idea were to prevail. Professional habits, as followed by those of the profession who have, as the French say, "arrived," are rather an index of how they achieved their position than, as is sometimes supposed by the irregulars, a creation to help them to keep it. The only way to permanent success is expertness, and this is to be attained not by working for work but by working at it. The young electrical engineer whose ideal or practice is to become a man in the street, dusting about to procure work for draughtsmen to do, has entered upon a career which can only have one end, the gradual elimination of real engineering from his work, and his own gradual elimination from a profession in which the first requisite is, after all, expert knowledge. The above paragraph is taken from the *Canadian Architect*, and is about architects, but it so fits in with our views that we have taken the liberty of altering the word "architect" to "consulting electrical engineer."

An Accidental Triple Electrocution.—A terrible accident, due to inadvertence under circumstances of excitement, and apparently, also, to the difficulty of impressing on workmen the danger of contact with conductors charged to a high potential, occurred on the 28th ult. at the Brillouin regenerated rubber factory situated at Puteaux, near Paris. A slight fire, due to the combustion of some indiarubber waste, producing a large quantity of smoke, had occurred in proximity to some conductors under a pressure of 2,400 volts. A fireman attached to the establishment, in endeavouring to extinguish the fire, appears to have caught hold of one of these conductors. He was instantly killed by the effect of the current, the wire remaining in contact with the body. A few minutes later one of the workmen, in endeavouring to aid his comrade, who was supposed to be asphyxiated by the fumes, was also instantaneously struck dead. A crowd had now collected, and a young coachman, in spite of the warnings he received, rushed forward to withdraw the bodies, with the result that he also fell a victim to the electric discharge. Only then, apparently, was the true character of the danger understood, and the current cut off. The fire was speedily put out, the only damage resulting from this cause being the destruction of some caoutchouc clippings. A police investigation of the circumstances connected with the case has taken place.

Institution of Electrical Engineers.—We have to acknowledge the receipt of Part 138 of vol. xxvii. of the *Journal* of the Institution. As this part contains the *Proceedings* up to the end of May, when the session 1897-98 terminated, and the next session does not commence until November, there will be no further issue of the *Journal* until the end of the year. Attention is specially called to the two letters placed within the cover of this number of the *Journal* relating respectively to premiums and subjects of papers, and the benevolent fund of the institution. This latter fund will be managed and administered on lines similar to those of the benevolent fund of the Institution of Civil Engineers, which has been the means of effecting a vast amount of good, and one of the chief features of which is that the names of the recipients of any grant from the fund are not published. The donations and subscriptions already received vary from £250 to 2s. 6d., and amount to £1,000, and the council trust that all members who have not yet contributed will give their assistance to the fund, not only by personally contributing, but by using their influence to obtain subscriptions or donations from such of their friends as take an interest in the Institution or in the profession which it represents. One of the rules provides that all present contributions shall, unless the donor express a wish to the contrary, be considered as capital until a sum of £10,000 has been invested in the names of the trustees.

Electrolytic Estimation of Cadmium.—Messrs. Daniel L. Wallace and Edgar F. Smith communicated to the *Journal* of the American Chemical Society a paper on the above, which is abstracted as follows from our own Chemical Society's *Journal*: "The authors state that Heidenreich's failure to obtain correct results with Smith's electrolytic process is probably due to the use of a current of different strength. Two experiments are communicated, showing that 50 cubic centimetres of a solution containing about 0·13 grm. of cadmium oxide in the form of acetate

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deposited all the metal when electrolysed at a temperature of 50deg. with a current of 0·02 ampere for 37 square centimetres of cathode surface, voltage 3·5, the time required for complete precipitation being about four hours. The same amount of cadmium oxide dissolved in two cubic centimetres of dilute sulphuric acid of specific gravity = 1·09, and diluted to 30 cubic centimetres, deposited all the metal when electrolysed for 4½ hours at 50deg. with a current of 0·08 ampere for 37 square centimetres cathode surface, voltage 2·5. The electrolytic process may also be employed for the separation of copper from cadmium if the liquid contains free nitric acid. A solution containing about 0·1 grm. of cadmium, and the same amount of copper per 100 cubic centimetres, and also two cubic centimetres of strong nitric acid, when heated to 50deg. and electrolysed with a current $N.D._{100} = 0·10$ ampere, voltage 2·5, deposits the copper completely in three hours, leaving all the cadmium in solution."

Electric Tramway Convention.—The sixteenth annual convention of the New York State Street Railway Association will be held at the Hotel St. George, Brooklyn, on Sept. 13 and 14. Mr. G. Tracy Rogers, president of the Binghamton Railroad, is president of the association. He was elected to this office in 1894, and has been re-elected each year since then. Among the subjects covered by the papers to be presented at the coming meeting are: Points on the care of dynamos—The use and abuse of transfers—How can we increase our receipts?—Low joints: how to prevent them—The power station from an economic standpoint—The office; suggestions for records, reports, etc.—Track bonding: how can we obtain the best results?—Street railroad *v.* the State; the relation to each system for single-track roads—General track construction: the most approved method of freight and express service on suburban and interurban lines—Are air and power brakes on electric cars practicable?—The most approved plan of long-distance power transmission—The best method of preventing accidents—Pleasure resorts as a means of stimulating travel; are they profitable?—The effect upon street railroads of the application of electricity to steam: possibilities and advantages from an up-to-date street car service and why the rate of fare should not be reduced—Daily inspection of car equipment and how can we accomplish the best results?—Receipts from other sources—How to obtain the best results from sale of extraordinary privileges, power, etc.

Word Pictures.—The United States untechnical Press is hard to beat for word pictures. In the anecdote below a picture almost as terrific as the well-known fight between Phra the Phœnician and the first steam-engine is depicted. Reading between the lines, we gather that, in spite of the efforts of the engineer, the engine in question first rushed round the engine-house and then escaped into the country. The *Macon Telegraph* gives the account as follows, under the heading of "An Engineer's Heroism": "A wild Indian is something awful, but a wild engine is about as terrifying a contrivance as a man could think of. Imagine a huge steam giant, with power enough to run away with a freight train, tearing about in a power-house, its governor strap broken, its huge arms making several hundred revolutions a second and smashing everything within reach. Such was the scene in the central station of the Macon Consolidated Street Railroad Company a few days ago. The engine was a stationary one of great power, and was one of those used to generate electricity for the street car company. When its governor strap broke, and before the engineer, W. M. Brevard, could reach it, the governor had blown wide open, and the increased speed had thrown it on its side. In spite of the escaping steam, mud, and pieces of iron which filled the air, Brevard, at the risk of his life, seized the governor and shut off the steam. As it happened, only 500dol. or 600dol. damage was done, and the engine will probably be able to go back to work in a few days."

Magnetisation and Length.—The small changes in length produced in a bar by magnetism have been investigated by many experimenters. Mr. J. S. Stevens, however, is, we believe, the first to use interference methods for measuring the changes so produced. He describes his experiments in the current number of the *Physical Review*. The "interferometer" has now become so well known that it will not be necessary to describe it again. This instrument was used with slight modification of its construction. The mirror frame, which is commonly attached to the movable bed, was removed and firmly screwed to the end of the rod to be tested. The other end of the rod was made fast to a brass cylinder, which could be moved backwards and forwards, and thus provide the adjustment usually afforded when the mirror is moved by means of a micrometer screw. The magnetising coil was supported so that adjustment in two directions was possible. The whole was attached to a heavy wooden frame, and little or no inconvenience was caused by vibrations in the building. The magnetising coil was composed of 15 layers of No. 25 copper wire, and was 21cm. long. It had a resistance of 420 ohms. Current was afforded by a storage battery of 110 volts. The rods were 30·5cm. in length and 0·953cm. in diameter. Tests were made with wrought iron, cast iron, steel, copper, brass, nickel, and aluminium. In conclusion, the author claims the following as the points of advantage of the method: since the mirror is practically a part of the rod, little or no annoyance due to vibrations of the building was experienced; the measurements are direct and the unit so small that the error need not exceed 1 per cent.; the errors liable to occur in any mechanical device, such as the use of levers, indicators, and the like, are eliminated; any auxiliary effects, such as distortion, are closely seen.

City and Guilds of London Institute.—At a meeting of the council of the institute, held at Mercers' Hall on July 25, 1898, it was resolved that the diploma of associate of the City and Guilds Institute (A.C.G.I.) should be conferred upon the following matriculated students, who have completed a full course of study at the institute's Central Technical College, and have satisfactorily passed the several examinations of the various departments. In physics and electrical engineering the new associates are: A. A. Cahen, W. H. Derriman, J. M. Donaldson (who was also awarded the Siemens memorial medal in his department), F. W. Fawdry, E. H. Freeman, B. Glass, G. F. R. Jacomb-Hood, F. J. Kimmel, W. N. Y. King, C. A. McCalla, G. D'A. Meynell, H. W. Oldham, A. H. Read, D. H. Slack, M. Solomon, and W. N. Wilson. The new associates who have qualified in Prof. Unwin's department of civil and mechanical engineering are: E. A. Byrde, W. C. Cantrell (who was also awarded the Siemens memorial medal in his department), H. K. Chambers, E. M. Dowson, H. A. Dupré, A. W. Elworthy, S. M. Fowler, O. T. Gnosspelius, A. M. Grant, L. Guttmann, J. L. Naz, H. A. Neild, H. J. B. Powell, D. M. Stewart, H. M. Warner, W. Waters, W. L. Waters, E. C. Winter, and C. G. Wright. In chemistry the successful students are: S. J. E. Bayly, J. H. Dolton, E. W. Lewis, R. S. Potter, and R. J. Seligman. Certificates were also awarded to the following students who have taken the regular course, and not qualified for diplomas, or else have taken special courses of studies in one of the various departments of the college. First-class certificates: A. Barritt, C. Collingwood, E. B. Gray, M. W. Henty, J. M.

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Hudgins, A. B. Jones, B. K. McMorris, E. Meldal, G. S. Odling, G. M. Russell, R. H. H. Stanger, G. Wilson, and G. H. Wyatt. Second-class certificates: A. C. T. A. Forsberg, E. D. Level, H. P. Peyton, and E. L. Scott.

Vacuum-Tube Luminosity.—Mr. Ewin S. Ferry's communication to the *Physical Review* on the relations between pressure, current, and luminosity of the spectra of pure gases in vacuum tubes is a most valuable one. The author describes his methods fully, and gives his results in a series of tables and curves, which lead to the following conclusions regarding the luminosity of the separate spectral lines of gases in vacuum tubes under different conditions of pressure and current strength: (1) With gas pressure of from 0·25mm. to 4·00mm. of mercury, and current strengths of from one milliampere to six milliamperes, the luminosity of the separate spectral lines of gases at a given pressure is directly proportional to the current strength. This is in exact parallelism with K. Angström's observation that the energy of the luminous radiation, as well as the total radiant energy of a gas rendered luminous by an electric current, is directly proportional to the current strength. (2) With constant current, the luminosity of a spectral line of a gas increases as the pressure decreases, at first slowly and then more rapidly. The curve showing the relation between the pressure of the gas and the luminosity of a spectral line is regular, but is different for different lines. The research work was performed in the Physical Institute of the University at Upsala, and in conclusion the author expresses his deep obligations and grateful thanks to Prof. Kunt Angström for the assistance and encouragement he received from him throughout the entire course of the experiments.

The New Aron Meter.—The meter we refer to is the one described in our columns in July last year, and, as we stated then, the meter is a most satisfactory one in every respect. This is proved by the fact that the Board of Trade have now passed the same, and we tender our congratulations both to Dr. Aron, the inventor, and to the General Electric Company, who are agents for the meter. As it is not often that the approval of a new type of electricity meter is announced in the *London Gazette*, we give the following full text extracted from the issue of July 29. It is headed "Board of Trade, Whitehall-gardens, London," and reads: "For the purposes of the Electric Lighting Acts, 1882 to 1890, and all provisional orders and licenses made and issued thereunder, the Board of Trade approve of the pattern and construction of the meter hereinafter described for the measurement of electrical energy when supplied on the constant-potential continuous-current system—namely, the meter deposited at the Board of Trade on Aug. 13, 1897, by or on behalf of the British Aron Meter Company, of 42, Essex-street, London, W.C., and sealed by the Board of Trade and known as the Aron meter. The Board of Trade further approve of the following manner of fixing meters of the above pattern and construction and of connecting them with the service lines: The meter is to be fixed securely on a vertical wall or support, great care being taken that it is accurately perpendicular as indicated by the plumb-line fixed on the left-hand side of the case. In connecting the meter with the service lines one service line is to be cut, the ends prepared as described below, and the conductors inserted and tightly clamped in the left-hand pair of terminals, so that the current circulates in the direction marked by the arrows engraved on the terminal blocks. Similarly, the other service line is to be cut and its ends prepared as described above and tightly clamped in the right-hand pair of terminals. In preparing the ends of the service lines, the conductor is to be bared of insulating material for a length not less than $\frac{3}{4}$in. and not exceeding 1in., the insulation being cut straight across. The outside of the insulating material is to be made to fit closely the hole through which the line is passed to the terminal, indiarubber tape or other insulating material being wound on to the requisite thickness if necessary. Signed by order of the Board of Trade this 26th day of July, 1898.—T. H. W. PELHAM, Assistant Secretary, Board of Trade." It will be remembered that this meter is self-winding.

Compulsory Purchase in Chelsea.—On Thursday last week the Select Committee of the House of Commons of which Mr. Brynmor Jones is chairman resumed consideration of the Bill promoted by the Chelsea Electricity Supply Company, Limited, for the purpose of empowering the company to compulsorily acquire lands in their district on which to extend the station and works now existing at Flood-street, Chelsea. Mr. Pennell, who is the leaseholder, and the London Assurance Company, the owners of certain property closely adjacent to the area on which the extension is sought to be made, opposed the Bill, and they based their opposition on the allegation that the new works will, or may, injuriously affect their property, and that under the Bill they will have no adequate remedy or means of recovering compensation. Mr. Moon, on behalf of the promoters, said the simple effect of giving the compulsory powers to carry on their work was to afford protection against the claims for damage which was unavoidable in carrying on their work. Avoidable damage could always be sued for. It was only because electric light was an entirely new enterprise that new obligations were attached to those enterprises, but the Joint Committee were satisfied that the restrictions imposed upon electrical enterprise were such as to impede the development of the industry in this country, and therefore they said the provision of electricity for various necessary public purposes had now become so important that they thought the time had arrived when compulsory powers ought to be granted to them. The Chairman gave the committee's decision as follows: We think, having regard to the present development of the electrical industry, that the undertaking of the company is of such magnitude and public utility as to bring the Bill within the category of electrical undertakings contemplated by the report of the Select Committee. Upon the evidence we are satisfied that the company's present powers do not, and the additional powers given by this Bill will not, if used with due and reasonable care and skill, and by means of modern machinery and appliances, which the company may be reasonably required to employ, cause any sensible physical damage to the structure of the buildings in which the petitioners have interests, or any such discomfort to occupiers of these buildings as might be reasonably com plained of by such occupiers. Subject to the amendment of Clause 8, in accordance with the report of the Home Office and the consideration of Clause 8, so far as it may relate to the use of the part of Mr. Pennell's property which has been purchased by the company, we declare this preamble has been proved."

Accumulator Traction.—Mr. E. R. Gilbert, the general manager of the Chicago Electric Traction Company, contributes a most interesting article on accumulator traction to the current number of the *Street Railway Review*. As Mr. Gilbert is actually running a tramway with accumulator cars he speaks with experience. The line in question is now the only storage battery road in successful operation in the United States. The road was designed and constructed by G. Herbert Condict, to whom the largest part of its mechanical success is due. Some eight

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cars are run regularly each day, while on holidays and Sundays as many as 40, including trailers, are used. Owing to the weight of the cars, which is about 15 tons, they cannot be started and stopped as quickly as a trolley car, which weighs but eight or nine tons, and at first thought it would seem that the liability to accidents would be increased. Experience shows, however, that this is not the case. For the last year the accident account was only two-thirds of 1 per cent. of the gross receipts. This Mr. Gilbert considers to be extremely low; the usual rate for a suburban trolley line is about 2 per cent. In the winter the 26 miles of track was kept clear by the use of only one plough and one sweeper. On account of their great weight—the plough weighing 22 and the sweeper 26 tons—there is little danger of their leaving the track, so that it is safe to "buck" drifts with the plough, a thing which is rather risky with a lighter machine. In one case, a drift of 7ft. high and several hundred feet long was cut through in this way. The longest round trip is 22 miles. With a good rail this is easily accomplished without a change of batteries; in fact, cars have run as far as 40 miles with one charge, but the conditions for such a long run are so often unfavourable that it has been found advisable to change batteries every half trip or 11 miles, the power plant being located in the centre of the system. By doing this all danger of a "push-in" is avoided, and the cars are able to carry trailers and make the trip under all conditions. Passengers do not seem to mind in the least the slight delay caused by changing batteries. The average length of time required for changing is 1¼ minutes. The road is nearly level excepting for one hill 300ft. long with a grade of 9½ per cent. The cars average 200 miles per day and their speed averages 12 miles per hour. The author then comes to the disadvantages. These are chiefly due to the replacement of batteries and the effects of the acid fumes on the car framework. In the year ending July 1, 1898, the depreciation of the accumulators came out at 1d. per car mile. The total expenses came out at 4·3d. per car mile, varying from 3·5d. in summer to 5d. in winter.

Institution Papers.—Of the reading of papers there appeared to be no end at the Institution of Electrical Engineers this spring, but more are wanted, and the summer holidays of the members will be marred by the following lengthy list of subjects on which papers are wanted. The premiums offered for papers are as follows: the Institution premium, value £25; the Paris Exhibition premium, value £10; and the Fahie premium, value £10. Two additional premiums, valued respectively at £10 and £5, are offered for papers received and printed but not read. The subjects on which papers are invited are as follows: Best methods of generating steam and steam power for variable loads; comparison of double and triple expansion engines for varying load conditions; the present position and applicability of gas or oil engines for electrical power stations; description of plants for the utilisation of water or wind power in the generation of electrical energy; the present position and prospects of the application of liquid and of powdered fuel in electrical power stations; the utilisation of blast-furnace gases or other waste products of manufactures in the generation of electricity; the application of dust destructors to the generation of electricity; improvements in dynamos; comparison of speed and cost of dynamos; comparison of single and multiple central stations; the wholesale supply of electricity to towns and factories from centres where very large generating units are employed; the distribution of electrical energy from a distant generating station through districts served from a different source of supply, or under a separate local authority; examination of relative advantages and disadvantages of direct-current and alternate-current transmission; examination of relative advantages and disadvantages of two-phase and three-phase transmission; description of the most practical methods of measurement in connection with polyphase distribution; description of the most practical methods for the conversion of direct current into alternate current; methods of providing for electrical supply during hours of small demand; utilisation of lighting plant for other electrical work during the hours of small demand; the electrical equipment of large blocks of offices in a city; description or comparison of systems of house-wiring; portable electric lamps of the "safety" type or otherwise; enclosed arc lamps; improvements in incandescent electric lamps; incandescent electric lamps with filaments other than pure carbon; application of electrical transmission in factories—(*a*) detailed description giving sizes of motors and power provided, (*b*) comparison of separate or combined direct and alternate current methods, (*c*) combination of lighting and power for such purposes; electricity meters; description of electrical methods, or comparison of these with other methods, of propelling vehicles; the supply of electrical energy for tramway purposes; the use of electrical methods of traction on railways served by steam-driven locomotives; the economy and design of electric elevators; the design and economy of electrically-driven pumps; the utilisation of electrical energy in mining; the applications of electrical energy in warfare; the use of electricity in the textile and other industries; the application of electricity in musical instruments; the establishment of municipal time-services by electricity; recent advances in telegraphy; Hertzian telegraphy; recent improvements in telephony; descriptions of systems tending to simplify the interchange of telephonic communications; the application of electricity to the generation of heat for domestic purposes (cooking, ventilation, heating, etc.); the construction and use of electric furnaces; the application of electricity to the welding or annealing of metals; the application of electrical heating methods in chemical or metallurgical operations; the applications of electricity in metallurgical processes; the applications of electrolysis in the smelting or refining of metals or in the chemical industries; the electrical equipment of chemical factories; chemical generators of electricity theoretically considered from a practical standpoint; improvements in and applications of primary batteries; examination of the present position of secondary batteries in electrical engineering; secondary batteries with plates other than lead; the economic employment of thermo-generators; improvements in the apparatus for producing, and in the applications of, cathode and Röntgen rays; the relative suitability and efficiency of the different materials available for any of the requirements of electrical engineering; recent advance in the manufacture or use of insulating materials; electrical applications of aluminium, sodium, etc.; the electrical uses of the rarer metals; the treatment, testing, specifications, or uses of iron or steel, or of iron alloys, for magnetic purposes; the manufacture of permanent magnets; the relation of chemical composition and physical condition to the electrical or magnetic properties of substances, considered in its bearing upon electrical engineering practice; high-resistance metals for instruments or resistance coils; the protection of laboratories and observatories against magnetic disturbances due to local causes; recent legislation in its relation to electrical undertakings; the relations between electric lighting or power corporations and municipal authorities.

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THE NEW ARC WORKS AT CHELMSFORD.

Last week we were conducted through the new works of Messrs. Crompton and Co. by the energetic founder of the original works, Mr. R. E. Crompton. These works represent what we believe is the fourth resting place of the manufacturing branch of this firm. Most of the removals and rebuilding have been due to the large increases in the demand for the goods produced, and it is worthy of special note that the present new works are already too small, so that the arc lamp department has had to be left at the old works. The other changes of works have been due to disastrous fires, but the firm has readily overcome the difficulties and derangement of works entailed by these fires. In the present case the new works offer most exceptional advantages, and should enable the company to quickly enter the dividend-paying stage. In fact, it is claimed that by the arrangements and facilities obtained after the previous experience, not only will the same number of men be able to turn out about 40 per cent. more work, but that the work will even then be of better quality and more highly finished. This is partly due to the piece-work system, whereby the men not only gain by turning out more work in a given time, but also get a half-

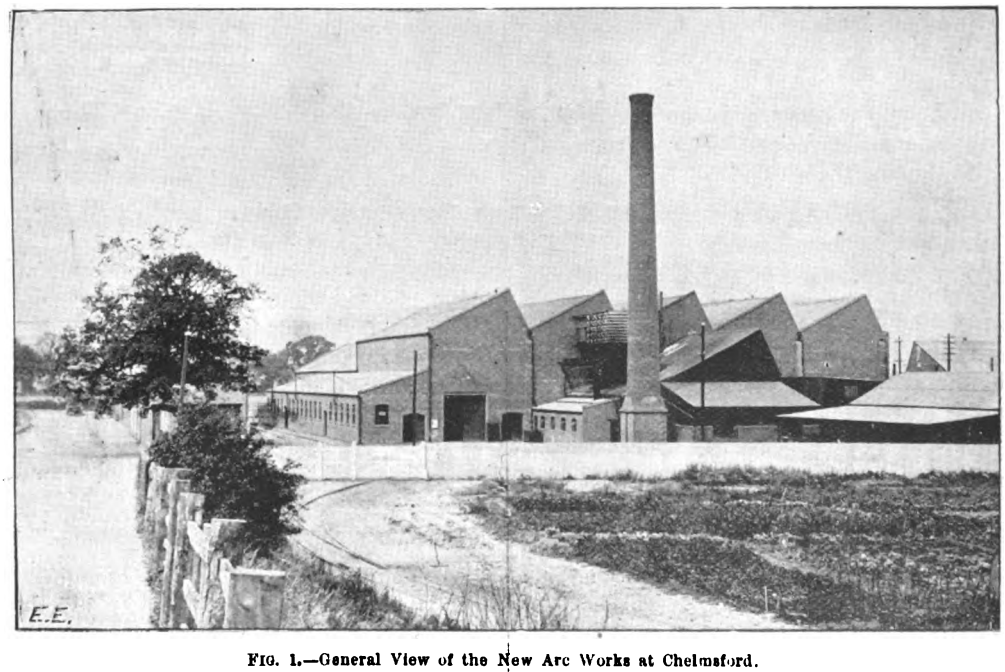

FIG. 1.—General View of the New Arc Works at Chelmsford.

share of the establishment charges saved by a given tool doing more than its usual quantity in a given time. This gives an incentive to individual effort, which has in the past been so much deprecated by the workmen's unions. The relations now at the Arc Works, Chelmsford, between employers and employés are excellent, and we trust that in future the mutual interest will outweigh small internal troubles.

Coming now to the shops themselves and to the arrangement of building and site, we gather that immediately following the fire which destroyed the greater portion of the works of Messrs. Crompton and Co., Limited, which were situated at Moulsham, Chelmsford, the firm being desirous of extending the works and getting better railway accommodation, entered into negotiations for the purchase of about 10 acres of land adjoining the Great Eastern Railway, and about threequarters of a mile from the old works. This took some time, and the possession of this site was not obtained until near the end of 1896, when the works were commenced. During this time Mr. Crompton himself, in company with Mr. Brunton, the manager, lost no opportunity of visiting and examining the most modern engineering works in Europe, and the new works, which we are now about to describe, are the result of much thought and consideration of all the problems presented by the great question of laying-out all modern engineering works in the best manner to manufacture high-class electrical plant cheaply and rapidly. The general view of the works, resulting from these gentlemen's combined labours, is given in Fig. 1, which is reproduced from a photograph taken from the bridge over the Great Eastern Railway. Fig. 2 shows the general plan of the works and part of the site.

The new works consist of offices facing the Chelmsford-Writtle road and the main shop, which is devoted almost entirely to dynamo, motor, and transformer work. This main shop has a width of 260ft., and the length which has now been constructed is 225ft., but the end wall is a removable wall, and it is contemplated at no distant date to take this down and lengthen the shop as the demand for more floor space increases. The present area of 260ft. by 225ft. is entirely unobstructed by internal walls or partitions, so that an uninterrupted view (Fig. 3) of the whole floor is obtained from the shop manager's offices or from the test-room offices, both of which are situated on a long gallery extending the full length of one wall of the building—*i.e.*, that nearest to the Great Eastern Railway. This floor space is divided into eight bays, the bays running north and south—that is to say, parallel to the Great Eastern Railway line. Four of these bays are provided with electrically-driven travelling cranes, varying from 15 tons down to three tons capacity, and the remaining bays with hand-power travelling cranes. Provision is made, however, for adding electrical travelling cranes in all the bays. Three of the largest bays are 33ft. high up to the roof girder, and 24ft. up to the travelling-crane gantry. Two of these large bays have a span of 40ft., and the third a span of 30ft. The remaining bays are 30ft. span and 20ft. to the inside of the roof girder, and 16ft. to the travelling-crane gantry. The roofing is of the "saw-tooth" or "weaving-shed" pattern, with large frames, so that the short side, which is entirely of glass, and faces the north, is of considerable height. Thus a very regular and perfect light is obtained all over the building. As these roof principals have a 30ft. span it will be seen that the height of the glazing for the north light is unusual. The entire floor space is paved with wood blocks. Across the top of the bays the Great Eastern Railway siding was laid, and at right angles to this a 27in.-gauge railway runs down the centre of each bay, these railways being connected at the north and south ends by cross railways with turntables to each bay. This double arrangement of railways and travelling cranes gives exceptional facilities for shifting heavy goods rapidly and easily.

After the bitter experience with their fire, Messrs. Crompton have taken special pains to construct the new building in the most fireproof manner, the whole of the building, with the exception of the flooring blocks, which from their position never do take fire, being constructed of

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non-combustible materials. The walls are of brick, the stanchions, travelling-crane girders, and roof girders are principally of steel, the glazed slopes of the roof are fitted with Helliwell patent glazing bars, and the long slopes of the roof are covered with heavy corrugated sheathing in two thicknesses spaced apart.

Across the southern end of the building runs a store for raw material, communicating with the main building only by three doors pierced in the brickwork and closed by sliding iron doors. One very important feature of the arrangements is that the store of finished parts (Fig. 4), on their way to be erected and made up in finished machines, motors arranged to work each tool, but in one bay, as stated above, there is some shafting which is divided into several lengths and driven by three motors, a group of small tools being driven off each length of shafting. A good example of driving machine tools electrically is shown by Fig. 5, in which all the lathes have their own motors placed overhead. It will be seen that there is one reduction of speed only between the motor axles and the speed cones. This reduction gear is varied in accordance with the speed required at the working head of the tool. The placing of all the lathes at right angles to the sides of the bay instead of parallel, enables nearly double the number to be got

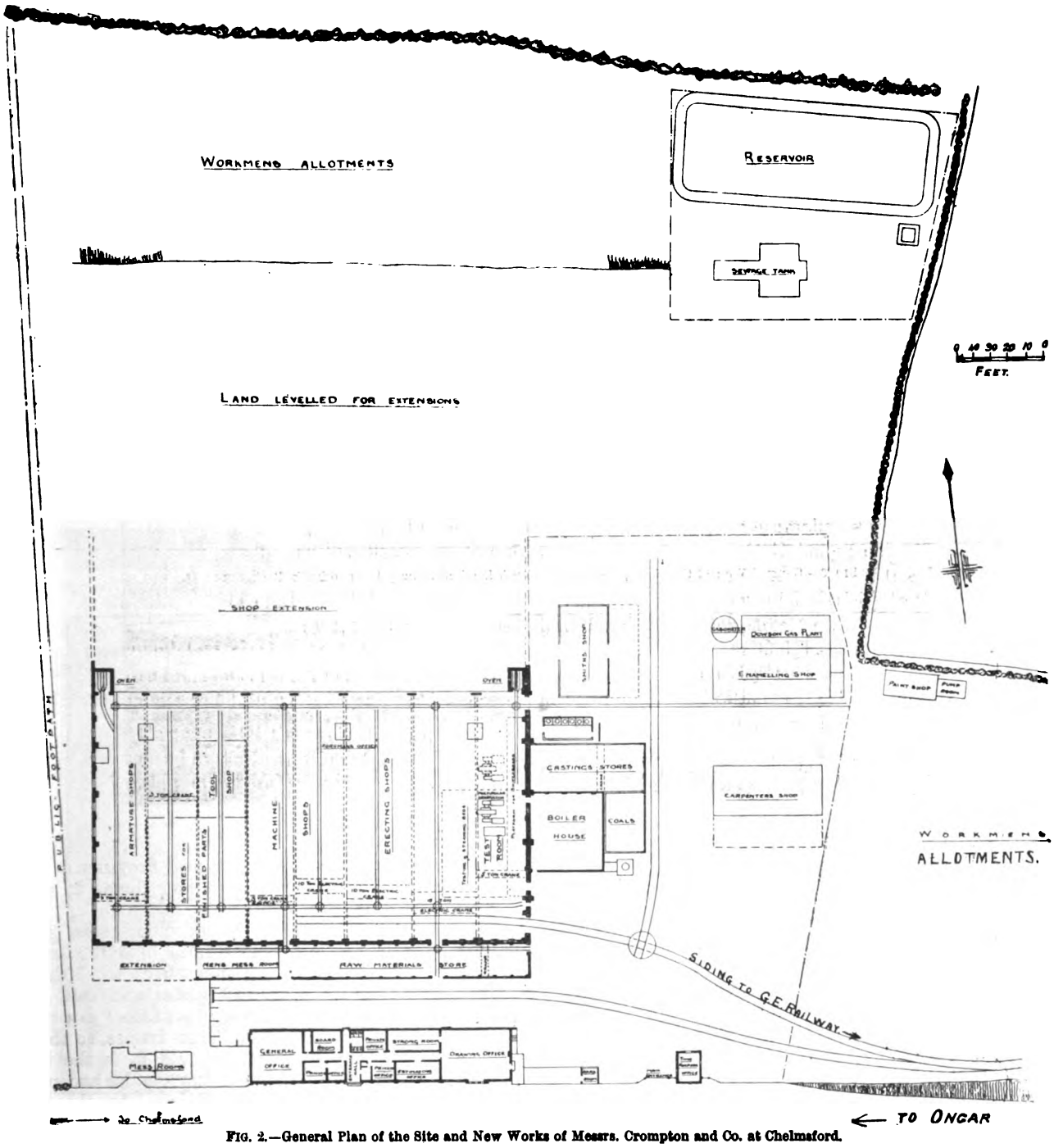

FIG. 2.—General Plan of the Site and New Works of Messrs. Crompton and Co. at Chelmsford.

occupies a portion of one of the bays in the main building. In this space everything is arranged as conveniently as possible for access; it is fenced off from the main shop by a low screen of iron surmounted by pierced ironwork, so that the view right along the shop is not interrupted, and the goods inside the store can be seen from the outside, although they are not accessible by the workmen. An important feature in this shop is that, as the whole of the power is transmitted electrically, shafting is used to a very small extent—in fact, there is only one short length in the whole building. As a rule the transmission is from the generating plant situated close to the east wall of the building through bare copper overhead mains to separate into the space. This, coupled with the practice of having the articles placed in the stores as soon as finished, allows of a vastly greater quantity of work to be turned out from a given floor space.

The next illustration (Fig. 6) shows the winding heads for the field-magnet bobbins. These are all motor driven, and are provided with counters, so that the number of turns put on is automatically recorded. The winding of the armatures is conducted in a special department, and is well organised. The most of the large sizes are now wound with interchangeable coils, which are prepared on formers and then laid on the cores. The cylinder type of end winding is adopted. The larger armatures are built up

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near the test-room, and a number of these in various stages of completion are shown in Fig

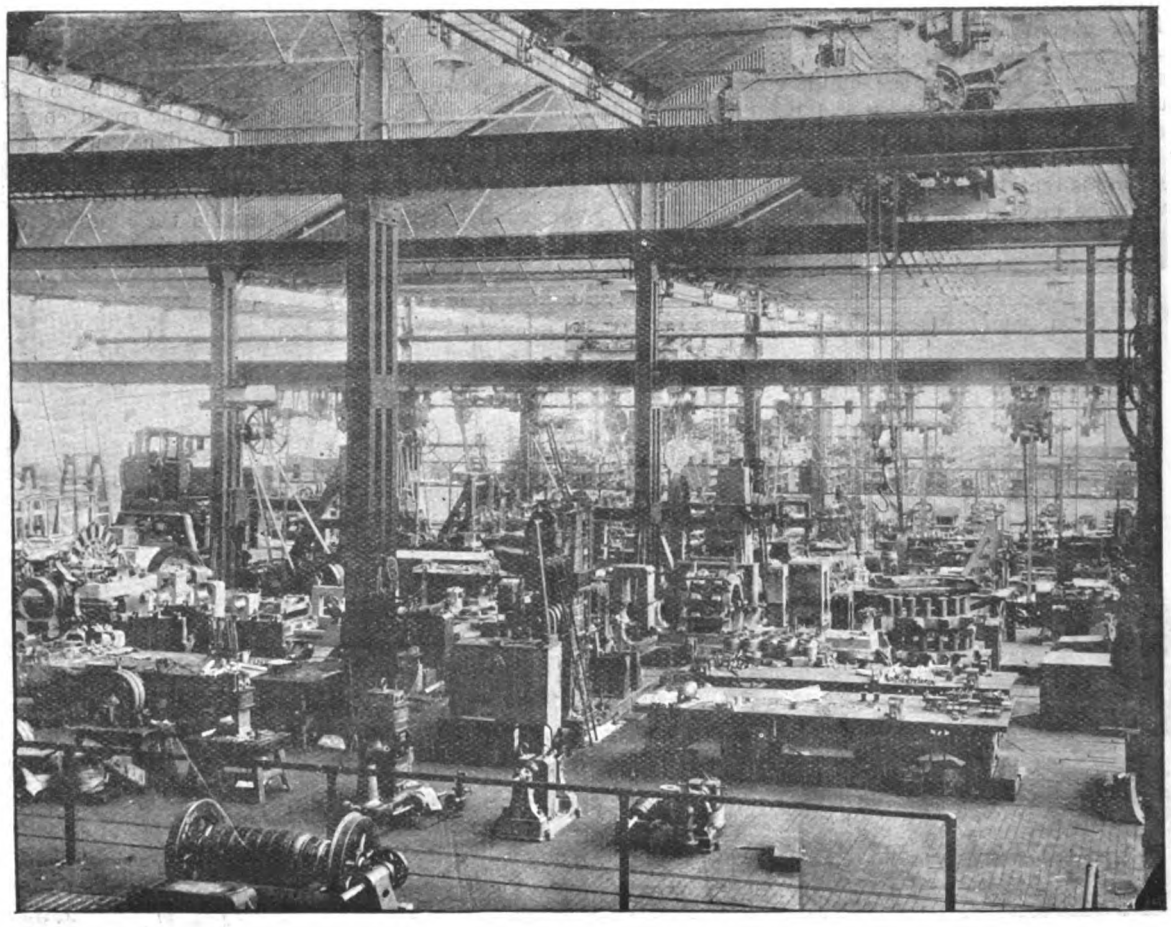

FIG. 3.—General View of the Shops, showing the South London Railway Locomotive in Background.

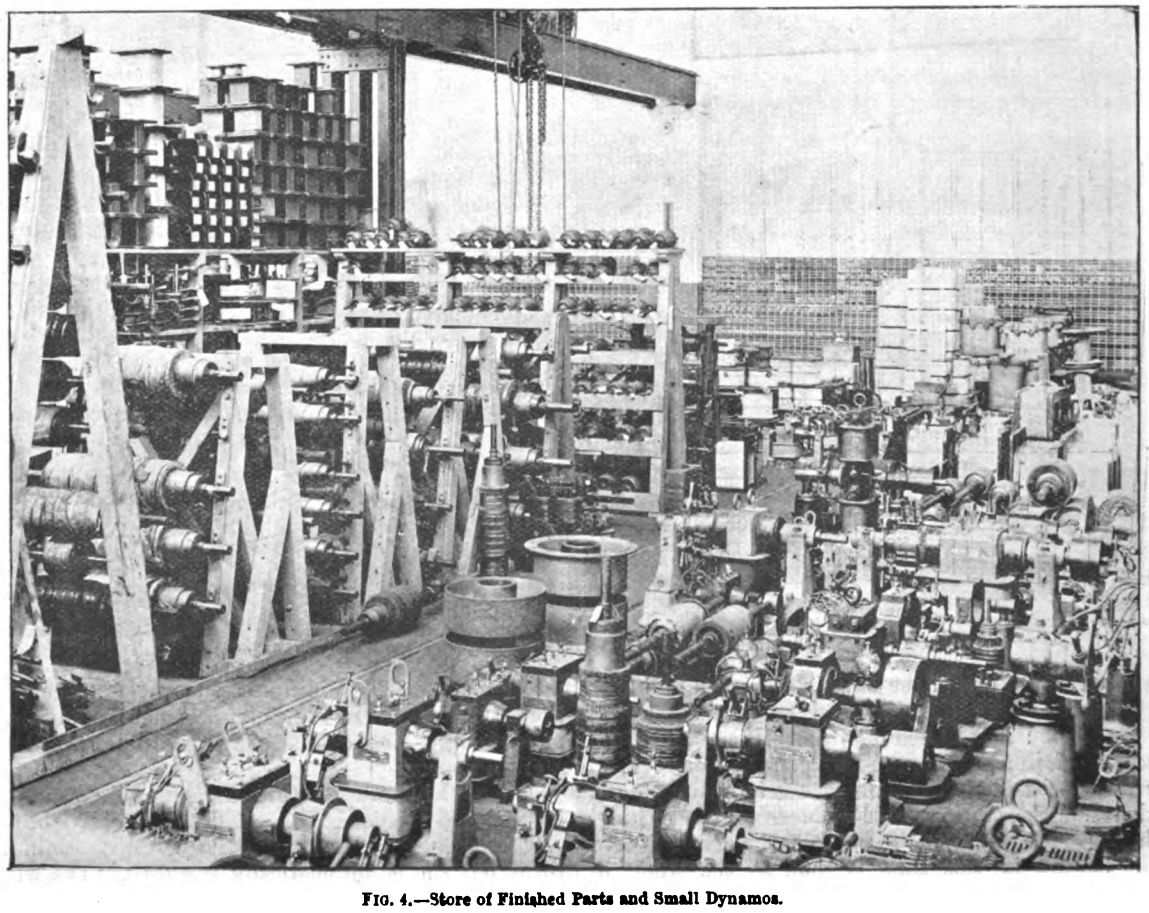

FIG. 4.—Store of Finished Parts and Small Dynamos.

There are two sets of generating plant, one a 240-h.p. Crompton-Marshall compound-condensing slow-speed set (Fig. 8), the engine being fitted with Proell valve gear and Corliss exhaust valves. The generator has a 6ft. diameter armature, built up on the engine crankshaft, and the eight-pole field magnets are all steel. The other set is a 200-h.p. Willans-Crompton set, the crankshaft of which is prolonged by an additional length of shafting, on which

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pulleys are keyed for testing purposes. This Willans set is also available for supplying current for driving the shop motors.

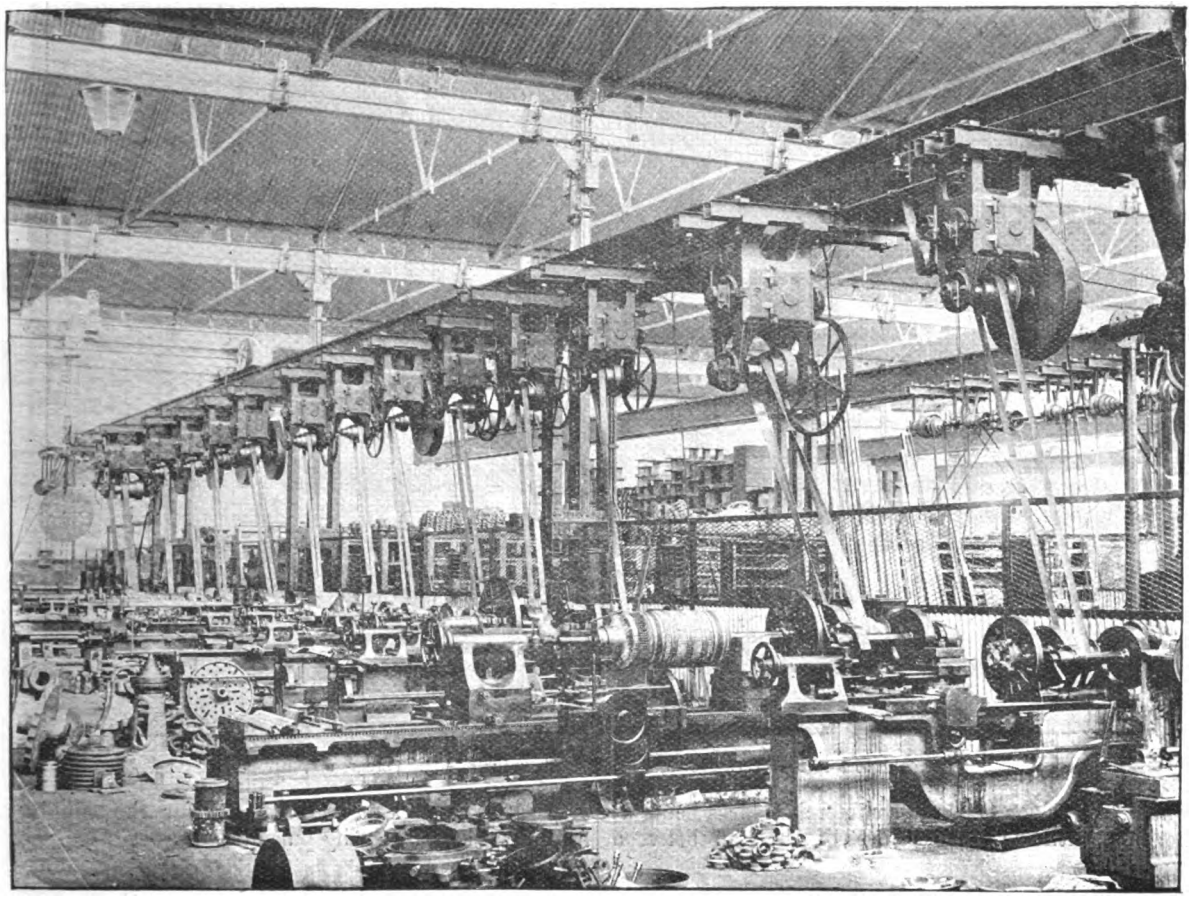

FIG. 5.—General View of the Bay of Electrically-Driven Lathes at the New Arc Works.

Steam is provided by two Babcock and Wilcox boilers which are rated at 5,000lb. of steam per hour. They are provided with two Babcock and Wilcox latest pattern Scotch furnaces for burning smoky coal, and they have

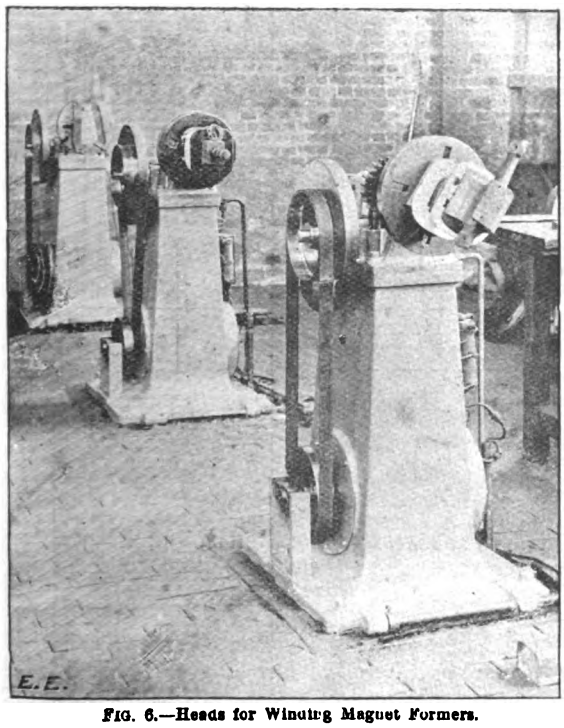

FIG. 6.—Heads for Winding Magnet Formers.

superheaters also of the latest pattern. A Green's economiser is fitted. The condenser is placed above the boiler-house, and is carried on steel stanchions. It is of the evaporative surface type, made by Ledward, and is large enough to condense the steam when either of the engines are working up to 200 h.p. The vacuum is obtained by an air-pump on the Edwards principle, made by the Central Marine Works of Hartlepool, and is driven by a motor. The centrifugal pump for circulating the water is also driven by a motor. The condensing plant is very satisfactory, and it is not difficult to maintain a vacuum of 25in.; in fact, 26in. has been obtained with a high barometer. The feed water is forced into the boiler by a three-throw horizontal pump motor-driven. The special feature of this is the employment of a three-speed coned belt-driving pulley. This allows of an extremely slow speed at times when the feed needed to the boilers is small, or a very high speed of the pump when a large quantity of water is to be delivered either for fire purposes or for pumping from the wells or from the reservoir. As the boilers have been constructed adjoining the engines, but on the outside of the main building and below the general level of the ground, the coal can be shot direct from the coal trucks into the bunkers, sliding down the inclined bottom of the bunker to a position close to the firemen in front of the boilers.

As these works are outside the borough boundary they have been provided with their own water supply and their own sewerage system. Several wells have been sunk and connected by piping, and an excellent supply of water is obtained. In addition to these, a reservoir has been constructed at the lower end of the space, cement lined, and capable of holding 500,000 gallons of water. To this reservoir the whole of the rain-water pipes from the buildings are led. For dealing with the sewage a system of tanks on the Scott Moncrieff system have been put down at the lower end of the ground. The sewage passes into the first of these tanks, which is a closed one, and there ferments under aërobic conditions, then enters a second tank, where it is attacked by anaërobic organisms, and thence it passes through filter-beds, where it is mineralised—*i.e.*, the decomposed products are turned into mineral salts by the action of nitriting organisms. The effluent from these last two tanks is quite clear and free from smell, and, although an excellent fertiliser, it is not capable of again decomposing and becoming a nuisance, as it then contains no longer any organic matter in an unstable condition.

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The offices, which front on the main road, measure 160ft. by 30ft. The drawing offices, which are lofty and well lighted, are at one end, the commercial offices being at the other end, with the private offices of the staff between them. Outside the main building are several detached buildings—one for the smith's work, another for the enamelling work on the electrical heating and cooking apparatus, a third for smiths and carpenters, and a fourth for casting. Alongside the enamelling shop is a complete apparatus for making Dowson gas for the supply of the whole works for heating purposes.

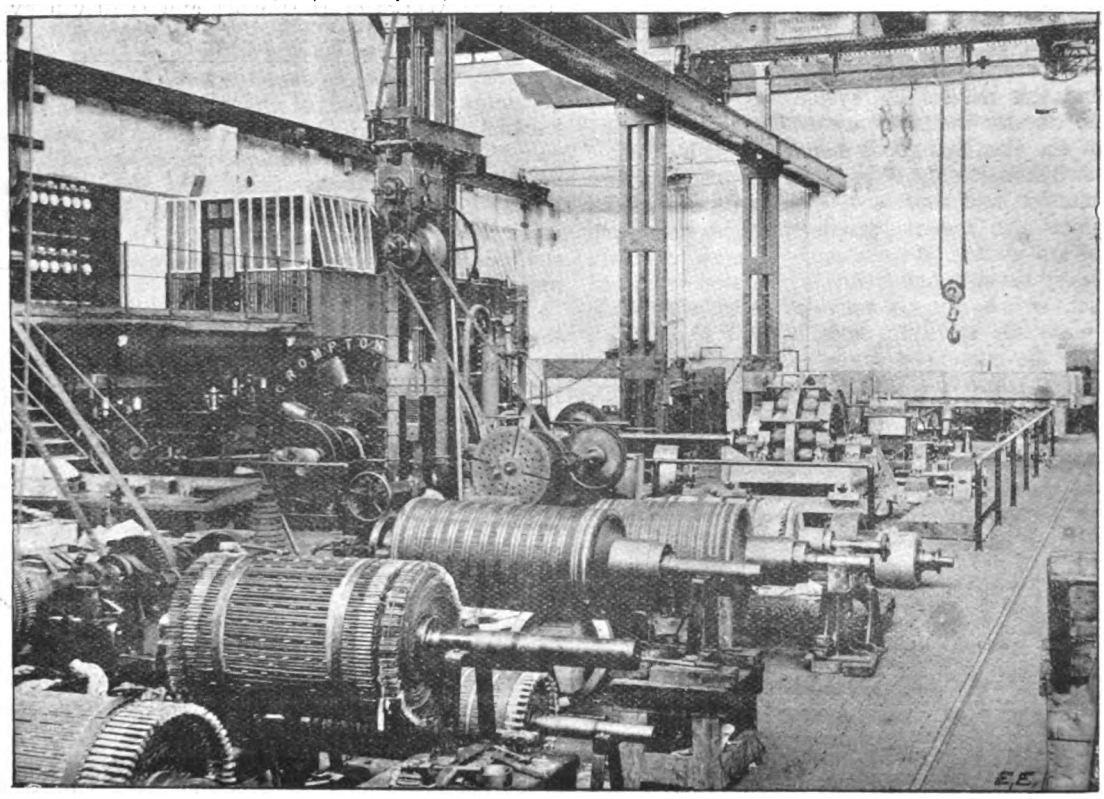

FIG. 7.—View of Test-room, with Large Armatures in the Foreground.

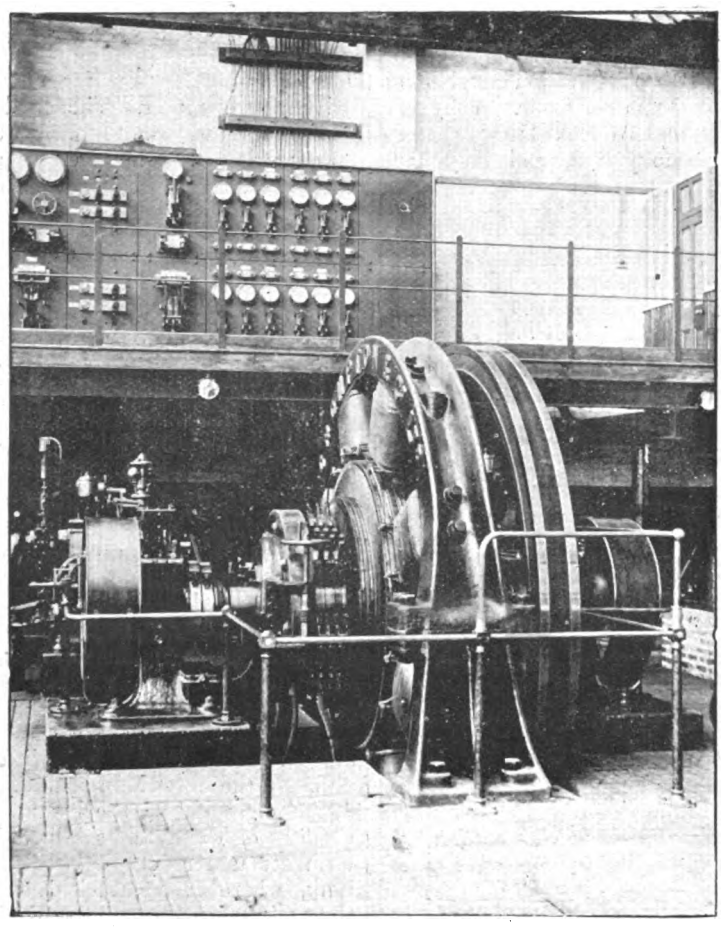

FIG. 8.—The Crompton-Marshall 240-h.p. Multipolar Generator.

The furnace in the enamelling department is of simple construction. It is, in fact, an unusually large muffle furnace fired by Dowson gas. In this furnace, not only

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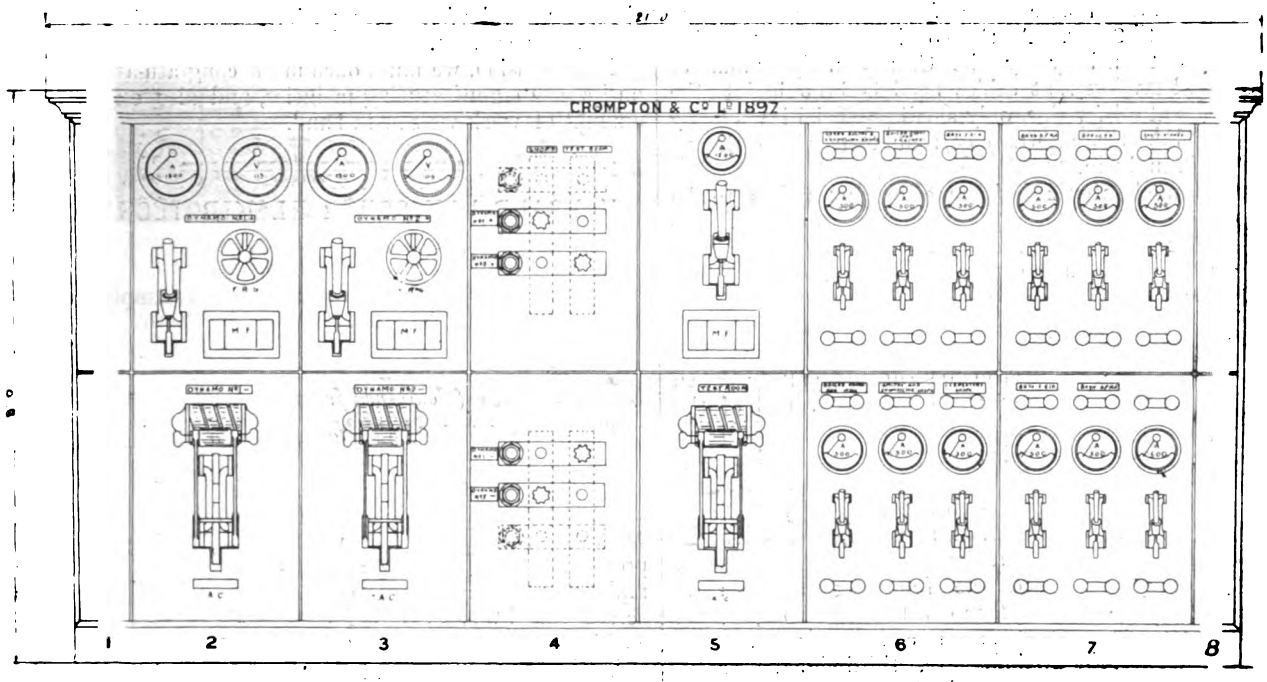
the electrical heating and cooking goods are enamelled, but also the supports and girders which carry the insulators for the Crompton system of underground mains. The covers of cut-out boxes, distribution or transformer boxes can also be enamelled on the inner side. Messrs. Crompton find this enamelling system of insulation so perfect and so durable that they are extending it to many other parts of the electrical goods manufactured by them.

The main switchboard (Fig. 9) has been designed in a very substantial manner, and represents Messrs. Crompton and Co.'s latest practice as regards details of the switches and other gear for low-tension distribution. The switches are all of very heavy pattern, and with bright steel insulated handles. Each switch, also, is provided with a separate and easily renewable sparking piece, by means of which all burning of the current-carrying contacts is avoided. The automatic cut-outs are modifications of the pattern which they have been successfully making for so long, and which are very largely in use in so many of the low-tension central stations as zero cut-outs on the dynamo panels. In the case of the present switchboard they are used as excess cut-outs. The instruments are of their latest dead-beat permanent magnet pattern, and have an accuracy within



MAIN SWITCHBOARD FOR NEW ARC WORKS, CHELMSFORD.

Fig. 9.

½ per cent. These instruments respond very rapidly to the slightest changes of load, indicating the correct reading at once without any preliminary swinging of the needle. The whole of these fittings are mounted on 1½in. slate panels carried in a heavy iron frame, and no woodwork is used in connection with the frame at all. The dynamo panels are arranged on the left hand facing the board, and the circuit panels on the right hand. In the centre is placed, first, panel No. 4, containing an arrangement of heavy plug bars, by which any combination between the two dynamos and the two main circuits can be made. Next to this panel, No. 5, supplying current up to 1,200 amperes for the use of the testing department, containing main switch, main fuses, ammeter, and on the other pole an excess cut-out. Panels Nos. 6 and 7 are devoted to the various circuits distributing power and light throughout the works, the upper six circuits being lighting circuits, the lower six motor circuits. No. 8 is a spare panel for additional circuits. No. 1 is a spare panel for an additional dynamo. No. 2 is a panel for the 240-h.p. Crompton multipolar dynamo with Marshall compound engine, and contains an ammeter to 1,500 amperes, voltmeter, main switch, fuses, shunt regulating switch, and on the other pole an excess cut-out. No. 3 is a panel for the 200-h.p. Crompton-Willans set, and contains a similar set of instruments to No. 2. This engine is chiefly used for heavy testing, and has a length of shafting coupled to one end of its crankshaft. It has also at the other end of its crankshaft a dynamo, and it can be used for power and light throughout the shops in the place of the Crompton-Marshall set, or in parallel with the same if so desired. The usual method of running is to supply the shops from the Crompton-Marshall set, and a large amount of testing is done by the same set at the same time by means of motors. If an unusually large heavy machine has to be tested it is belted on to the shaft connected with the Crompton-Willans set, and run independently of the shops.

The testing department is situated in the south-west corner of the works. No special building has been provided for this, but a portion of the main shop has been railed off. By this means the transference of the machinery to and from the test-room is effected with the minimum of labour and by the ordinary shop traveller. This department covers a floor space of about 3,000 square feet, part of which is covered by the instrument gallery. In addition to this, in three other parts of the shop there are special enclosures, one for testing armatures during the process of manufacture, another for testing transformers during and after manufacture, and the third containing the liquid and other resistances used for high-tension tests. About the middle of the test-room is a 200-h.p. Willans engine, to one end of whose crankshaft is connected a heavy testing shaft, provided with pulleys of various sizes. On either side of this shaft a series of longitudinal rails is fixed to concrete foundations in the floor, and by means of transverse rails on these longitudinal rails any size of dynamo can be accommodated. All the larger dynamos from about 50 kw. upwards are belt-driven off this shaft. Smaller dynamos are tested by being belted to motors, the current for which is obtained from the shop generator.

As has already been said, the steam plant comprises two direct-coupled sets—one of 200 h.p., the other of 240 h.p. It is possible in special cases to test dynamos taking as much as 400 h.p., half the power being delivered to the shaft from the Willans engine direct, and the other half from the Marshall engine by means of motors. As duplicate boiler power has been provided, and also two complete sets of exhaust pipes, either of which can be connected to the atmosphere or condenser as may be desired, it is possible to make steam tests, condensing or non-condensing, up to 250 i.h.p., and a convenient system of steam and

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exhaust valves and connections is now being put down for this purpose.

In testing dynamos the load is taken up on resistance frames of the usual kind, of which a large assortment is provided. A special feature of these resistance frames is that they are self-contained with their switchboards, by means of which various combinations of resistance can be made, and they are mounted on wheels. By this means it is possible (since the current is measured by potentiometer methods) in most cases to bring the resistance frame close to the machine and so avoid having long lengths of cable about the test-room. Occasionally the load is taken up by coils of wire under water, and suitable arrangements have been provided for this by means of which a continuous supply of water is supplied. These water-cooled resistances are arranged in the same building as the water resistances for the high-tension tests.

A dynamo or motor undergoing tests has the whole of the measurements made in a room on the testing gallery overlooking the testing beds. In this room is provided four Crompton potentiometer sets for continuous-current testing; one Wheatstone bridge; a complete range of electric dynamometers for measuring alternate currents, either low or high tension, from ·01 of an ampere and upwards; also wattmeters, measuring from 10 watts upwards; and a complete range of electrostatic voltmeters from 10 volts to 8,000. As the continuous-current testing is carried out entirely by the Crompton dynamometer method, no heavy-current cables need be brought into the testing cabin at all for this, only small potential leads being required. For the alternate-current tests the ordinary cables are brought in.

When a moderate-sized dynamo or motor has to be tested, it is dropped on to the testing bed by an electrically-driven traveller, fixed down by the test-room staff, belted (in the case of a dynamo) on to one of the test-room sets, the resistance frame is run up alongside and connected on, and a pair of light potential leads are run on crutches to terminals on the nearest stanchion, which communicate by permanent wiring to the instrument gallery. An attendant takes his station at the commutator end of the machine to be tested, with a speed counter and electric bell in readiness. The machine is started up and the load put on (a rough indication being given by the ampere-meter near the resistance frame), the brushes are adjusted, and when everything is ready accurate readings commence. In the instrument gallery is a large centre seconds clock, and speeds are taken in the following manner: A signal is given to the dynamo attendant to prepare, at a second signal the speed counter is put into the end of the dynamo spindle, at a third signal (exactly half a minute after the second) it is withdrawn, and the reading communicated to the instrument gallery by speaking tube. During this half minute several accurate readings of current and E.M.F. have been taken by means of the potentiometer. The machine is then left to run for a number of hours at full load, the exact time, which is usually from three to six and occasionally twelve hours, depending on its size. At the end of this period the machine is stopped for a few moments to enable temperatures to be taken. It is then started up again, and complete series of readings at all loads is taken, after which it is stopped, and the whole of the resistances are measured and the insulation tested. If the machine is satisfactory, it is returned to the shops to be finished off. Before this testing, however, the armature, the most important part of the machine, has already been tested twice, if not three times—firstly, as soon as it is wound, and before the commutator is fixed; secondly, when the commutator is fixed; thirdly, when the armature is finished; so that if any fault should exist it is discovered at as early a stage as possible during manufacture. There are four of these preliminary tests which an armature has to pass before it is allowed to be put into its field: (1) a galvanometer test, by which the resistance of all its sections is compared; (2) an alternate-current test, by means of which, should there be any short-circuited sections, these are burnt out; (3) a test of insulation—this latter is usually carried out by means of an alternate-current transformer with an adjustable secondary voltage; (4) the test pressure applied is an alternating E.M.F. 1½ times the working E.M.F. The transformer used for this purpose can be adjusted to give any secondary voltage between 200 and 10,000 volts. With a transformer of this kind, 50,000 volts have been successfully dealt with for other purposes.

As regards the field-magnet coils of machines, immediately they leave the winding heads (Fig. 6) the resistance is measured, the turns and gauge of wire are recorded, and an insulation test is applied.

As regards alternators, the usual insulation and resistance tests, as mentioned above, are carried out during manufacture, the insulation being tested at double the working voltage in this case. Similar tests are applied to transformers. The final tests on transformers include the measurement of the open-circuit watts, the primary and secondary voltage at various loads, and of the fall of secondary E.M.F. as the load is increased. A final insulation test is taken with every transformer when it is complete with all its fittings in its case. The standard to which all test-room measurements, whether continuous or alternating current, is referred, is the Clark cell. By means of the Crompton potentiometer, continuous-current instruments of all kinds can be readily checked and compared with this cell, and the alternate-current instruments (electric dynamometers and electrostatic voltmeters) can be also referred to the same standard if a comparison is made first with the continuous current.

In conclusion, we must once more congratulate the firm on its new manufacturing facilities, and also on the large amount of work we saw in hand.

VERBAND DEUTSCHER ELEKTROTECHNIKER.

FRANKFORT MEETING.

[BY OUR SPECIAL CORRESPONDENT.]

FRANKFORT ELECTRICITY WORKS.

(Continued from page 106.)

The potential difference generated by the several alternators—thereby, of course, that also of the main feeders—is controlled by regulating the excitation to their respective field systems, this being accomplished by means of the variable resistances with which each exciter circuit is provided. A voltmeter arranged in conjunction with a multi-contact switch through which it may be connected across the leads of either of the alternators as desired enables the pressure generated by the individual machines to be observed. Two small transformers are also arranged—one on either side—in connection with this voltmeter, their primary and secondary windings being proportioned to transform in the ratio 2,850 : 123—that is to say, in the same ratio as that for which those forming the connecting links between the primary and secondary networks of mains are designed, so that the pressure indicated by the machine voltmeter really corresponds to the existing tension at any point of the secondary network in the town plus the relative loss of tension in the mains between the central and particular point in question. Besides this an ampere-meter is connected in circuit with each machine. An ampere-meter is likewise connected in circuit with the main 'bus bars, enabling the total current output to be read off at a glance. Pilot wires are run back to the switchboard from the various distributing centres in the town. Provision is made whereby these wires may be connected with a voltmeter, and the mean tension between the different points so ascertained. At the same time, a multi-contact switch arranged in connection with a voltmeter is provided, by means of which it is rendered possible to ascertain the existing pressure at any one of the individual distributing points from which the pilot wires are brought, and in this manner to keep an efficient control over the whole of the distributing system. An ampere-meter is connected with each of the main feeders; these, of course, being mounted on the distributing switchboard. Nor must mention be forgotten of the synchroniser, or phasing voltmeter, which, besides the phasing lamps, is mounted upon the machine switchboard. As

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previously mentioned, the exciter rheostats are housed under the machine board. An arrangement is provided whereby these may be adjusted separately from hand regulators mounted upon the switchboard front, besides which provision is made for coupling the regulating apparatus appertaining to the several rheostats to a common spiral-turned shaft. The latter extends the whole length of the board and is actuated through the medium of a centrally situated hand lever, so that as soon as the alternators have been separately brought up to the required tension, and their exciter resistances coupled to the main regulating shaft, all subsequent adjustments affect the whole of the machines contemporaneously, and are, moreover, accomplished through the manipulation of a single hand lever.

Paralleling is effected without the medium of an artificial load. The alternator to be paralleled with the machine already on load is first run up, and its excitation at the same time adjusted to give a somewhat higher tension than that existing between the 'bus bars. Its speed is then adjusted to correspond as closely as possible with that of the machine already on the 'bus bars. This is effected from the steam regulator of its driving engine, and the moment is awaited when the speed and positions of the respective cranks approximately agree, whereupon the synchronising voltmeter is watched, and directly the crank positions and phases of the new and already loaded machine exactly agree the alternator to be paralleled is thrown on to the 'bus bars. The existing load is then balanced as evenly as possible between the two machines by manipulating the steam regulators of their respective driving engines contemporaneously with the resistances in the exciter circuits. Finally, the regulating apparatus is coupled to the common actuating shaft. The main feeders, it may be observed, are provided with safety fuses, designed at the same time to serve as emergency switches.

We come now to the details of the distributing system. This is arranged on the closed-ring principle, whereby the individual branches of the distributing network may be fed from either or both sides, or cut out as desired.

The whole system may be divided into four component sections as follows: (1) the main feeders; (2) the primary network; (3) the transformer sub-station; (4) the secondary network.

The main feeders conduct the untransformed current from the generating station to various centres, whence the current is in turn conveyed by the primary network of mains to numerous widely-dispersed transformer sub-stations, at which points it is transformed down for the secondary or service network. The main feeders are designed for a voltage loss not exceeding a 4 per cent. maximum, while the cables comprising the primary network are proportioned for a maximum loss of 1 per cent. at full load. Further, the maximum loss in the transformers is estimated at 2 per cent., and in the secondary network as 1·2 per cent.; that in the house leads at 1·8 volts, and the mean fall of pressure in the same at 1·5 volts. It follows from these values that, with a current generated in the central at a pressure of 3,000 volts, the maximum possible fall of tension in the main feeders amounts to 120 volts, and that in the primary network to 30 volts, which ensures a minimum tension between the primary terminals of the transformers of 2,850 volts, the latter being transformed in the secondary windings to 123 volts. Consequently, with a loss of 1·5 volts in the secondary network, and an equal fall in the house leads, a pressure of 120 volts is secured at the lamps.

The main feeders are laid at an average depth of 0·70m. below the road surfaces; they are embedded in sand, and further protected from mechanical injury by a superimposed layer of wrought-iron plates. These cables, it may be mentioned, were manufactured in sections of the greatest possible length, so as to reduce to a minimum subsequent jointing, and are laid in unbroken runs from the central to the different feeding centres, at which latter points their respective loads are transferred to the various branch circuits constituting the primary network through the medium of 'bus bars. These branches are interconnected with the various feeding centres, and can thus be fed individually from either or both sides. They deliver *en route* the requisite energy to the transformers situate in the different transformer chambers or on the premises of large consumers. With the exception of a few special connecting leads between the main feeding centres, for which a greater cross-section was necessary, concentric cables of uniform sectional area—*i.e.*, 35 square millimetres—have been exclusively employed for all recent extensions of the primary network. Greater simplification is secured in this manner, besides which the very careful handling required in laying the 25 square millimetres concentric cables originally employed—owing to the fine wire used for their outer conductors—is thereby avoided. Likewise for recent extensions to the secondary network only one size of cable has been used. The transformers already connected number 191, representing a total output of 3,940·5 kw. The mean distance between the sub-stations in the outskirts of the town is about 200m., and in the town itself 150m., these slight distances being accounted for in that the distribution throughout is on the two-wire system. In the majority of cases they are constructed under street corners. Little of interest remains to be said about the transformers themselves or their sub-stations, suffice it to say that the former are of the C. E. L. Brown pattern and designed to secure high efficiency, together with an easy interchangeability of parts. Great care has been bestowed upon the equipment of the sub-stations to facilitate the replacement of the different details. In conclusion, it may be mentioned that, except for quite isolated installations, only three sizes of transformers are employed at Frankfort, namely, of 12, 20, and 30 kilowatt normal capacity respectively, and the oil-containing boxes are of uniform size for the two smaller types, in order to facilitate interchange in case of necessity.

SPARKLESS REVERSAL IN DYNAMOS.*

BY H. N. ALLEN, B.SC.

INTRODUCTION.

Since the output of a large dynamo is limited by the occurrence of sparking, it is a matter of considerable practical importance to determine the conditions on which this depends. If the armature coil were entirely surrounded by air, or some other non-conducting material, the energy wasted in each spark would be proportional to LC^2, where L is the inductance of the coil, and C the change of current which takes place during the spark. The inductance of an armature coil is thus a quantity of some practical importance, but, as it is small, it is not easy to determine experimentally. The approximate theoretical value can be determined by the method given by Swinburne in his paper on "The Theory of Armature Reaction in Dynamos and Motors," read before the Institute of Electrical Engineers in 1890 (*Journal*, vol. xix., p. 90). It is, however, difficult to form a clear mental conception of the varying distribution of the tubes of magnetic induction when the current varies rapidly; and, as the matter did not appear to have been investigated experimentally, it was decided to devote some attention to it with the view of finding some of the factors on which the inductance depends, and to see how nearly the results obtained by experiment would agree with the theory. Throughout the investigation the writer was indebted to Prof. W. E. Ayrton, F.R.S., in whose laboratory the experiments were made, and to Messrs. T. Mather and A. H. Allen, his assistants, for their sympathetic interest and help.

Two methods were made use of to determine the inductance. In the first, the impedance of the coil was measured by observing the virtual volts between the terminals when an alternating current of measured magnitude and frequency was sent through it. The resistance of the coil having been determined, its reactance and inductance could be calculated. The second method was to make use of the secohmmeter, and to balance the inductance of the coil, which was placed in one of the arms of a Wheatstone's bridge, by means of an adjustable standard of inductance in the neighbouring arm.

It was not considered desirable to disconnect one of the armature coils from the commutator for these experiments,

* From the *Journal* of the Institution of Electrical Engineers.

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but the inductance of a single coil of a drum armature can be determined fairly accurately with the secohmmeter without doing this, by making connections with two contiguous commutator segments. With a simple closed-coil drum armature this gives a circuit consisting of a single armature section, shunted by all the other sections in series. The impedance of the latter branch is so great, as compared with that of the former, that the impedance of the combination will be nearly equal to that of a single coil. It was found that, with the highest frequency which could be made use of, the resistance of an armature coil was too large, as compared with the reactance, to give very satisfactory results by the alternating-current method. The experiments were therefore conducted with artificial armature coils, of thicker wire, wound round the armature core. In the first experiments they were outside the ordinary winding, so that there was a space between them and the iron core. Afterwards a special cylindrical core was constructed of thin soft-iron ring discs, threaded on a wooden spindle, so that the wires could be brought close up to the iron. The dimensions of this core were as nearly as possible those of the actual armature core of the small series-wound Immisch motor which was experimented on.

Measurement of Inductance with Alternating Currents.

The virtual volts between the terminals of the armature coil when an alternating current flowed through it were measured by a reflecting electro-dynamometer, with its fixed and moving coils in series. The moving coil was suspended by means of a phosphor-bronze strip, the other connection being made by a spiral of strip at the bottom. It was damped by means of a platinum vane, which dipped into a mixture of paraffin and engine oil of suitable consistency. Originally this vane dipped in mercury, and the lower connection was made in this way. This, however, proved very unreliable: the surface of the mercury rapidly became dirty, and the zero of the instrument most irregular. The inductance of the voltmeter was so small that the impedance did not differ from the resistance by a measurable amount at the highest frequency used in the experiments.

Inductance with the Coil in the Median Plane.

Table I. shows the results of measures made on five different coils. The coil was in each case in the median plane of the motor, which is marked A A in Fig. 1, where

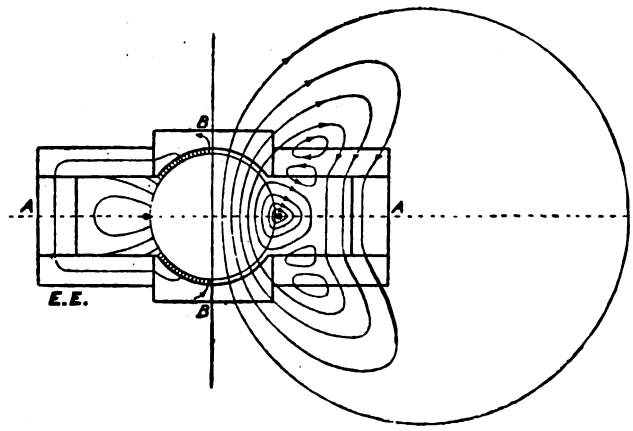

Fig. 1.—Left: Magnetic Field due to Continuous Current. Right: Magnetic Field due to Alternating Current.

A B A B represents the motor frame. The coils marked A, B, and C in Table I. were of No. 12 wire, A being more loosely wound than B. Coil D was of square copper rod 0·2in. thick; E was made of the same rod hammered into a rectangular section, the sides being 0·23in. by 0·165in. Coils D and E were used on the model armature core, so that the conductor was close to the iron.

In order that the values in the last column, for different coils under similar circumstances, may be compared together, they are tabulated in a different form in Table II. for speeds of 1,500 and over.

As will be seen, the observations were made with three of the coils under four different conditions: (1) the coils on the field magnets were left open; (2) they were short-circuited by a thick wire; (3) the core, with the coil on it, was removed from the field; (4) the coil was removed from the core, so that there was no iron near it. The second value of the inductance of coil D, without iron, is probably the more correct, as with the larger current the deflection of the voltmeter becomes much greater. The reason why the values for A and C are smaller than the rest is that A being loosely wound, and C consisting of a greater number of turns, a number of lines of force escape being linked with all the turns.

Table I.

Coil.	Turns.	Condition.	R.P.M.	Inductance. Henrys.	Inductance divided by square of number of turns.
A	6	Field open	1,500	0·0000493	0·00000137
,,	6	,,	1,100	0·0000537	0·00000149
,,	6	,,	700	0·0000648	0·00000180
,,	6	Field closed	1,500	0·0000278	0·00000077
,,	6	,,	1,100	0·0000280	0·00000078
,,	6	,,	700	0·0000297	0·00000083
B	6	Field open	1,500	0·0000563	0·00000156
,,	6	,,	1,100	0·0000622	0·00000173
,,	6	,,	700	0·0000699	0·00000194
,,	6	Field closed	1,500	0·0000333	0·00000093
,,	6	,,	1,100	0·0000339	0·00000094
,,	6	,,	700	0·0000297	0·00000082
,,	6	On core	1,500	0·0000309	0·00000086
,,	6	,,	1,100	0·0000333	0·00000092
,,	6	,,	700	0·0000338	0·00000094
,,	6	No iron	1,500	0·0000201	0·00000056
,,	6	,,	1,100	0·0000182	0·00000051
C	11	Field open	1,500	0·000151	0·00000125
,,	11	Field closed	1,500	0·000076	0·00000063
,,	11	On core	1,500	0·000077	0·00000063
,,	11	No iron	1,540	0·000054	0·00000045
D (114 amp.)	1	Field open	1,600	—	0·00000158
,,	1	Field closed	1,600	—	0·00000111
,,	1	On core	1,600	—	0·00000095
,,	1	No iron	1,600	—	0·00000072
D (137 amp.)	1	Field open	1,600	—	0·00000157
,,	1	Field closed	1,600	—	0·00000106
,,	1	On core	1,600	—	0·00000093
,,	1	No iron	1,600	—	0·00000062
E (163 amp.)	1	Field open	1,600	—	0·00000159
,,	1	Closed by 0·1 ohm	1,600	—	0·00000102
,,	1	Closed by thick wire.	1,600	—	0·00000104

1,500 R.P.M. correspond to 200 alternations per second.

Table II.

Coil.	Field open.	Field closed.	On core.	No iron.
A	0·00000137	0·00000077	—	—
B	0·00000156	0·00000093	0·00000086	0·00000056
C	0·00000125	0·00000063	0·00000063	0·00000045
D (114 amp.)	0·00000158	0·00000111	0·00000095	0·00000072
D (137 amp.)	0·00000157	0·00000106	0·00000093	0·00000062
E (163 amp.)	0·00000159	0·00000104	—	—

Effect of Frequency on the Apparent Inductance.

If the values obtained with open field circuit at different frequencies are examined, it will be seen that as the frequency diminishes the observed inductance increases. At very low frequencies it would no doubt be the same as the true inductance of the coil, which can be obtained by calculation from the reluctance of the magnetic circuit, or by finding the flux through the coil experimentally when a continuous current flows in it. For a coil of six turns the true inductance was found to be about 0·0000835. When the field circuit was closed, the lowest available frequency did not show any increase in the observed inductance. When the frequency is low the impedance and resistance are nearly equal, so that the inductance cannot be obtained with much accuracy. No doubt for very low frequencies the inductance in this case also would approach the value 0·0000835 given above.

Effect of the Short-Circuited Field on the Inductance.

When the field circuit is closed, it acts as the secondary of a transformer. A current is induced in it which may

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TABLE IV.

Position of coil.	Volts on the terminals of the armature coil.			Apparent inductance.—Henrys.		
Median plane	0·371	0·256	0·260	0·00000159	0·00000102	0·00000104
Just outside pole-tips	—	0·288	—	—	0·00000119	—
Just under pole-tips	0·400	0·331	0 343	0·00000173	0·00000140	0·00000146
¼in. in from pole-tips	—	—	0·406	—	—	0·00000178
At right angles to the median plane	0·594	0·560	0·584	0·00000266	0·00000251	0 00000261
Resistance in field circuit	∞	0·1 ω	0 ω	∞	0·1 ω	0 ω

almost entirely neutralise the tendency of the current in the armature coil, or primary, to produce a varying flux through the field magnet. Table III. shows the effect of closing the field circuit through different resistances. The first column gives the resistance in ohms which was connected across the terminals of the field, and the second the volts at the terminals of the armature coils of 11 convolutions, in which a current of 13·7 amperes was flowing. Frequency, 128. Resistance of field coils, 0·143 ohm.

TABLE III.

Resistance in ohms used to close the field circuit.	Volts at the terminals of armature coil, C.
0	1·03
0·4	1·07
0·8	1·11
1·2	1·13
1·6	1·15
2·0	1·17
2·4	1·19
6·0	1·34
10·0	1·48
20·0	1·64
30·0	1·72
100·0	1·83
Field circuit open	1·92

An increase of inductance in the field circuit produced a similar effect to that produced by increased resistance: the volts at the terminals of the armature, required to send a given current through it, were increased. This point was tested by including the secondary of a large transformer in the field circuit. This hardly affected the resistance at all, but the increase of inductance diminished the induced current in the field coils, and increased the apparent inductance of the armature coil, so that the volts rose from 1·1 to 1·15, the deflection of the voltmeter changing from 37 to 42.

Effect of a Current in the Field Coils.

A strong current through the field coils diminished the inductance slightly. The permeability of the iron was diminished, and thus the flux through the armature coil was less. In one experiment 20 amperes sent through the field coils lowered the volts on the armature coil terminals from 1·11 to 1·07, though the resistance in the field circuit was in reality a little larger in the second case, since that of the 12 storage cells used was added, and the field coils were heated by the current.

Effect of the Position of the Coil on the Armature.

Table IV. gives the results of experiments on the inductance of coil, E, in different positions with respect to the poles. The same current of 163 amperes, with a frequency of 213, was used throughout. Several of the values are the means of a number of observations.

It will be seen that when the coil is at right angles to the medium plane, in the position marked B B in Fig. 1, the apparent inductance is not appreciably changed by short-circuiting the field, and that the value obtained is not very different from the number 0·00000232 calculated, as is described further on in this paper, from the flux through the air-gap produced by a steady current in the armature coil. In obtaining this value a considerable amount of magnetic leakage is neglected. As the coil is moved from the plane, B B, towards the median plane, A A, the volts on the terminals and the apparent inductance diminish. This diminution is greatest when the field coils are short-circuited, since the specific resistance of the copper coils is less than that of the iron masses of the field-magnet limbs, and so larger currents are induced in the former than in the latter. It is, of course, these induced currents which tend to check the variation of flux through the field magnet.

Flux through the Magnet Yokes.

A special series of experiments was made to investigate this choking action of the short-circuited field coils on the magnetic flux. A coil of 12 turns was wound on one of the field-magnet yokes, and was connected to the reflecting voltmeter when the current was flowing in the armature coil in the median plane, the field coils being short-circuited. The result was to show that about 6·5 per cent. of the total flux produced passed through the field yokes. The rest, or 93·5 per cent. of the alternating flux, passed through air in going from one surface of the armature core to the other.

Now, with a continuous current of the same virtual value the leakage field—that is, the portion of the flux which does not pass through the field magnets—is estimated as only 55, the above total virtual alternating flux through the armature coil being taken as 100. With the alternating current, then, a larger flux passes through the air about the motor, without going through the yoke, than is the case with a continuous current. Fig. 1 is intended to illustrate this. On the left is indicated the field produced by a continuous current in the armature coil, with a large flux round through the field magnets and a small leakage field. The right half of the figure gives some idea of the configuration of the field with an alternating current when the field coils are short-circuited. The effect of the induced current in the field is somewhat exaggerated, so that there is on the whole a flux through the field coils in the opposite direction to that which would be produced by the current in the armature coil. It will be seen on comparing this with Fig. 3, which represents the field produced by the same continuous current in the coil, when it is on the iron core outside the field (the thickness of the conductor is greater), that the form of the magnetic field is in a general way similar in the two cases. With the alternating current it is a little distorted; but the effect of this distortion on the magnetic reluctance between the top and bottom of the core is rather more than balanced by the fact that some of the tubes pass for a considerable distance through iron, instead of through air; the apparent induction is thus a little larger in this case.

Table V. gives the volts observed when two coils, of 12 turns each, were wound on the two field yokes, and connected in series with the voltmeter, an alternating current of constant value being sent through the armature coil.

TABLE V.

Position of coil.	Volts induced in yoke coils.	
Median plane	1·5	0·166
Just outside pole-tips	—	0·121
Just under pole-tips	1·26	0·111
At right angles to the median plane	0·074	0
Resistance in field circuit	∞	0·1 ohm

The numbers in the first line show the diminution in flux when the field is short-circuited. The vertical columns show that as the coil is moved under the pole-tips more and more of the flux passes round through the pole-pieces without going through the magnet limbs and yokes. When the coil is exactly at right angles to the median plane there will be no flux through the yoke coils.

(To be continued.)

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FORESIGHT AND FINISH.

It is almost impossible to read any periodical publication in this country without coming across a diatribe against foreign competition. As a nation we are free traders; individually there are very few real free traders, many people calling themselves fair traders, and some revelling in the exploded doctrine of protection. All agree that it is the Englishman's prerogative to sell everywhere without competition, and if that state of things does not exist, why, 'tis the fault of our Ministers, who allow themselves to be bamboozled and outwitted by other nations. The funny part of all this talk is that statistics tell us the wealth of this country is increasing year by year and the bulk of production is not growing less. The economic problem of return per unit production is a large one, and certainly not one easily understood. Profit per unit may largely decrease while total profit may increase. However the question is discussed, it will be found that the state of this country is not so parlous as some of the pessimists would have us believe. It has long been understood amongst thinkers that the death of a great nation is seldom or never due to outside pressure, but to internal matters. It is the house or the nation divided against itself that goes to the wall, and allows itself to be kicked out of existence. The constant succession of labour troubles, the influence of political votes in the hands of those who are not in the real sense of the term Britons, but who are merely settlers on the soil, and, as far as possible, spoilers of the people, are some of the internal matters that lead to political flabbiness and manufacturing incompetency. In many cases manufacturing supremacy is held only by great foresight, the being able to provide at once readily and cheaply for a new departure. This frequently means the expenditure of great sums of money to provide special machinery, machinery that cannot earn any return for the expenditure perhaps for two or three years to come. The demand at first is small, it increases, and the time comes when the machinery is in full work, and amply paying for the capital sunk, and so proving the wisdom of the outlay. When, however, the manufacturer is threatened with interference in carrying out his work, he is naturally a little disinclined to embark capital in providing for the future. His disinclination does not stop the demand, which increases and increases. At the present moment there are several instances of such a state of things in connection with electrical matters. Take, as an example, the gearing required in electric traction apparatus. If the whole of Britain is searched, it will be found that no single manufacturer can supply at anything like the cost that the goods can be obtained from America? And why? Is it that the raw materials are cheaper there than here? No. It is simply that special machinery has been designed and erected there, and that the labour organisation over there is utterly different from what it is here. According to our information, the best work is done when one man or one set of men see the work through from start to finish. He

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or they have to preside, so to speak, at several special machines very much of an automatic character, with the practical result of getting the gear almost as perfect and as cheap as it is possible to get it. The men earn individually more money than here, and, at the same time, produce the work at a lower charge for labour. This is done by allowing the automatic tools to do the work without a skilled man to watch each tool, as is done on this side to conform with the requirements of the trades unions. Perhaps our example may be thought of little consequence, but look around and note the geographical points from which electrical apparatus has initially proceeded. Little of it is indigenous to this country, although it may be urged we have taken hold of the crude and made it practical. We should prefer to see a little more initiation here.

PATENT LITIGATION.

The latest in this expensive form of legal contest is likely to arise out of the 1885 patent granted to Messrs. Carl Zipernowsky and Max Deri for an alternate-current distribution system. The date of the patent is March 16, and it is claimed to be a master patent by Mr. M. Rücker, the present owner. The London Electric Supply Company have been selected by this gentleman as the first parties to proceed against, although all the alternate-current stations in the kingdom are said to be equally liable. A combined defence is therefore probable. It seems rather late in the day to commence actions on a patent which expires in March of next year. The patent in question is most interesting reading, and only one claim is made, which is as follows: "In the application of induction coils or transformers for alternating electric currents, the arrangement of several stations of second order as branch circuits of the main line—*i.e.*, connecting up the local centres with the main line in multiple arc—to which main line is supplied an alternating electric current of a tension as constant as possible, substantially as described and shown in the drawing." Our sympathies naturally tend toward the people who have used the alternate-current system so long, and who have overcome the practical difficulties of so doing. Still, the inventor has his rights, and Budapest was certainly the home of most of the early alternate-current work.

COMMERCIAL TREATIES.

1. Canadian Preferential Tariff.

The following information has been forwarded to us by the High Commissioner for Canada:

By an Act of Parliament of Canada, assented to on June 13, 1898, it is provided:

"1. That all articles except wines, malt liquors, spirits, spirituous liquors, liquid medicines, and articles containing alcohol, tobacco, cigars, and cigarettes, which are the growth, produce, or manufacture of any of the following countries, and which are declared to be dutiable upon importation into Canada, may, when imported direct into Canada from any of such countries, be entered for duty or taken out of warehouse for consumption in Canada, on and after the first day of August, 1898, at a reduction of one-fourth from the general tariff rates of duty."

The preferential tariff will apply to the United Kingdom, Bermuda, the British West Indies, British Guiana, British India, Ceylon, New South Wales, and the Straits Settlements. It may also be extended by Order in Council to any other British colony or possession the Customs tariff of which, on the whole, is as favourable to Canada as the British preferential tariff of Canada is to such colony or possession.

Raw sugar, including sugar drainings or pumpings drained in transit, melado, or concentrated melado, tank bottoms, and sugar concrete, the produce of any British colony or possession, may, when imported direct from any British colony or possession, be entered for duty or taken out of warehouse for consumption in Canada at the reduced rate of duty provided in the British preferential tariff.

The reduction under the preferential tariff will only apply to refined sugars when evidence satisfactory to the Minister of Customs is furnished that such refined sugar has been manufactured wholly from raw sugar produced in the British colonies or possessions.

Copies of the "Memorandum of Information and Instructions respecting the British Preferential Tariff," issued by the Canadian Customs Department, of the "Regulations for the Entry of Goods under the British Preferential Tariff of Canada," and of the "Schedule of Forms" that are to be used, as referred to in the regulations, may be obtained from the High Commissioner for Canada, 17, Victoria-street, London, S.W., or from any of the Canadian Government agents in the United Kingdom, as follows: Mr. A. F. Jury, 15, Water-street, Liverpool; Mr. C. R. Devlin, 14, Westmoreland-street, Dublin; Mr. H. M. Murray, 52, St. Enoch-square, Glasgow; and Mr. W. L. Griffith, 10, The Walk, Cardiff.

2. British-Belgian Commercial Treaty.

With regard to the establishment of a provisional *modus vivendi* between the United Kingdom of Great Britain and Ireland and the Kingdom of Belgium pending the conclusion of a definite treaty of commerce and navigation between the two countries, both Governments have agreed not to make any modification after July 29, 1898, in the system actually applied to the subjects and products of the United Kingdom of Great Britain and Ireland, unless previous notice of any such change shall have been given three months beforehand by either party. It is clearly understood, however, that the present engagement does not prevent either of the two Governments making in the system actually in force between the two countries such modifications as may be made applicable to all other countries.

ELECTROLYTIC THEORIES AND THEIR RELATION TO COMMERCIAL ELECTRO-CHEMISTRY.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

(Continued from page 104.)

Considerable interest attaches at the present moment to the various recently invented methods of electrolytic refining of metals. Already electrolysis has supplied us with copper which may be obtained by the ton in a state of greater purity than Mathiessen and Hockin, for example, were able to produce it by other methods on a small scale for laboratory experiments. At some not very distant date most of the copper extraction throughout the world may be effected by electrolytic methods. The reported failure of the Ashcroft process for refining zinc as instituted at Cockle Creek, New South Wales, only points to the necessity of further research into the mechanism by means of which an electric current is propagated in an electrolyte. Dr. R. Threlfall has recently pointed out that the failure to obtain dense metallic deposits of zinc seems to have little to do with the current density employed, from 2 to 100 amperes per square foot producing uniformly good results with a solution of the proper constitution. The cause of trouble appears to lie in the presence of minute traces of impurities in the electrolyte. Since, in many cases,

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these impurities exist in quantities so small as almost to defy detection by ordinary chemical means, it becomes evident that great gain would result if we could deduce the nature of their action from recognised theoretical principles.

A brief consideration of the phenomena attending the electrolysis of a salt of copper may not be without interest. Let us suppose the anode to consist of a very impure specimen of metallic copper. As the current is passed, some only of the impurities will pass into solution with the copper; thus silver, gold, platinum, bismuth, tin, arsenic, antimony, and lead will be precipitated in the "anode sludge," whilst nickel, cobalt, iron, and zinc will pass into solution. With a pressure of ·5 volt the copper alone will be deposited on the cathode.

As the process proceeds the resistance of the bath increases, owing apparently to the place of copper in the solution being taken by nickel, cobalt, iron, etc. After a time, moreover, the copper deposited becomes spongy. At one time it was thought that the addition of sulphuric acid would remedy this latter defect, but it has finally been recognised that in the present state of our knowledge the last traces of copper may best be removed by ordinary chemical means. An Austrian firm has lately succeeded in refining a copper ore containing 20 per cent. impurities. Hence valuable applications of electrolytic processes may be anticipated in connection with the Canadian nickel ore of copper.

On reviewing the salient points of a process such as the above, one is struck with the fact that scarcely one seems to admit of an easy explanation, still less of anticipation, from the older electrolytic theories. Ultimate theories frequently possess little value to the practical man; what *is* of almost priceless value is a sound working hypothesis, according to which the results of any particular operation may be accurately calculated beforehand. It may be not altogether without interest, therefore, to examine in rapid review the various electrolytic theories which have been proposed. In doing so, importance will be chiefly attached to quantitative relations which appear to promise assistance in practical applications, such as those discussed above.

One of the earliest quantitative relations in connection with electro-chemistry is that originally given by Helmholtz in 1847 and Sir William Thomson (now Lord Kelvin) in 1851, and commonly known as Thomson's law. According to this law, *the electrical energy which may be obtained from a given galvanic element is equal to the mechanical equivalent of the total heat energy capable of being generated by the chemical reactions at work in the element.* When this relation is combined with Faraday's well-known law of electro-chemical equivalence, a value for the E.M.F. of any given cell may be easily calculated. Take the well-known case of a Daniell's cell. In this we have zinc dissolving in dilute sulphuric acid, whilst copper is deposited from the copper sulphate on the cathode of the cell.

According to Faraday's law, the electricity transferred by $\frac{63\cdot4}{2}$ grm. of copper will correspond to that carried by $\frac{65\cdot2}{2}$ grm. of zinc or 1 grm. of hydrogen. Further, the mass of copper which will be deposited during the passage of one C.G.S. unit of electricity is known to be equal to ·00326 grm., whilst ·00336 grm. of zinc will be dissolved.

Let E be the E.M.F. of the cell measured in C.G.S. units. Then Thomson's rule states that:

$E \times 1$ = heat developed in dissolving ·00326 grm. of zinc in dilute H_2SO_4, less the heat which would be developed if ·00326 grm. of copper were dissolved in dilute H_2SO_4.

But 1 grm. of Cu dissolved in dilute H_2SO_4 generates 909·5 units of heat, and

1 grm. of Zn dissolved in dilute H_2SO_4 generates 1,670 units of heat.

Hence, taking the mechanical equivalent of heat as equal to $4\cdot2 \times 10^7$, we obtain finally

$$\begin{aligned} E &= (\cdot003736 \times 1670 \times - \cdot00326 \times 909\cdot5)\ 4\cdot2 \times 10^7 \\ &= (5\cdot61 - 2\cdot96) \times 4\cdot2 \times 10^7 = 1\cdot11 \times 10^8 \\ &= 1\cdot11 \text{ volt.} \end{aligned}$$

This calculated value is exceedingly close to the actual E.M.F. of a Daniell element as determined experimentally—viz., 1·096 volt. Indeed, the agreement in this case has led to the conclusion that Thomson's law expressed the conditions of the production of an electric current in a cell with a much greater degree of accuracy than is really the case. I shall have occasion later on to consider forms of batteries whose action Thomson's law is wholly incapable of explaining. The point which I wish to emphasise here, however, is that a most important feature of electrolyte conduction is entirely neglected—I mean that Thomson's law gives no explanation of the fact that the E.M.F. of most galvanic elements possesses a temperature coefficient. Thus the E.M.F. of a Daniell's cell is increased by about 1·5 per cent. when the temperature of the electrolyte is raised from that of a room to 100deg. C., whilst a diminution of about 15 per cent. takes place in the E.M.F. of a bichromate cell under similar conditions.

It now becomes necessary to distinguish between *reversible* and *irreversible* cells. The properties of the former class may be understood from the consideration of an example—a modification of the Daniell element. For simplicity, suppose that the dilute sulphuric acid bathing the zinc in the Daniell's cell is replaced by zinc sulphate, so that the element may be represented by

$$Zn \mid ZnSO_4 \mid CuSO_4 \mid Cu.$$

If a unit of electricity passes through this cell from the zinc to the copper, a certain definite amount of zinc is dissolved, whilst an equivalent amount of copper is deposited. The solution of the zinc and deposition of the copper will increase the amount of the zinc sulphate present, and decrease the amount of copper sulphate by an equivalent amount. If, now, a quantity of electricity equal to that previously sent through the cell from the zinc to the copper is made to pass through it in an opposite direction, the cell will be brought back to its original condition—the copper previously deposited will be dissolved, increasing the amount of the copper sulphate to its original value, whilst the zinc formerly dissolved will be deposited, thus reducing the zinc sulphate to its initial amount. In fact, one operation exactly reverses or neutralises the others. Such a cell is said to be reversible. On the other hand, a cell represented by

$$Zn \mid H_2SO_4 \mid Cu$$

is *irreversible*. For let any quantity of electricity be sent through it from the zinc to the copper, zinc will be dissolved, whilst an equivalent amount of hydrogen will be given off at the copper electrode. Now let an equal quantity of electricity pass through the cell in the reverse direction. Copper will be dissolved, whilst an equivalent amount of hydrogen will be given off at the zinc electrode. Thus the two operations will involve the solution of an equivalent of zinc and another of copper, together with the evolution of two equivalents of hydrogen—*i.e.*, the second operation does not reverse or neutralise the first, but leaves the cell in a different condition to that obtaining before the cycle was performed.

(To be continued.)

THE PRESENT STATUS OF ELECTRICAL ENGINEERING.*

BY DR. A. E. KENNELLY.

While mechanical engineering may be said to have an antiquity coeval with civilisation, its latest offshoot, electrical engineering, only came into existence with the advent of the electric telegraph some 60 years ago. For the greater part of this time, electrical development was confined to the telegraphic industry, but with the extended introduction of the arc and incandescent lamps, the utilisation of the magnetic properties of iron and steel made rapid progress in dynamo construction, so that the magnetic properties of steel now play almost as important a part in the advance of civilisation as do their mechanical properties.

By far the greater proportion of electric development

* The inaugural address presented at the general meeting of the American Institute of Electrical Engineers, Omaha, June, 1898.

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has come within the past decade and a half. Looking back from the Trans-Mississippi Exposition at Omaha of to-day, to the International Electrical Exhibition of Philadelphia in 1884, the birthplace of the American Institute of Electrical Engineers, it is doubtful whether, outside of telegraphy and telephony, there was at that time in the United States a total investment of 1,000,000dol. in electrical applications. The words ammeter and voltmeter were just commencing to be generally recognised, and of electric traction there was none. At the present time the capitalisation in electrical applications in the United States is estimated at about 1,900,000,000dol.

In 1884 a 50-kw. dynamo was considered a large machine, while a 100-kw. Edison steam dynamo was justly called a "jumbo." At the present time the largest size of generator built or building is of 4,600 kw. capacity. The price of dynamos in 1882 was about 20 cents per watt of output, while dynamos of similar running speed in comparatively small sizes, without switchboards, now cost about two cents per watt. The great reduction in price represents the aggregated result of the very large amount of labour devoted to this branch of engineering in the last 15 years.

It is interesting to notice that the efficiencies of continuous-current dynamos have not made any marked nominal advance since the birth of the institute, though their output per unit of mass has considerably increased. Thus the 50-kw. dynamo tested at the Philadelphia exhibition is stated to have had an efficiency of approximately 92 per cent., and this would be considered a satisfactory performance in that size of machine to-day. But, whereas the output then was only six watts per pound of net weight, the output of a machine of similar rating and speed to-day would be about 10 watts per pound. In other words, the efficiencies of the best dynamos of 1884 were already so good that it has not paid, at existing costs of power, to markedly improve them, and such improvements in material and design as have since been effected have enabled manufacturers to increase the rating or yield, and, therefore, the cheapness of the machines. It seems probable, moreover, that this will continue to be the direction of future progress. We scarcely can desire more efficient machines than the best we have now, but we shall always desire cheaper and more powerful machines, and shall welcome any improvements which lead to them.

Another evidence of the development in dynamo machinery is its improved appearance. Formerly the only claim possessed by such apparatus was utility. More recently grace, the expression of unconscious power, has supervened, and the modern dynamo is often pleasing to look upon as well as useful to operate.

The cost of generating a kilowatt-hour of electric energy from steam for electric lighting appears to have been at least 7·5 cents at the 'bus bars in 1884. At the present time the cost of delivering a kilowatt-hour to large street railway systems from steam is only about one cent, and the power-house operating costs are reported in some cases as low as half a cent. In municipal electric lighting systems supplied at low pressure from steam central stations and hampered by relatively heavy distributing expenses, the retail price of the kilowatt-hour varies from 20 to about 4½ cents, according to the locality and quantity consumed. Niagara power is now sold to consumers in Buffalo at rates varying, according to the amount delivered, from two cents to slightly less than two-thirds of a cent per kilowatt-hour delivered.

The price of a 16-c.p. incandescent lamp 16 years ago was about 1dol. Now it is about 18 cents. The best lamps at that time, under laboratory conditions, gave about 0·28 mean horizontal normal British candle-power per watt, and under commercial conditions about 0·20. The highest pressure for which they could then be obtained was about 110 volts. At the present time lamps are obtainable giving normally 0·4 mean horizontal British candles per watt, while under commercial conditions the average lamp normally develops about 0·25 candle per watt. They can also be obtained (at 0 25 candle per watt) for pressures up to 240 volts, and are frequently installed on 220-volt mains.

Arc lamps were already so far advanced in 1884 that comparatively little improvement in their effectiveness has taken place, the gain having been made in economy of operation. Thus the carbons which cost at that time about six cents apiece now cost about two cents apiece. The enclosed arc lamp has of recent years become popular, owing to its diffused light and a carbon life of from 100 to 150 hours.

It has been estimated that about 600,000,000dol. have been invested up to the present time in electric lighting stations and plants in the United States.

The best storage cells tested at the Philadelphia exhibition of 1884 gave a yield, under laboratory conditions, of 3·4 watt-hours per pound of electrodes with an energy efficiency of 69 per cent. when discharged at the mean current density of 12 amperes per square foot of negative plate surface; while the deterioration was comparatively rapid. At the present time storage cells are in use giving, under laboratory conditions, a yield of from five to six watt-hours per pound of charged cell, with an energy efficiency of about 85 per cent., when discharged at a current density of 4·8 amperes per square foot of negative plate surface. There are now storage batteries installed in the United States to the aggregate capacity of about 56,000 kilowatt-hours. The largest installation has 166 cells, weighs 500 short tons, and has an eight-hour discharge capacity of 22,400 ampere-hours, or 3,136 kilowatt-hours at 140 volts pressure.

A very great development has taken place in the direction of electric traction, by virtue of which the horse car, once so well-nigh ubiquitous in the city streets, has almost entirely disappeared, while electric locomotives of 1,500 h.p. have even made their appearance on steam railroad tracks. The introduction of soft cast steel has been very advantageous to the electric motor, enabling its output to be increased from five watts per pound of net weight in 1884 to about 14 watts per pound in street-car motors at the present time. It is estimated that there are to-day in the United States about 14,000 miles of electric railroad, with a nominal capital of about 1,000,000,000dol., and employing about 170,000 men.

The electric transmission of the power of falling water is a branch of engineering that has come into service since 1884, and is making rapid strides owing to the recent successful employment of high voltages and multiphase alternating currents. It has been estimated that about 150,000 kw. of this class of machinery is installed in the North American Continent, commercially transmitting power to various distances up to 85 miles at various pressures up to 30,000 volts.

The alternating-current induction motor has become very popular in recent years, mainly owing to its powerful starting torque and its freedom from commutator and brushes. A burned-out armature, the perpetual source of dread in motor operations of days gone by, is practically unknown in this type of machine, even when put to severe service. Indeed, its depreciation under fair conditions appears to be as low as in any class of rotating machinery.

The alternating-current transformer has been correspondingly improved, developing in large sizes an efficiency of about 98·5 per cent., and an output, when cooled by external power, of about 100 watts per pound of weight.

The principal engineering value of electricity to-day lies in its adaptation to the transmission of power through mills or cities, or from some locality where power is cheap to others where it is dear. A steel rope by its bodily motion can transmit, with appreciable friction and depreciation, some hundreds of kilowatts to a distance of some thousands of feet. A bare quiescent copper rope, ½in. in diameter, and supported on poles, can, by maintaining an effective potential of 10,000 volts by the motion of electric waves over its surface, transmit, say, 2,500 kw. with an energy loss of two-thirds per cent. per mile, and with practically no depreciation except that of the poles and supports.

The use of high pressures has thus become more frequent during the last few years. Alternating-current generators are now made to supply 10,000 volts at their terminals, and insulation testing sets have been made for producing alternating pressures up to 100,000 volts effective.

The application of electric power to domestic use and household comforts, irrespective of illumination, has made steady progress. In the large cities the fan-motor day load of summer is in the aggregate a perceptible quantity,

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while electric ranges and heaters on a small scale have found favour through their convenience.

In telegraphy, comparatively little change has recently taken place beyond the substitution of the dynamo or dynamotor for the voltaic battery, and of copper line wire with some five ohms per mile for iron wire with some 13 ohms per mile. About 1.000,000 miles of telegraph wire are now strung on some 200,000 miles of pole line in the United States, connecting about 25,000 offices, and working an invested capital of about 150,000,000dol.

In the United States, the uniformity of the closed-circuit Morse system, simplex, duplex, or quadruplex, is only varied by an occasional Wheatstone set. This crystallisation of methods is not due to any lack of invention or capability of improvement in signalling speed, but rather to the apparently settled belief that the present systems are the most economical under existing conditions of traffic. In long submarine telegraphy, the pressure of increasing traffic has made itself more distinctly felt, and automatic curb-senders have, to some extent, been introduced, but the physical difficulties in the way of attaining high speeds have, as yet, been obviated only in part by an increased expenditure in copper and guttapercha, to obtain a diminished conductor resistance per mile. Wireless telegraphy has entered its experimental stage, and bids fair to enter practical service in the future, at least within a limited range. Its public use thus far in the United States seems to have been limited to blowing up at stated intervals, in the recent New York Exhibition, miniature models of the "Maine," at a distance of some 25m. from the oscillator.

In telephony the most notable improvement in recent years has been the general substitution of metallic circuits for ground return circuits, with great advantage to the convenience and effectiveness of the traffic. At the present time conversation is carried on commercially up to a distance of 1,800 miles, and quite frequently at distances of 1,500 miles. There are at the present time in the United States about 1,000,000 telephones connected with the telephone service of the country, employing a capitalisation of about 100,000,000dol., 400,000 stations, and about 900,000 miles of wire. Every day about 17,000 employés make on the average more than 3,000,000 of connections. About 300,000 miles, or nearly one-third of the total length of telephone wires, have within the last few years been made up into aerial and subterranean cables within city limits, owing to the reduction of the electrostatic capacity effected in such cabled wires to less than one-twelfth of a microfarad per mile.

A considerable development has occurred in electro-thermic and electrolytic processes. More than 4,000 kw. of Niagara power are now employed in such processes. Among electro-chemical processes are the electrolytic refining of copper to the extent of about 150,000 tons annually, the production of aluminium, the production of sodium and alkalis, and the treatment of ores. Among electro-thermic processes are the production of the carbides of silicon and calcium in steadily increasing quantities.

In electrotechnical theory considerable advance has been made of recent years, particularly in the study of alternating currents. Accompanying the expansion of knowledge in the various branches there is a tendency among them to combine and unite into one general theory. Thus, while the low-tension electricity of dynamo origin was once regarded as something so dissimilar to high-tension electricity as to require separate treatment and classification, to-day the high tensions derived from alternators through step-up transformers so far invade the territory of so-called frictional electricity that a dividing line between the two classes can no longer be maintained. Similarly telephony and telegraphy are coming to be regarded as sub-classes of alternating-current power transmission, while electricity and magnetism cannot properly be studied apart.

Although a large amount of electrical work is done in physical laboratories in the United States, a comparatively small amount of the results of this work becomes available to the science or art of electrical engineering. Each year sees more than 100 students engaged in experimental thesis work after a laborious training and preparation for several years in the technical college. Many of these men have the time and facilities to do the best experimental work of their lives under the guidance of their instructors. Some of the men display aptitude and interest in some special line of research in which they would be best left untrammelled, but in most cases the experimental work under co-operative guidance could accomplish a great deal for the knowledge and progress of our branch of applied science. There are numerous questions concerning the various electromagnetic properties of matter and of the ether that are of great and growing importance, and there are numerous scientific subjects of immediate practical importance that it is necessary to measure and observe, so that by uniting the available experimental resources of the various colleges in this country under a common leadership, in sympathy with the college instructors, the results which now largely fill thesis books lying on neglected shelves might be incorporated into permanent results for the general advancement of our profession. The plan would involve practically no expenditure beyond the voluntary efforts of those upon whom the duty devolved of formulating and dividing the subjects of research, and classifying or comparing the results attained. Such a system of co-operation among the students through their instructors would economise a large amount of the most skilled technical labour, and accelerate progress in all branches of enquiry, application, and industry. No better work could be undertaken by our institute than the fostering of such an organisation.

The technical progress of a profession like ours is shown by the precision of which it is capable. A loose nomenclature begets looseness of observation and description, and is inconsistent with a high degree of development in a science that quickens the footsteps of every human industry. The tendency of our machinery and definitions to become standardised is apparent in the impulse which has led the American Institute of Electrical Engineers to appoint a committee on standardisation, the preliminary report of which is to-day laid before this institute for consideration.

In connection with standardisation it is important to observe that there has been of recent years a tendency to depart from the regular standards of dynamo machinery built by the manufacturers, in favour of special machinery of independent design. To a limited extent this is, of course, necessary under the pressure of changing methods and conditions, but there is reason to believe that much more special machinery is built than necessity can warrant. Not only is the special machinery thus ordered or specified considerably more costly than standard machinery, but the tendency, by interfering with the natural shop methods of standardising and cheapening protection, prevents regular consumers from purchasing standard machinery at as low rates as would otherwise be possible. When we consider that the industrial radius of application of electricity mainly depends upon the first cost of the apparatus it employs, it needs no homily to drive home the conviction that the necessary introduction of special machinery is a puncture in the tyre of progress.

Our institute may well take pride in the share which it has taken in the electric progress of the 14 years which have elapsed since its inception. It now numbers 1,100 members. Its purpose is to aid all who seek to acquaint themselves with this branch of science and art, and to set the stepping stones of progress in the sands of time for the advance of the industrial applications of electricity.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE I.

(Concluded from page 150.)

IMPORTS INTO THE UNITED KINGDOM AND FLUCTUATION OF PRICES.

The yearly imports into the United Kingdom from various specified countries is given in a table in the supplement, but the total amounts are also graphically represented in Fig. 17 by a continuous line. The dotted curve shows the quantity of raw guttapercha exported from Singapore during each year from 1845 to 1896. The two curves representing the export from Singapore and import into the United Kingdom are on

* Cantor Lectures delivered before the Society of Arts.

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the whole concomitant, thus showing that the guttapercha exported from that place mostly came to these islands, but there are some interesting features which should not be passed over. Thus, in the year 1873, the imports to Great Britain largely exceeded the exports from Singapore. In that year a large quantity of guttapercha was imported to England from Holland, whither it had been brought direct from the Dutch Indies. A good deal was also purchased from other European countries, which was originally obtained from Singapore. The high peak in the curves occurring in 1882 is largely due to the Atlantic cables manufactured at that time, and shows the great influence which that manufacture has on the import of guttapercha. Another significant feature is the increased distance between the two curves during later years, owing to the greater quantity of material used by other countries. The total import of raw guttapercha into the United Kingdom from 1844 to 1896 inclusive rmounts to 82,607 tons. The curve at the lower part of Fig. 17 shows the annual fluctuation of the value per pound as deduced from the quantity and total value for each year. The horizontal line consisting of dots and dashes represents the mean value during the period here considered—viz., from 1854 to 1896—which is 17·88d. It is readily seen that the average value per pound for any particular year does not only depend upon the price of a standard material, but also largely upon the relative proportion of superior and inferior guttapercha imported during that period. I, therefore, thought it would be useful and instructive to show some further curves which represent the fluctuations of price on the Singapore market for certain recognised brands of the material. Diagram Fig. 18 graphically represents these particulars for the first grade of six different brands during the last nine years; the figures themselves will be given in the supplement. The prices are given both in dollars per picul (133⅓lb.) and in pence per pound, to show how greatly the rate of exchange influences the price which the manufacturer has to pay for his material. That the variations in the exchange may sometimes apparently reverse the actual conditions can be seen, for instance, from the prices of "Pahang" in 1893 and 1894 respectively. As the curves show, the price per picul in these two years was 152dol. and 180dol. respectively, whereas that per pound was 36·76d. and 35·2d., the value of the dollar having fallen from 32·22d. to 25·92d., or about 20 per cent., during that particular period. We have now followed the guttapercha from its existence in the latex of the plant until it reaches the works, and in our next lecture we shall see how the manufacturer receives and treats the material.

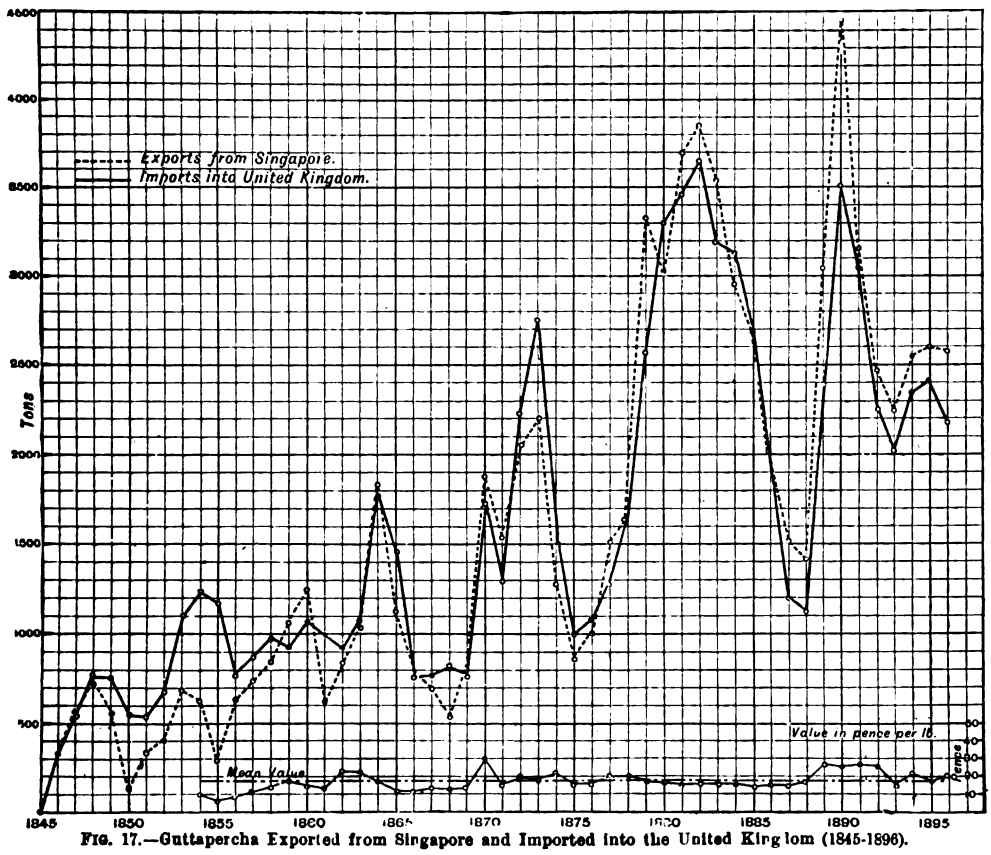

FIG. 17.—Guttapercha Exported from Singapore and Imported into the United Kingdom (1845-1896).

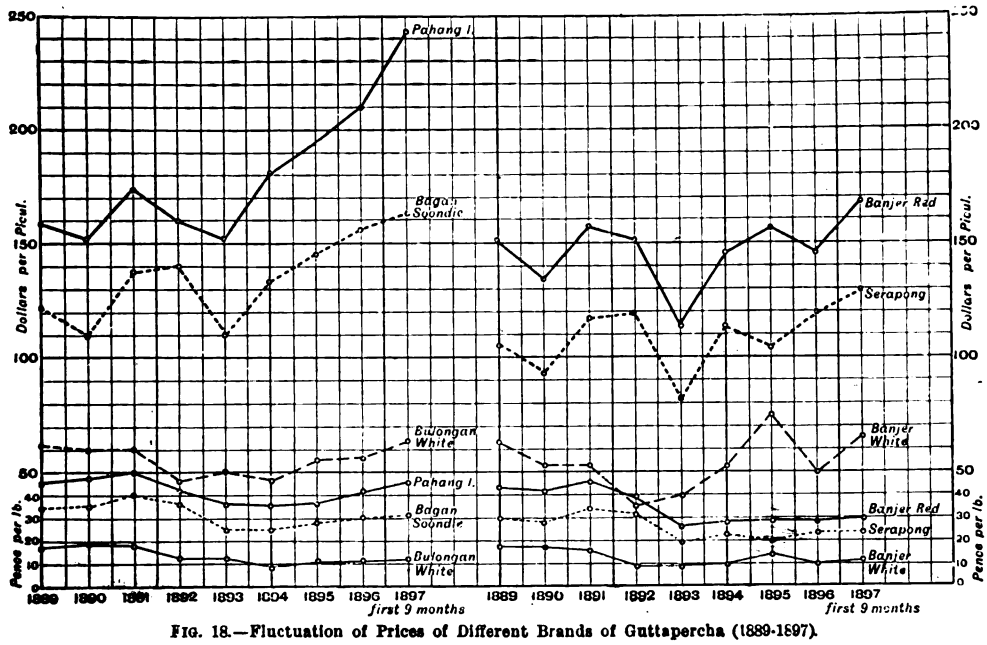

FIG. 18.—Fluctuation of Prices of Different Brands of Guttapercha (1889-1897).

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LECTURE II.

THE CLEANING PROCESSES.—Mechanical cleaning process—Loss during mechanical cleaning—Chemical washing process—Chemical hardening process—Extraction from raw material and from leaves by means of solvents—Advantages and disadvantages of the different processes—Natural substitutes for guttapercha, including balata.

MECHANICAL CLEANING PROCESS.

To-night we have to consider the various cleaning processes to which the raw guttapercha is subjected after reaching the premises of the manufacturer, and I will begin with the mechanical cleaning process.

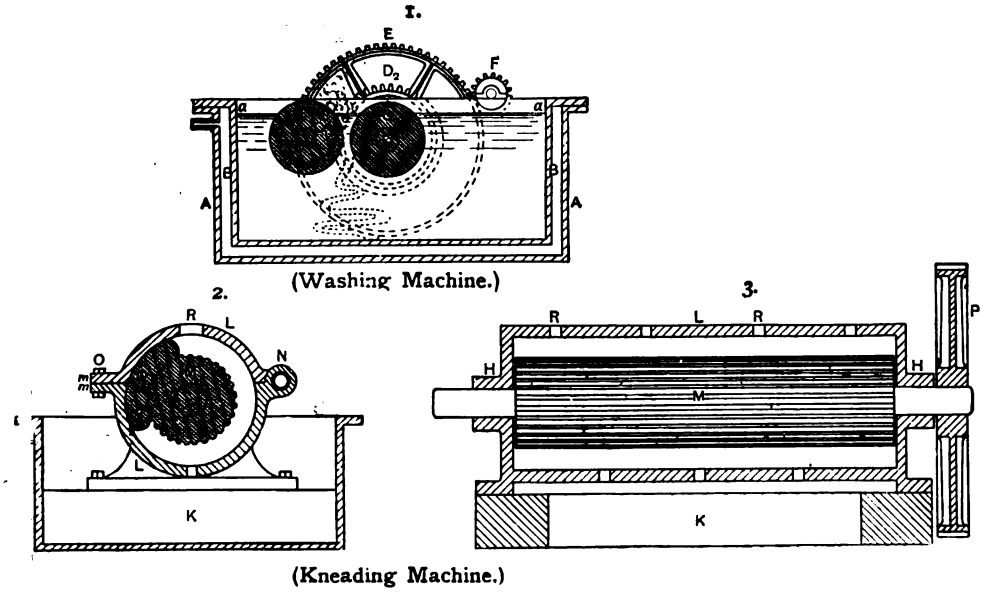
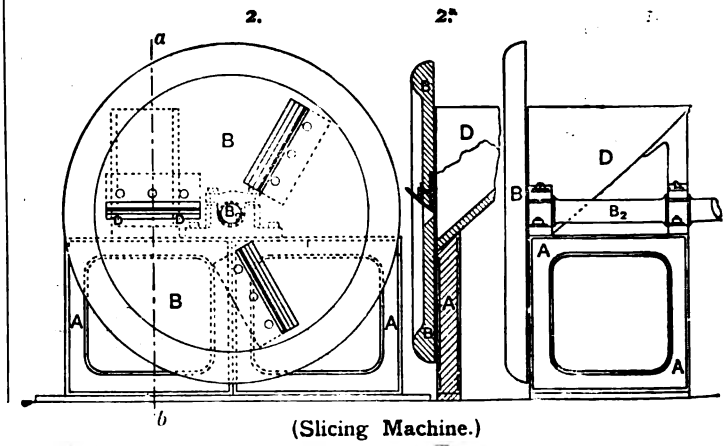


FIG. 19.—R. A. Brooman's Patent of March 11, 1845.

The first patent specification in which reference is made to the cleaning of guttapercha, is one by Richard Archibald Brooman (No. 10,550* O.L.), dated March 11, 1845, and entitled as follows—viz., "Employing Guttapercha in the Manufacture of Artificial Fuels, Mastics, and Cements." The invention is described as having been communicated from abroad, but it appears that the true inventor was no other than Charles Hancock, the patentee of several other inventions relating to guttapercha, as I am informed by his son, Mr. Walter Hancock.

Brooman describes apparatuses for washing and kneading guttapercha, and illustrates them by diagrams which are reproduced here. Diagram Fig. 19 shows the washing machine (1); it consists of two smooth rollers, C^1 and C^2, rotated in opposite directions, and with different speeds by means of the toothed wheels, D^1 and D^2. The rollers are almost completely immersed in water in a tank provided with a steam-jacket for heating the water. The guttapercha is put between the rollers and passed through them several times in succession, until it appears sufficiently clean. Fig. 19 also shows the kneading machine (2 and 3) in section. It consists of a grooved roller, M, rotating concentrically in an iron shell surrounded by hot water. The shell is provided with a hinged lid, L, which can be kept closed by bolts, O. The softened charge of guttapercha, Q, is taken round and round by the roller, M, object being to tear up the material into shreds, in order to expose the dirt enclosed therein. The slices from the first machine are softened in hot water, and then thrown into the hopper, H, on the left side of the long trough, T. This trough is divided into three compartments, t^1, t^2, and t^3, containing cold water. The soft guttapercha in the hopper is taken up by the feeding rollers, G^1, and forced against the rapidly rotating breaker, F^1, provided with a number of serrated plates on its periphery. The disintegrated material falls into the water, the heavy dirt sinking to the bottom, whilst the lighter guttapercha floats and is taken up by the endless web, H^2, which carries it to the next pair of feeding rollers, G^2, and they in their turn force it against the second breaker, F^2. This operation is repeated once more at F^3. The material then passes to the mincer, K, where it is cut up by means of rotating knives passing close to fixed ones in the block, L. The



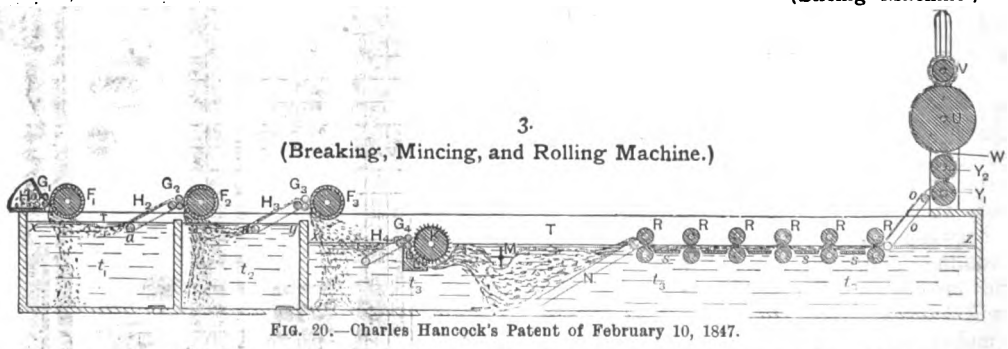


FIG. 20.—Charles Hancock's Patent of February 10, 1847.

Another patent (No. 11,575* O.L.) of Feb. 10, 1847, was a patent taken out by Charles Hancock, under the title: "Preparation and Application of Guttapercha." Here a machine is described and illustrated for slicing the raw material, and another for still further disintegrating it. Diagram Fig. 20, which is a reproduction of the drawing in the patent specification, represents the slicing machine (1, 2, and 2a). B is a heavy iron disc with three slots, each provided with a knife resembling the blade of a plane or spokeshave. The disc is rotated by means of a shaft, B^2, and the lumps of raw guttapercha are thrown into a hopper, D, whence they drop against the disc and are cut into slices by the knives on passing. The other arrangement, which may be termed a breaking and mincing machine, is shown at (3); it is a rather complicated one, its agitator, M, stirs it up in the water and throws the lighter guttapercha towards the endless band, N, which lifts it up to the first pair of rollers, R, which, with the succeeding rollers, compress the material into a sheet; the latter is then taken up by the endless web, O, and passed through the two large rollers, Y^1 and Y^2, round the wooden drum, U, and then to the taking-up roller, V. The apparatus, in a simplified form, is still in use at some works under the name of ticker, and I have here some guttapercha in "flocks," which have evidently been produced by such a machine. I also have some very thin "strippings," obtained by passing the material between closely-set rollers, and which are in a very favourable condition for further treatment.

(To be continued.)

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

86. What are the great essentials of an arc lamp for series working?—J. C. B.

87. Discuss the advantages and disadvantages of a common return in a two-phase system for supplying power and light.—C. P.

ANSWERS.

Question No. 80.—What are the essentials of a good fuse to protect the street mains from the effects of a short-circuit on a consumer's premises? Give sketches.

Answer to No. 80 (*awarded 7s. 6d.*).—The essentials of a fuse, respecting the material of which it is constructed, are that it should be capable of carrying the required current

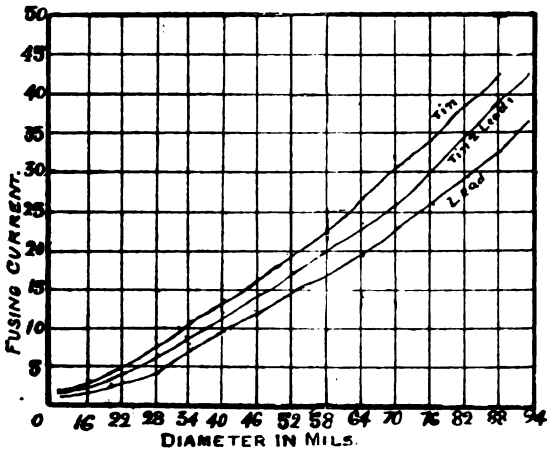

FIG. 1.

without over-heating, but also to melt at a known constant temperature, which must be considerably below red heat, and must be made of a material whose physical structure and conductivity does not deteriorate with a minimum rise of temperature, and of a metal which is not easily oxidised. The metals used, and answering to a great extent the requirements, are tin, lead, and bismuth. The ratio of the current-carrying capacity of the two former are shown in the following curve (Fig. 1). Respecting the shape of the fuse, it is essential that they have sufficient radiating surface. They should be of uniform thickness or cross-section throughout, so that the resistance and therefore the heat will also be uniform, which will prevent fracture from unequal expansion and contraction. They must present good contact surfaces to the terminal under which they are clamped, and should never be less than 1in. in length between the terminal blocks so as to prevent the cooling effect of the terminal. The proper length and cross-section must be calculated for the current they will have to carry, but these values are calculated by the maker, and should be stamped upon the strip of fuse metal, also the melting point, and the length they should be between terminals; for the terminals to which the fuse is connected exercise a very marked effect upon the fusing point. The relation which exists between the length of a fuse wire and the amount of current required to melt it are shown in the curve (Fig. 2), and it will be noted that a fuse 8in. long require a current of 6·6 amperes, while a fuse only ½in. long of the same material will carry a current of 12·5 amperes, thus showing a variation of more than 100 per cent. in the carrying capacity of the fuses, due to the cooling effect of the terminal blocks to a great extent. But the alteration of the current-carrying capacity is due also to the reduced resistance of the shorter fuse. It is very essential that this cooling effect should

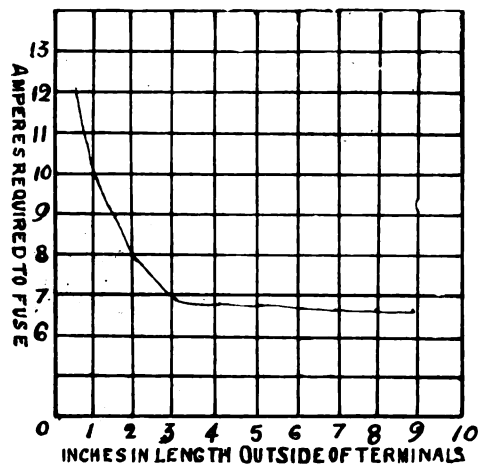

FIG 2.

be taken into account, to ensure the fuse acting at or below 50 per cent. above the normal current. In order to concentrate the action of the heat, and to check the radiation and convection effect, some fuse wire

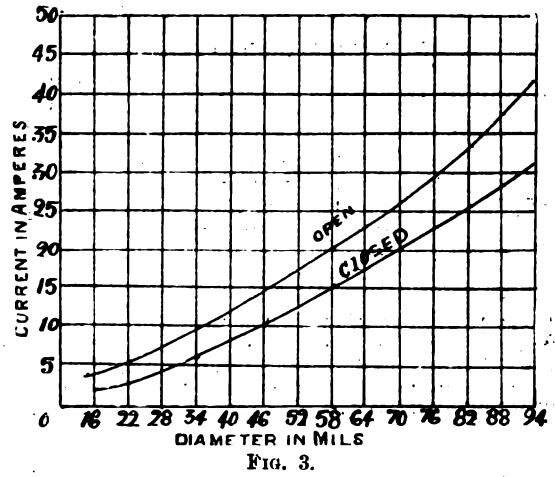

FIG. 3.

is enclosed in glass tubes, but this depresses the carrying capacity of the metal, causing the fuse to fail with a smaller current, therefore it is essential that the fuse should be selected with reference to the kind of fuse block in which

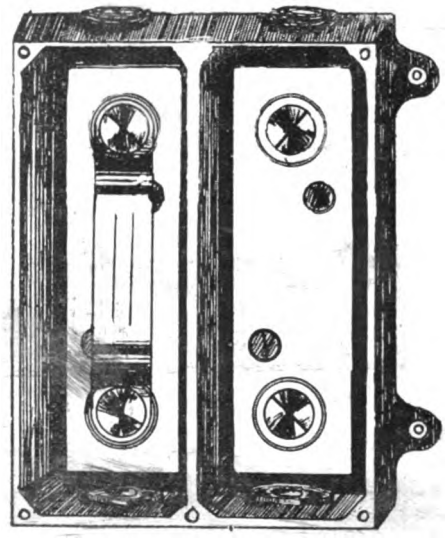

FIG. 4.

they are to be used, as a fuse enclosed would not carry the same current as one the same length and cross-section open to the atmosphere. The ratio of these values can be gathered from the curve (Fig. 3).

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The regulations respecting the position of and the construction of fuse boxes in connections with consumers' premises say that, where fusible cut-outs are used, the section should be so situated within its frame that the fused metal cannot fall where it will cause a short-circuit or an ignition, for all main conductors cut-outs should be provided for flow and return leads, and the two fusible sections must not be in the same compartments. The compartments. They cannot make a short-circuit, being raised above the porcelain slabs, and if raised to a high temperature cannot cause a fire within the box itself.—J. C. B.

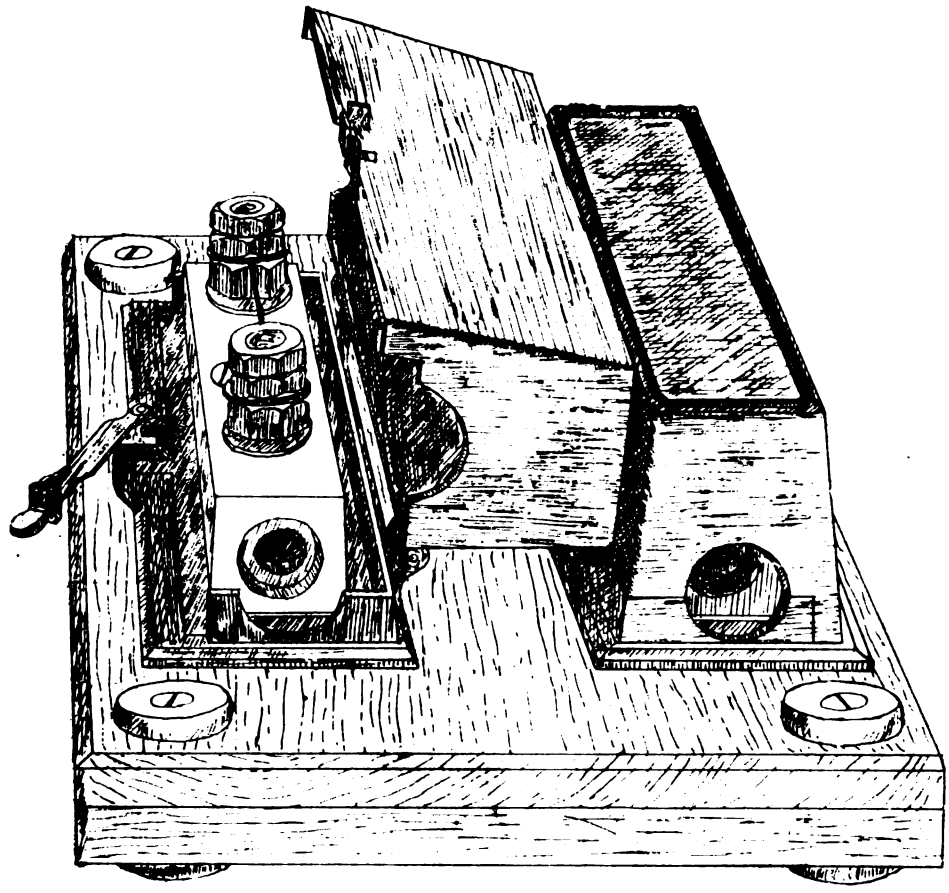

FIG. 1.

Answer to No. 80 (*awarded* 7*s.* 6*d.*).—Every fuse or cut-out used for the protection of the street mains from the effects of a short-circuit on a consumer's premises should embody the following requirements: certainty of action,

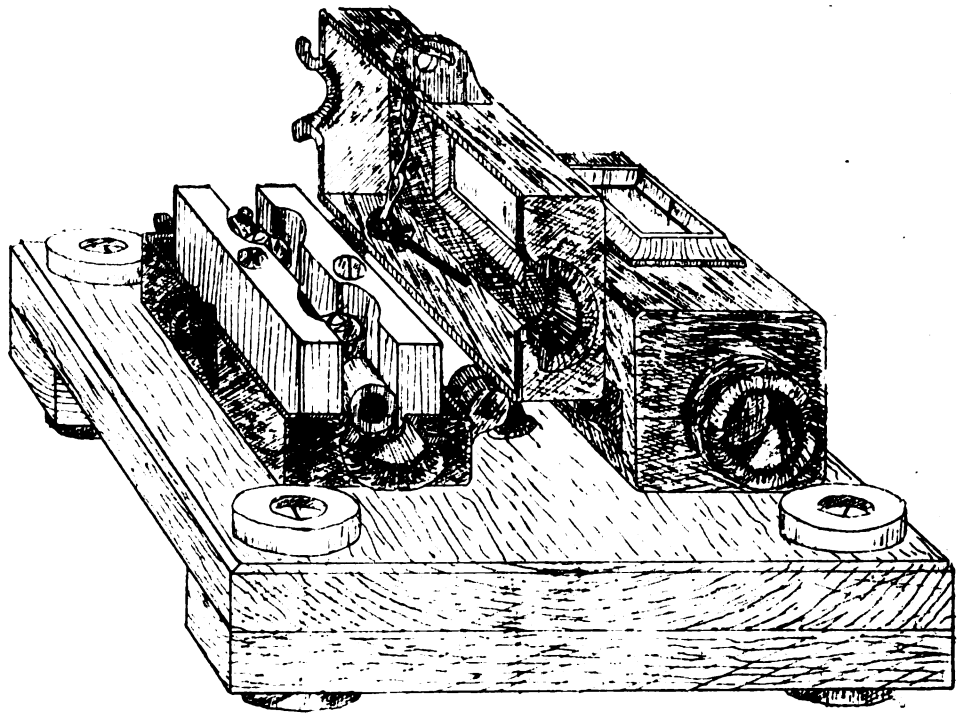

FIG. 2.

fuse block answering best to these conditions is what is termed a double-pole cut-out in watertight cast-iron box. One of these arrangements is shown in the sketch (Fig. 4), the cover and one of the fusible strips being removed, and it will be seen that the fuse blocks are in separate safety in use, durability, high insulation, impossibility for arcing from wire to wire, cheapness, protection from improper use, impossibility for short-circuit to be caused through careless handling of tools, protection from surface moisture, protection to both service wires. As

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the question evidently does not refer to cut-outs of the magnetic type, only those of the fusible type will be considered. To ensure certainty of action the distance between the fuse binding posts should be considerable; even in the smallest sizes this should never be less than 1in. If the distance is small the heavier metal work exercises a cooling effect upon the fuse wire, thus greatly altering the current density at which it should break. None but pure tin fuse wire should be employed, and of a size suitable for carrying 50 per cent. more current than the rated capacity of the wire it protects Tin has a very low melting point, is not easily oxidisable unless repeatedly heated and cooled, and when it melts it does not fly about in the form of molten globules. If the wire be weighted at its centre—as in the Cockburn fuse—all evil effects of oxidation will be overcome.

Safety in use will be attained by screening all metal carrying current in such a way that shocks may not be received. The whole should be mounted in an incombustible case, iron for preference. The fuse should be of some metal which does not melt explosively, and one which has a comparatively low melting point. Durability will be obtained by enclosing the fuse completely in some case which is not easily broken and which is fireproof. In all cases high insulation is necessary, especially where high voltage is employed, otherwise waste of current, failure of lights, etc., will ensue.

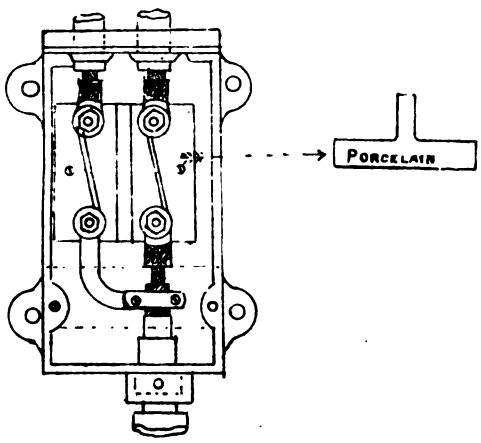

FIG. 3.

As what are known as double-pole fuses are almost universally employed for the purpose under consideration, it is necessary that provision be made to prevent the possibility of an arc forming from pole to pole when the fuse "blows." If the cut-out or fuse be mounted in an iron case, it is necessary that the two fuses for the two service wires be mounted in separate cases and insulated from each other. It often happens, especially on motor circuits, that where the two fuses are mounted in separate compartments of the same iron box, that when the fuses blow an arc is established from pole to pole by means of the iron case, and in this way the cut-out aggravates an evil which it was introduced to prevent.

To keep down capital expenditure and distribution expenses, it is necessary that the fuse or cut-out, whilst being thoroughly good and clean, must also be cheap. To prevent improper usage, an efficient means for sealing the cut-out should be provided. Perhaps the best method is to prevent the withdrawal of the releasing catch, or bolt, nut, etc., by passing a strand of wire through a hole drilled at a suitable point of the catch, and sealing by means of a lead seal the projecting ends of the wire. The seal would, of course, bear a device decided upon by the supply authorities. It should be impossible to short-circuit the supply mains through the accidental or careless handling of workmen's tools. This end may be attained by sinking the current-carrying metal below the surface of the porcelain insulating base, as in Fig. 2, by interposing a bridge or web of slate or porcelain between the terminals of opposite polarity, as in Fig. 3, or, best of all, by so arranging the cut-out cases that when one cut-out or fuse is being manipulated the other is automatically locked close, as in Figs. 1 and 2. Provision should be made for the protection of bare cable and fittings from surface moisture. This may be by means of rubber sleeves and stuffing boxes, or by partly filling the cases with insulating compound. It is necessary that provision should be made for protecting both service wires by means of fuses or cut-outs. This may be done by using one double-pole fuse or by using two single-pole cut-outs. Figs. 1, 2, and 3 embody the above essentials. Fig. 1 would be used for house connection work of an ordinary kind. Fig. 2 would be used for damp places or where high insulation was necessary. This type is fitted with nozzle-shaped ends for the reception of rubber sleeves, which effectually protect the cables and fittings, where exposed, from surface moisture. Fig. 3 is a house connection and fuse box for concentric cables, and is intended to be buried in the ground. It may be partially filled with compound and is provided with stuffing boxes. It is closed with a watertight cover and buried direct in the ground. In Figs. 1 and 2 it will be noticed that the cases of the cut-outs in each instance open inwards, so that the opening of one case automatically locks the other, thus entirely precluding the chance of a short-circuit at the fuse blocks consequent upon careless handling of tools. When used for a three-wire system, a third cut-out is introduced having its lid hinged at the top. This third case is placed between the other two, but with its upper edge a couple of inches higher up the mounting board than the lower edges of the other two. In this way it is possible to have but one case open at the same instant, the open case locking the other two. Figs. 1 and 2 are Reason cut-outs, Fig. 1 being the Brighton pattern. Fig. 3 is Reid's house connection and fuse box as used by Messrs. Callender and Co.

F. STOTT.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

The fifteenth ordinary general meeting of the shareholders of the Edison and Swan United Electric Light Company, Limited, was held on the 29th ult. at Cannon-street Hotel, E.C., Mr. James Staats Forbes (chairman of the Company) presiding.

The **Chairman** said that the details of their business were of a character which they did not care to make public, because competitors learnt too much. The business was expanding and the profits were increasing, and for the first time a 6 per cent. dividend had been reached. They had taken the Altrincham Electric Supply shares at the time of their fusion with the Manchester Company. That promised to be a paying concern. They could not afford to rely on the lamp alone. When it was a monopoly, and when they got any reasonable price for it, it was a very good thing, but their very existence now depended as much on auxiliaries as on the lamp itself.

The adoption of the report and accounts was agreed to after a brief discussion.

A dividend resolution, declaring 7 per cent. on the "A" shares for the six months, making, with the interim dividend, 6 per cent. for the year, was also agreed to.

The retiring directors (Mr. Ernest Villiers and Major Flood-Page) were re-elected, Messrs. Welton, Jones, and Co. were reappointed auditors, and the meeting terminated with a vote of thanks to the chairman and directors.

CENTRAL LONDON RAILWAY.

The sixth ordinary general meeting of the shareholders of the Central London Railway Company was held on Wednesday last at the offices, 16, Great George-street, Westminster, S.W., Sir Henry Oakley (the chairman) presiding.

The **Chairman** said the shareholders now numbered 1,594, there having been an addition during the past half-year of 521. The progress of the works during the past six months had been very satisfactory. Commencing from Shepherd's Bush, the buildings, carriages, and, in fact, the whole machinery were well in hand, and neither there nor at any other point, except the City, had any difficulty been found to impede their progress. From Shepherd's Bush to the Post Office both the running tunnels and the station tunnels—which were larger and wider than the running tunnels—had been completed except at Davies-street, Oxford-street, where there was a diversion of a very large sewer to be made. The latter had practically been completed, and the work of constructing the railway at that point would be pressed forward. The greatest impediment to rapid progress had been at the Bank Station, where the immense number of gas, water, and other pipes rendered it imperatively necessary that at that point the work should be very carefully and safely done. They had achieved the removal of three enormous gas-mains, which were practically the source of supply for the

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North of London. These had been safely housed in a subway specially built for the purpose below the public subway. The station tunnels could not be commenced until that serious part of the work was done, but they were now in hand. The five shafts to enable the public to reach the stations were progressing, and some of the heavier portions of the machinery would be delivered shortly. The carriages had been contracted for in this country, and the first carriage would be ready for inspection in a very short time. The lifts were also in hand. One trial had been made experimentally at the Notting Hill Station, and the lift worked very satisfactorily. Probably at the end of June next year they would see their undertaking at work. The contractors—the Electric Traction Company—were keeping up to their work, and the Company was still in their debt to the amount of £248,000. The expectation of getting that and some other money would, he hoped, be an incentive to them to push on with their work. Six pounds per share had now been paid upon the whole share capital, and the Company was in a position to issue their debenture stock. He then proposed "That the report and accounts as now submitted be received and adopted, and that the payment of interest at the rate of 3 per cent. per annum on the paid-up capital of the Company be and the same is hereby approved."

Lord Rathmore seconded the motion, which was carried unanimously.

At an extraordinary general meeting which was subsequently held the **Chairman** moved the following resolution: "That the directors be and they are hereby empowered to create and issue debenture stock amounting to £900,000, authorised by the Central London Railway Acts, 1891 and 1892, to be created and issued by the Company, and which debenture stock shall pay a fixed and perpetual interest of 4 per cent. per annum, payable half-yearly on Jan. 15 and July 15 in each year."

Mr. Henry Tennant seconded the resolution, which was carried unanimously.

A vote of thanks to Sir Henry Oakley and to the directors terminated the proceedings.

CHATHAM, ROCHESTER, AND DISTRICT ELECTRIC LIGHTING COMPANY.

The annual general meeting of this Company was held at the Sun Hotel last week, Mr. H. Jasper presiding.

The report of the directors and the accounts were taken as read.

The **Chairman** said: Mr. M. H. Hurrell having resigned his position as managing director, we have appointed Messrs. Geipel and Lange, of 68, Victoria-street, Westminster, as consulting engineers. Mr. W. Geipel was 15 years with the Brush Electrical Engineering Company, and acted for several years as their superintending engineer. With regard to the price of 5d. per unit, they hoped to further reduce the price as the use of electricity extended. Extensions of the mains in the following districts—viz., Railway-street, Chatham Maidstone-road, Ordnance-terrace, Albany-terrace, and Luton-road; also Castle-hill, St. Margaret's-street, Borstal-road, Watts's-avenue, King Edward-road, Rochester, Maidstone-road, and High-street, Strood—were contemplated. To meet the increasing demands orders had been placed for extending the present generating plant with leading makers of this class of machinery, and with a view to increasing the capacity of the present boiler plant the directors had decided to adopt mechanical stokers. One of the boilers had been already so fitted, with the result that, in addition to producing more steam, they were able to use a cheaper class of fuel with a resulting economy. Other improvements were being adopted, all tending to reduce the coal bill, as well as to improve the general reliability of the plant. It was satisfactory to know that the improved services resulting from the new arrangements in their staff were already effecting a steady and growing increase in the number of customers.

The report and accounts were adopted.

The retiring directors, Messrs. J. S. Benton and W. J. Mackey, were re-elected; also the auditors, Messrs. Butts and Watson.

DUBLIN UNITED TRAMWAYS COMPANY, LIMITED.

The fourth ordinary meeting of the shareholders of the Dublin United Tramways Company (1896), Limited, was held on July 26, in the Imperial Hotel, Sackville-street, Dublin. Mr. Wm. Carte, chairman, presided.

The report stated the receipts amount to £23,365. 13s., derived from the profits of the Dublin United Tramways Company and the Dublin Southern District Tramway Company, making with the balance brought from last half-year £24,288. 11s. 6d. at credit of net revenue account. Deducting mortgage debenture interest and directors' fees, a sum of £22,409. 2s. 4d. will remain available for division. Out of this sum the directors have declared a dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 4 per cent. per annum on the ordinary shares, leaving a balance of £400. 5s. 2d.

The **Chairman**, in moving the adoption of the report and accounts, said that they had completed the electric equipment of the Clontarf line, which was opened for traffic by electric traction to Nelson's Pillar on March 20; the Haddington-road line, which was opened on July 12, and the North Quay lines was expected to be open in a week or two, when the fares would be reduced. Besides the foregoing, they had all but completed the construction of the new line from Rathmines to the sea, and were now engaged upon its electric equipment. The electric equipment of the North Circular-road line was in progress. A large capital expenditure was going on in carrying out all these works, as well as in relaying some of the older lines with new girder rails, and in constructing the central power station on Ringsend-road. Up to the present time the greater part of the expenditure had not been producing any return, and some time must yet elapse before the full results of the capital outlay were available. As each line was opened for electric traction they anticipated a material increase in the revenue. The lines which could be worked by the plant of the existing stations at Clontarf and Ballsbridge were necessarily limited by the power at those stations. In addition to the tramways which they were originally designed to work, they expected to be able to operate from those stations the North Quays and the North Circular-road lines, the line from Rathmines to the sea, and perhaps the Donnybrook line. The general system of tramways throughout the city and suburbs, however, could not be worked electrically till the new station at Ringsend was completed, and by that time they hoped to have the electrical equipment also of the remaining lines completed, so that all could be opened simultaneously and worked from the new station at a very much reduced cost. Mr. Parshall had assured them that with the special advantages of water supply and coal handling, which the site on the edge of the Ringsend Docks afforded, they could expect to produce electric current at less than half what it cost at the existing stations. An important advantage in connection with this central station was that they would be able to work the Dublin Southern line from it at a considerable saving in the cost of generating the electric current. The receipts on the Clontarf line fully realised their expectations, and the figures showed the great value of electric traction in much increased earnings and decreased cost of working. Owing to the transition state of the Company's system of traction, comparison between this year and last was not of much practical value, but during the half-year they worked the Dublin United cars (horse and electric) 13,723,442 passengers had been carried, which was an increase of 1,334,826 compared with the corresponding period of 1897, the increase being chiefly in the Clontarf electric section. The decrease of £800 on the Dublin Southern (Dalkey) line was largely attributable to the very low rate of speed (a maximum of eight miles an hour) imposed by the Act of 1893, which authorised the introduction of electricity on the Southern District Company's lines, and which rate of speed, owing to the watchfulness of the Dublin, Wicklow, and Wexford Railway Company they were not allowed to exceed. Parliament, however, had just approved of the Bill promoted by the Company repealing the clause limiting the speed to eight miles an hour, and empowering the Board of Trade to fix the rate. He quoted the following return of traffic on the Clontarf line from March 21 to June 30, showing the increase of traffic on the introduction of electricity: 1897, horse—receipts, £4,934; passengers, 697,928; average fare, 1·71d. 1898, electricity—receipts, £6,775; passengers, 1,246,020; average fare, 1·30d. The figures for the first 24 days of the present month are still more remarkable, being: 1897, horse—receipts, £1,492; passengers, 204,639; average fare, 1·75d. 1898, electricity—receipts, £2,621; passengers, 390,944; average fare, 1·27d.

The resolution was adopted, and the dividends recommended in the report were declared.

The meeting was then made special, when resolutions were passed approving of a series of alterations in the articles of association necessary to bring them into conformity with the rules of the London Stock Exchange.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The half-yearly general meeting of this Company was held on July 29 at Winchester House.

Mr. Francis A. Bevan presided, and said that the report (published in our last issue) was one of the best that they had had. The financial result of the half-year was that, after paying the preference stock in full up to date, they had left to carry forward the sum of £17,580. He hoped that the deferred shareholders would feel in good spirits, because if the Company could maintain anything like that increase during the next six months the prospect of a dividend on the deferred shares was certainly nearer.

The report was adopted after some discussion, in which the action of the Board in regard to the charging of the repairs to revenue was adversely criticised.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

The report of the directors of this Company states, according to the *Financial Times*, that the gross receipts for the half-year ended June 30 last amount to £67,247, and the working and general expenses and renewals to £49,461, leaving a net balance of £17,786, which the directors propose to appropriate as follows: interest on 4 per cent. mortgage debenture stock, etc., £2,189; dividend at the rate of 6 per cent. per annum for the half-year, £11,000; balance to leased premises redemption fund, £250; to contingencies, £2,520; electrical renewals, £1,000; permanent-way renewals, £827. The receipts from the tramways department show an increase of £6,906, and those of the carriage department an increase of £732. The total number of passengers carried in the half-year was 10,680,379. Reference is made in the report to the agreement arrived at between the Company and the Corporation whereby electric

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traction will shortly be substituted for horse power on the existing lines and extensions in the city of Bristol, and it is expected that the change will have been completed in two years. A call of £2. 10s. per share on the £5 paid shares is to be made, payable on Oct. 1, and the balance will probably be called up next January.

CHILI TELEPHONE COMPANY.

The directors, in their report to March 31 last, state that the aggregate number of subscribers at all centres at the end of the year was 4,463, as compared with 4,407 at the beginning, or a gain of 56 for the year. The gross revenue from all sources was 609,384dol., against 610,717dol. in the previous year. The expenditure in Chili was 373,049dol., against 373,009dol., and the net income 236,334dol., against 237,707dol. The average rate of exchange for the year was 17·52d., as compared with 17·47d. in the previous year. The balance to the credit of the revenue account, including £1,020 brought from the previous year, is £12,779, of which £4,051 has been carried to reserve for depreciation and renewals. The directors recommend the payment of a dividend of 4s. per share, less income tax, being at the rate of 4 per cent. per annum, absorbing £8,506, and leaving a balance of £220 to be carried forward.—*Financial News.*

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

An extraordinary general meeting of this Company will be held on Thursday next for the purpose of confirming special resolutions referring to increase of capital and for the purpose of ratifying the agreement with the London Platino Telegraph Company, Limited. Several alterations in the articles of association will also be brought forward, providing for the appointment of directors of the Western and Brazilian Telegraph Company upon the Board of the Company.

An extraordinary general meeting of the Western and Brazilian Telegraph Company, Limited, has also been convened for the same day for a similar purpose.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Melbourne (Victoria).—The Town Council invite tenders for a supply of arc lamp carbons. Particulars may be obtained of, and tenders addressed to, the Town Clerk by Aug. 16.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns Tenders by Aug. 10.

Tiflis (Russia).—Tenders are invited by the Municipal Authorities, from whom particulars may be obtained, for the electric lighting of the central part of the town. Tenders by Aug. 1/13.

Wimbledon.—The Urban District Council are prepared to receive tenders for the supply, delivery, and erection of pipework, for particulars of which refer to our advertisement columns. Tenders by 5 p.m. on Aug. 29.

Barking Town.—Tenders for electricity supply meters, main cut-outs, columns, and free wiring must reach the Clerk to the Council not later than 5 p.m. on Wednesday, Aug. 10, instead of Aug. 3, as previously advertised.

Southampton.—The Town Council are about to advertise for tenders for the right of advertising on the present cars—or electric cars—and on the 'buses for a period of three years from Sept. 29 next, subject to certain conditions.

Hendon.—The Managers of the Central London Sick Asylum District invite tenders for supplying the necessary plant and for installing the electric light at their new asylum, Hendon, Middlesex. Further particulars appear in our advertising columns. Tenders by Aug. 15.

Ashton-under-Lyne.—The Electricity Committee are prepared to receive offers from persons desirous of entering into arrangements for the wiring of premises within the borough on any system of deferred payment, for particulars of which refer to our advertisement columns.

Kingston-upon-Hull.—The Electric Lighting Committee of the Hull Corporation are prepared to receive tenders for the supply and erection of certain plant in connection with their electric lighting works, for particulars of which refer to our advertisement columns. Tenders by noon on Aug. 25.

London.—Tenders are invited by the Vestry for the erection of a new battery-room, boiler-house, and extension of offices at the electric light station, Coronet-street, Shoreditch. Specifications, etc., can be obtained and the drawings can be seen on and after Aug. 2 at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders, endorsed, by Aug. 15.

Pemberton (Lancs.).—Tenders are invited by the Urban District Council for suitable schemes for carrying out the electric lighting in their district. Schemes must be sent to Mr. Paul Partington, clerk, before Aug. 14. They should be accompanied by explanatory details, and must be such as will satisfy the requirements and comply with the regulations of the Board of Trade. Information as to the area and population of the district and other essential particulars may be obtained on application to the Clerk.

London, E.C.—The East Indian Railway Company invite tenders for the supply and delivery of electric overhead travelling cranes and a steam electric power plant, as per specifications to be seen at the offices, Nicholas-lane, London, E.C., on payment of £1. 1s. for each specification. Tenders are to be sent to Mr. A. P. Dunstan, secretary, marked "Tender for Travelling Cranes," or as the case may be, by 1 p.m. on 17th inst. The company reserve to itself the right to divide the order, also to decline any tender without assigning a reason.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1 000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Rochdale.—The Corporation invite tenders for the following plant: Specification No. 2: (Section A) boilers, fittings, etc.; (B) economisers; (C) condensing plant; (D) feed pumps, tanks, etc.; (E) steam and exhaust pipes; (F) travelling cranes; (Specification No. 3) switchboards; (4) accumulators; (5) cables. Specifications, forms of tender, and conditions of contract may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 12, Delahay-street, Westminster, on payment of £3. 3s. for each specification, which sum will be returned on receipt of a bona fide tender. Tenders (endorsed "Electricity Works") must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by noon on Sept. 6.

Ball's Bridge.—Tenders are invited by the Pembroke Township Commissioners for the erection of buildings and foundations in connection with the township electric lighting works designed by the Board's consulting engineer, Mr. Robert Hammond, M.I.E.E., 64, Victoria-street, London, S.W., and according to plans, specifications, and conditions which may be examined at the Commissioners' Office, Town Hall, Ball's Bridge, county Dublin, during office hours, and bill of quantities with form of tender can be obtained on payment of £1, which will be refunded on receipt of a bona fide tender. The buildings to be completed within seven months from date of acceptance of tender. Approved security will be required. Tenders, enclosed in sealed envelopes and marked "Tender for Buildings," and addressed to the Chairman of the Board, must be delivered at the office of Mr. J. C. Manly, secretary, Town Hall, Ball's Bridge, co. Dublin, by 16th inst.

RESULTS OF TENDERS.

Barrow.—The County Council have recommended that the offer of the Brush Electrical Engineering Company, Limited, be accepted for two 25-kw. transformers at the price of £829, including one set of switch gear for the generating station and Abbey sub-station.

Wolverhampton.—The Lighting Committee have recommended that the tender of Messrs. Callender's Construction and Cable Company, Limited, for the supply and laying of mains, at an estimated cost of £898. 12s. 1d., and also that the tender of Messrs. Wilcock and Co., amounting to £379 for the construction of a new sub-station adjoining the Exchange Hall, be accepted.

Kingston.—Eleven tenders have been received by the Lighting Committee for the supply of coal for the electric lighting works, and the committee ordered three trucks from Messrs. Purnell and Son for testing, the price quoted being 10s. 3d. for Hartley rough small, or 11s. for screened peas. The tender of Mr. W. Youldon, jun., at 1s. 5d. a ton for carting the coal was also accepted. The coal mentioned above was found to be unsuitable for the electric works, and the committee ordered a sample barge from Messrs. Brentnal and Cleland at 11s. 6d. per ton, a contract to be entered into with the firm if the sample proved satisfactory.

London.—The London School Board have received the following tenders for supplying a duplicate plant for the electric lighting of the "Shaftesbury" training ship:

Drake and Gorham	£1,369
L. C. Tate	1,360
Laing, Wharton, and Down, Limited	1,312
H. F. Joel and Co. and T. Potter and Sons United, Limited*	1,130

*Recommended for acceptance.

London.—The Metropolitan Asylums Board have received the following tenders for supply of boilers in connection with proposed electric light installation at the Northern Hospital:

R. Taylor and Sons, Marsden, Yorks (accepted)	£725
E. Danks and Co., Limited, Oldbury Boiler Works, near Birmingham	725
Davey, Paxman, and Co., Limited, Colchester	780
Tinkers, Limited, Hyde, near Manchestar	800
Fraser and Fraser, Limited, Bromley-by-Bow, E.	827
J. Thompson, Ettingshall, Wolverhampton	870
Hawksley, Wild, and Co., Sheffield	900

Consulting engineer's revised estimate (including the cost of certain mechanical stokers, tenders for which are still under consideration) was £1,000.

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London.—The following tenders have been received for supply of dynamos and engines, etc., for proposed electric lighting installation at the Northern Hospital, for the Metropolitan Asylums Board:

Dynamos and engines.

E. Scott and Mountain, Limited, Newcastle	£1,995
Clarke, Chapman, and Co., Limited, Gateshead	1,778
T. Parker, Limited, Wolverhampton	1,891 1,651
Easton, Anderson, and Goolden, Limited, Erith	1,802
P. R. Jackson and Co., Limited, Salford, Manchester	1,816 2,145 1,955
India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, E.	*1,705 1,605 1,890
Crompton and Co., Limited, Chelmsford	1,742 1,877
Mather and Platt, Limited, Salford	1,743 1,748
Siemens Bros. and Co., Limited, Queen Anne's-gate, S.W.	1,680 1,780 2 100
Johnson and Phillips, Old Charlton, Kent	1,560 1,640 1,750
Electric Construction Company, Limited, Bushbury, Wolverhampton	1,913 1,804 2,307 2,090
J. H. Holmes and Co., Newcastle-on-Tyne	1,890 1,740 2,075 2,230

Spare armature.

E. Scott and Mountain, Limited	110
Clarke, Chapman, and Co., Limited	110
T. Parker, Limited	96 72
Easton, Anderson, and Goolden, Limited	96
P. R. Jackson and Co., Limited	120 135 135
India Rubber, Gutta Percha, and Telegraph Works Company, Limited	*71 60 71
Crompton and Co., Limited	81 90
Mather and Platt, Limited	87 87
Siemens Bros. and Co., Limited	82 87 82
Johnson and Phillips	69 69 79
Electric Construction Company, Limited	95 90 95 95
J. H. Holmes and Co.	116 100 116 112

* Accepted. Consulting engineer's revised estimate, £1,900. Where two or more prices are quoted they are alternative tenders for machines of different types.

BUSINESS NOTES.

South Shields.—The Town Council have decided to borrow £20,000 for additional electric lighting plant.

Lancaster.—Two new mains are to be laid. The engineer's pupil has been appointed dynamo assistant, his term being completed.

Walthamstow.—At its last meeting the District Council agreed to apply to the Local Government Board for a loan of £41,000 for electric lighting.

Tunbridge Wells.—The Local Government Board have ordered an enquiry, on the Council's application, for sanction to borrow £15,000 for electric light purposes.

Dukinfield.—The employés at the Tudor Accumulator Company's electrical works have struck against a reduction of wages on the introduction of improved machinery.

Kingston.—The Lighting Committee have resolved to charge 3d. per unit for day load current to motors, on arrangements being made satisfactory to the borough electrical engineer.

Annual Outing.—On Saturday last the employés of Messrs. J. S. Cunnington and Co. had their annual outing. Hastings was the place selected, and a most enjoyable time was spent.

Aberdeen.—At the meeting of the Town Council on the 1st inst. it was intimated that Royal assent had now been given to the Bill empowering the Council to purchase the tramway system.

Westminster Electric Supply Corporation, Limited.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 10 per cent. per annum, payable Sept. 1 next.

Personal.—Mr. Charles E. C. Shawfield has been appointed borough electrical engineer to Wolverhampton.—Mr. J. A. Bell, of Blackpool, has been appointed electrical engineer at Aberdeen.

Poplar.—At a special meeting of the Board of Works a resolution to the effect that the contractors for the dust destructor be requested to immediately put into working order the destructor works was carried.

Cox Thermo-Electric Company, Limited.—A compulsory winding-up order has been made against this Company, leave being given to apply to discharge the order by persons interested in obtaining a compromise.

Bilston.—The District Council have decided to fix the seal of the Council to an agreement appertaining to the provision of electric lighting throughout the town by the Midland Electric Power Distribution Company.

Douglas.—Prof. Fleming has presented a report with regard to the lighting of Douglas by electricity to the Corporation. The report is in favour of such lighting by the Corporation. The estimated cost is about £30,000.

British Insulated Wire Company, Limited.—The directors have decided to pay an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the half-year ending June 30. The dividend will be paid on Aug. 12.

Cannock.—The National Telephone Company having decided to extend their system to Cannock and Hednesford, they were granted permission by the Urban District Council last week to erect poles where necessary in the district.

Bournemouth and Poole Electricity Supply Company.—The directors have announced payment of the dividend upon the preference shares at the rate of 4½ per cent. per annum for the six months ended June 30, payable on 15th inst.

Southwark.—The Vestry have resolved to inform the County Council that they are in favour of by-laws being framed for regulating or even prohibiting flash-light advertisements, so far as they constitute a source of danger to the Metropolis.

Laundry Exhibition.—The sixth annual laundry exhibition, which will be held at the Royal Agricultural Hall, Islington, from Monday, Aug. 22, to Saturday, Sept. 3, will contain a large number of novelties, and will show a distinct advance in laundry engineering.

Manchester.—The Corporation have passed a resolution to the effect that in their opinion it is undesirable that the telephone service of the city and neighbourhood should exist as a monopoly in private traders' hands, and have appointed a committee to enquire into and report on the matter.

Transfer of Business.—We are informed that Messrs. J. Carter, Sons, and Co., engineers, machinists, general tool makers, etc., of Salford, have purchased the business of the late Mr. Edwin J. Oxley, which has been conducted for 78 years in Port-street, Manchester. The business will be continued under Mr. Oxley's name.

Barnsley.—The electric lighting question has been raised in the Town Council by a report of the Park and Lighting Committee that the Board of Trade had approved the system for the supply of electrical energy for the purposes of the Barnsley Electric Lighting Order, 1890, and of other necessary arrangements connected with it.

Monte Video Telephone Company, Limited.—An extraordinary general meeting of the shareholders has been called for Aug. 10 for the purpose of considering resolutions reducing the capital of the company from £220,000 to £160,000, and giving effect to the terms of the proposed rearrangement of capital recently approved by the shareholders.

Stoke.—The Rural District Council having received notice from the Potteries Electrical Traction Company of their intention to apply for a provisional order to supply electrical energy for public and private purposes within the Council's district, have decided to join other local authorities in opposing the company's application if found to be necessary.

South Staffordshire Mines Drainage Commission.—Further details and sketches of the suggested sites for electric pumps and the gravity works connected with them have been prepared, and it is proposed to proceed with the gravity works as far as practicable at once, and the surveys and levels are already taken for several such extensions of surface works.

Chester.—The Town Council have decided to request Mr. R. A. Yerburgh, the member for the city, and Mr. H. J. Tollemache, the member for Eddisbury, to oppose the General Power Distributing Company's Bill in Parliament. In making the proposition, the Mayor remarked that it was very important that local authorities should have command of their own districts.

Charing Cross and Strand.—The provisional orders granted to the Charing Cross and Strand Electricity Supply Corporation, Limited, by the Board of Trade enabling this corporation to supply electric energy in that part of the St. Giles's and Holborn districts lying to the south of New Oxford-street and High Holborn respectively, has now been confirmed by Parliament, and only awaits the Royal assent to become law.

Bournemouth.—The Town Council have accepted tenders for carrying out a scheme for lighting the lower pleasure gardens, pier, and winter gardens by electricity, and decided to hold a special meeting to consider the advisability of applying for

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a provisional order empowering the Corporation to adopt a scheme for lighting the town generally by electricity.

Halifax.—The tramways are now in full operation, the section from Commercial street to the Horton-street railway station having been opened on Wednesday. Trams now run from King Cross to the station, and from Highroad Well to the station. It appears probable that the Rochdale Corporation will convert their steam tramway system into an electric system like Halifax.

Boness.—At a meeting of the Harbour and Dock Commissioners the engineers reported that the electric lighting contract would not be finished before the middle of August, instead of at the end of July, as anticipated. The engineers were asked to press the contractors to have the light made available at as early a date as possible, so as to supersede the lighting of the dock and harbour again with gas.

Sutton Coldfield.—The Town Council have decided that a provisional order for electric lighting should be applied for, and also to support the Association of Municipal Corporations in their opposition to the second reading of the General Power Distributing Company's Bill for supplying electricity in an area within a radius of 26 miles from Warsop, in the county of Nottingham, without the consent of the local authorities.

The Vatican.—From Jan. 1 next the Vatican will be lighted throughout by electricity. Preparations for the installation have already been commenced. The motor power will be supplied by water flowing at a quick rate of speed from Lake Bracciano, which lies high up in the mountains 20 miles north of Rome. The Pope is displaying great interest in the work, and seldom neglects to make a personal inspection of its daily progress.

Appointments Vacant.—The Electricity Committee of the borough of Ashton-under-Lyne are prepared to receive applications for the appointment of borough electrical engineer.—For the winter session an electrical engineering draughtsman and designer is required by the Northampton Institute, Clerkenwell, E.C., to take charge of design classes in electrical engineering and instrument making. Particulars of these vacancies appear in another column.

St. George's, Hanover-square.—At a meeting of the Vestry held yesterday, a report was received from the delegates who attended a conference of representatives of the London County Council and of London local authorities at the County Hall, Spring-gardens, on June 14, in the matter of the telephone service and generating stations for the supply of electricity in bulk. The delegates reported that they cordially agreed with the resolutions passed at that conference.

Leeds.—At a quarterly and special meeting of the Leeds City Council on Wednesday, the following resolution was passed: "That the Corporation, in pursuance of Section 59 of the Leeds Electric Supply Order, 1891, do give notice in writing to the Yorkshire House-to-House Electricity Company, Limited (being the undertakers for the purposes of the said order), requiring them forthwith to sell to the Corporation their undertaking upon the terms contained in Sub-section 1 of the said Section 59."

West Bromwich.—The General Purposes Committee have reported to the Town Council that having fully considered the question of municipalising the tramways, they resolved that it is desirable that the Corporation should acquire such portion of the undertaking of the South Staffordshire Tramways Company as lies within the area of the municipal borough, and when the proper time arrives all necessary steps should be taken by the Council, under Section 43 of the Tramways Act, 1870, to give effect to this resolution.

Macroom.—The Town Commissioners at their last meeting signed a contract for lighting the town by electricity with Messrs. Thierman and Co., electrical engineers and contractors, Manchester. Mr. Walterlake, of Manchester and Dublin, consulting engineer to the Board of Control, and Mr. Michael Purcell, solicitor acting for the contractor, attended. It is expected that the lighting of the town will be an accomplished fact by Oct. 1 next. The plans and specifications in connection with the work have been prepared by Mr. Walterlake.

Beccles.—A special meeting of the Town Council was held last week to receive the report of the Public Lighting Committee recommending an agreement with the gas company for the public lighting for the ensuing year, and also the employment of Mr. Medhurst to report on the electric lighting of the borough. It was pointed out that the Council had already decided that the town was insufficiently lighted, and incandescent lighting having failed, it was highly desirable to obtain proper advice before embarking on electric lighting. After some discussion, the recommendation of the committee was adopted.

Woolwich.—The Woolwich District Electric Light Company, Limited, are about to make large extensions of the electric light mains in Woolwich, and they have asked the Board of Works whether the latter were prepared to consider the question of using the electric light for some portion of the street-lighting, in which case the company would be very glad to go into the question and make out a scheme for that purpose and estimate of the cost. The letter continued that it would be possible at a very small extra expenditure to light the streets very much more thoroughly than at present, and the necessary mains for this work would be laid at the same time as laying the other mains in the district. The letter has been referred to the Highway and Works Committee.

Lynn.—The Mayor, in moving the adoption of the minutes of the whole hall in committee at a special meeting of the Town Council, said he had ventured to put a question to Prof. Robinson. There was a great stir in the lighting world just now, as everyone knew, and seeing that acetylene gas was very much more brilliant than the electric light itself, and that another mantle was about to be put on the market, he asked whether there was any probability in the near future of electric lighting companies introducing some kind of incandescent light that would be equal to any of those other lights that had been introduced. Prof. Robinson replied that as far as the electric lighting professors were concerned they already had before them some very important considerations and he believed they would quite surpass any other light that might be introduced. The minutes were adopted.

Lowestoft.—The Town Council have received notice that the sanction of the Board of Trade to the provisional electric lighting order has been given, and that nothing now remains but for the Town Council to proceed as they may be advised by their engineer, Mr. Hawtayne. A short time since a letter was received from a motorcar company, and, should the Council proceed with the electric lighting works, the probability is that before long a change may be effected in the means of communication between the various parts of the town. Owners of yachts now have to go to Yarmouth or Norwich to get their accumulators stored, which could be done at Lowestoft. One of the first things to be done, in all probability, would be the lighting of the esplanade. The Corporation have many applications from electric lighting companies, who are anxious to secure the rights and privileges given by the order, should the Council not undertake the work themselves.

Stock Exchange.—The Stock Exchange Committee has appointed Aug. 18 a special settling day for Central London Railway—further issue of 12,356 ordinary shares of £10 each fully paid, 49,124 ordinary shares of £10 each £6 paid, 1,779 preferred half-shares of £5 each £1 paid, and 3,767 deferred half-shares of £5 each fully paid; and City of London Electric Lighting Company, Limited—10,000 ordinary shares of £10 each fully paid, Nos. 90,001 to 100,000, in lieu of the provisional certificates now quoted. Applications have been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to, the Eastern Telegraph Company, Limited—provisional certificates for £500,000 3½ per cent. preference stock, and the Electric Construction Company, Limited—8,657 7 per cent. cumulative preference shares of £2 each fully paid, Nos. 16,344 to 25,000. During the week the business in electric shares was on a very small scale.

Cardiff.—The Corporation have decided to reduce the price of electricity from the 1st inst. The following table shows how the new tariff compares with the old:

Average daily use.	Old tariff.	New tariff.
One hour	6d. per unit	6d. per unit.
Two hours	6d. per unit	4½d. per unit.
Three hours.....	5·16d. per unit	4d. per unit.
Four hours	4·75d. per unit	3⅔d. per unit.

At the last meeting of the Lighting Committee a long discussion ensued upon the motion to accept tenders for a new 500-h.p. steam alternator for use at the electric lighting works. It was proposed that the tender sent by Messrs. Easton, Anderson, and Goolden, of Erith (£3,179), should be accepted, but an amendment that Messrs. Ferranti's tender (£3,250) be accepted was carried by the casting vote of the chairman.

Glasgow.—At a meeting of the sub-committee of the Electricity Committee of the Corporation last week, a report by Mr. Chamen, electrical engineer, was submitted in regard to the charges proposed to be made for the supply of electricity. The sub-committee recommended (1) that all consumers for the current year should have the option of continuing the demand indicator system or adopting a new method of paying 4s. 6d. per annum for each 8-c.p. lamp, and 2d. per unit, in addition to the fixed charge, for each unit consumed as recorded on his meter; (2) that the initial charge under the demand indicator system should remain at 6d. per unit for the first hour, and 2½d. per hour thereafter to 100-volt consumers (instead of 3d.), and 2d. per hour thereafter to 200-volt consumers (instead of 2½d.); (3) that the fixed charge under the proposed new method should be 4s. 6d. per lamp per annum, but the consumers who use the current for more than seven hours per day should have the charge of 4s. 6d. per lamp rebated.

Ealing.—At the last meeting of the Council a discussion took place with regard to the coal supply to the electric lighting works. It was contended that there would be a saving of 25 per cent. if a particular coal were obtained from the firm who supplied the St. James's electric lighting works. The Chairman said he understood the electrical engineer had declared against that particular coal. A vote was taken on the question whether the coal tenders should be referred back to a special meeting of the Works Committee, and the proposal was defeated by a large majority. The Vice-Chairman said that would not prevent the Council from ordering a sample of the particular coal. The Surveyor asked for authority to order 150 tons so as to give it a fair trial. Mr. Griffin said it was very doubtful whether the furnaces would deal with the special coal, and that question should be carefully considered before any order was given. It was agreed that the matter should be referred to the Electric Lighting Committee for enquiry and report. Some of the members of the Council are to visit the Shoreditch dust destruction and electric lighting works.

Durham.—At the quarterly meeting of the County Council the Earl of Ravensworth, commenting on a proposal to introduce electric light into some of the wards at the Sedgefield Asylum at a cost of £1,678, asked whether it was desirable to introduce the electric light into a lunatic asylum. He very much doubted whether it was. What was to become of the eyesight of the poor people in the asylum if the light was used? The Chairman said a portion of the building was already lighted by electricity, and it was intended to further extend it subsequently. The committee

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found themselves in the position that they would have to spend a large sum in practically remodelling the gasworks at the asylum, and, under the advice of Dr. Smith, they considered the question of the electric light both economically and from the point of view of health. They came to the conclusion that economically it would be best, and they were of opinion that for health reasons it would be best, because in these places the amount of fresh air was an important element, and if they were not burning it up with innumerable gaslights they would get a better supply for the patients.

Stourbridge.—At the monthly meeting of the Urban District Council the Consulting Committee reported that they had had under consideration the notice under the Electric Lighting Act, 1882, given by the Midland Electric Corporation for Power Distribution, Limited, of their intention to apply for a provisional order to supply electric light and power in the urban district. The committee were informed that two similar notices had been served by other companies. The committee recommended that the Council apply to the Board of Trade forthwith for a provisional order to enable them to supply electric light and power in the urban district, and that the Council oppose any applications for similar powers from outside corporations. It was stated that the application for powers by the Council would involve more expense than the application not proceeded with last year, apart from the cost of opposing the applications of other bodies for similar powers. After a discussion, the recommendation of the committee was adopted. On the recommendation of the Railway Committee, it was resolved to grant the British Electric Traction Company, Limited, permission to erect poles in connection with the conversion of the existing tramline to electric traction.

Cheltenham.—The special committee of the Town Council appointed to consider the various applications received for permission to construct and work a light railway in the town, and on to Cleve and Winchcombe, presented their report to the Town Council at its monthly meeting on the 2nd inst. Having regard to the proceedings in this matter last year, and the abortive result of them, through no fault of Mr. Nevins, the committee consider they can do no less than give him the preference in considering the several applications before them at the present time. Mr. Nevins in his letter proposes to adopt the agreement and arrangements come to last year prior to the hearing before the Light Railway Commissioners. The committee propose to adopt the provisional order and clauses for insertion therein as settled last year, and that a copy thereof be sent to Mr. Nevins for his approval, subject to the several alterations in additions to the route then agreed on. The committee consider that whoever constructs an electric tramway should take the power from the electric lighting station of the Corporation, and that the pitching or paving in the borough which the promoter has to lay down and maintain should be either of Australian or other hardwood blocks, or of the MacDougall bricks, as the Corporation may determine. The report was carried, subjection to the omission of one route.

Accidents.—On August 1, while an electric car, with trail carriage attached, was being drawn up Temple-hill, Dublin, the trolley slipped and caught a span wire, the trolley brake causing the cars to stop. Both cars were full of passengers, but fortunately none of them were hurt. The disabled car was pushed back to the depôt at Blackrock, where another car was obtained and attached to the tramcar, which then proceeded to Dalkey. No further inconvenience than a short delay was caused by the mishap.—On Sunday afternoon, at the junction of Roundbay-road, Chapeltown-road, and North street, Leeds, one of the overhead wires in connection with the electric tram system snapped, and the traffic was stopped for three-quarters of an hour. The dissevered wires emitted brilliant flashes for some time, but no one sustained injury. Mr. Burbridge, the electrical engineer, was sent for, and the fractured wire was quickly repaired, so that traffic could be resumed, but men were at work during the night making the wires more secure.—During the height of the wind on Tuesday night the large telephone cable which stretches along the valley from Crookes Valley-road above the dams to Crookesmoor, was blown down and snapped, the broken end dropping into the dam. The cable formed a barrier across the road somewhat embarrassing to those passing in vehicles in the early morning. The *Sheffield Daily Telegraph* says it is to be hoped there was no active current passing through the water to destroy the swarms of fish which tenant it and are so rigidly preserved.

Isle of Man.—The new line of electric tramway between Laxey and Ramsey, in the Isle of Man, was opened on the 2nd inst. by the Lieutenant-Governor of the island (Lord Henniker). From the report in the *Yorkshire Post* we learn that the first car conveyed a distinguished company from Douglas to Ramsey, a distance of 18 miles in one hour and a quarter. At Ramsey Mr. J. M. Cruickshank, the high bailiff, welcomed the governor and the tramway directors. Mr. A. Bruce (chairman of the company) asked his Excellency to declare the line open, and Lord Henniker, in performing the ceremony, predicted that the line would greatly benefit the island. He was afterwards entertained to luncheon by the townspeople of Ramsey. The tramway is an extension of the system which has, for several years, been in operation between Douglas and Laxey. The extension is 10¼ miles long, and as the Douglas-Laxey line has a length of seven miles, the whole tramway covers a distance of nearly 18 miles. This does not include the four-mile branch line from Laxey to the summit of Snaefell. The new line opens out some fine and little known coast scenery. It is the property of the Isle of Man Tramways and Electric Power Company, Limited, but it is a separate undertaking from the Douglas-Laxey line, with a separate body of shareholders. It has been constructed and equipped by the company, under the superintendence of Mr. J. Aldworth, the company's general manager. Mr. W. Knowles, C.E., is the engineer. The line is a double one, and the gauge is 3ft. The overhead wire and trolley system of traction has been adopted. During the holiday season the service of trams will probably be half-hourly.

Barrow.—The Lamps Sub-Committee had asked the Lighting Committee to give the lowest price they would be prepared to accept for a complete scheme of 42 lamps or for an experimental scheme of eight lamps, including one in Michaelson-road between the high-level bridge and the Burlington Hotel, and one opposite the entrance to the Central Railway Station. The Borough Electrical Engineer reported on the matter, and recommended that three alternative offers be made to the Highways and Lighting Committee. The committee then resolved that the three alternative offers recommended by the borough electrical engineer be made to the Highways and Lighting Committee, and that they be informed that if the cost price to the committee should be found at the end of 12 months to be less than that estimated in the report of the electrical engineer, the committee will not charge more than such cost price. The Borough Engineer reported to the last meeting of the City Council that the bricks for the electric light station delivered on to the ground by the contractor were of inferior quality to those specified, and it was resolved to recommend that the contractor be permitted to use Huncoat bricks for the chimney, the contractor allowing the sum of £10 on account of the difference in price between such bricks and those specified in the contract. It was further resolved that the borough electrical engineer be authorised to purchase a length of conduit (about 1,500 or 1,600 yards) sufficient to provide for an installation of 21 arc lamps for street lighting, for use in case the Highways and Lighting Committee decide to have some of the streets lighted by electricity. After discussion, the City Council adopted the above minutes at their last meeting.

Bradford.—The use of electricity as a means for the propulsion of tramcars for practical purposes was formally introduced in Bradford on the 29th ult. The *Leeds Mercury* says some years ago the system was the subject of experiment in connection with the steep gradients in Cheapside and Otley-road, but steam power was utilised in that connection. In extending the tramway service, under the auspices and management of the Bradford Corporation, however, installations of electricity on the overhead principle have been made, and it was in the opening of one or two new lines that the system was entered upon last Friday. The line extends from the General Post Office to Bolton, a distance of some two miles, and it touches Peel Park about midway. As the result of the traffic facilities, building operations will be encouraged, for the land along the route offers very eligible sites for residential property. The construction of the line and accessory features is upon the most approved principles, and the equipment generally complete in its effectiveness, adequate to all traffic demands, and affording comfort in travelling which is bound to be highly appreciated in a district which has been somewhat neglected up to the present time. At the outset a 15 minutes' service has been organised. The line was officially inspected by Sir Francis Marindin, of the Board of Trade, on Friday morning, and was pronounced satisfactory. Alderman Joseph Cowgill, chairman of the Tramways Committee, formally opened the line in the afternoon, the party of members of the City Council and others being conveyed to the outer terminus and back in two cars. They were entertained to luncheon by Mr. J. Virr, ex-councillor, at Bolton, and subsequently dined at the Bradford Town Hall. The other branch of electrical tramways—not yet complete—will serve Horton, and will be calculated to develop the district in very appreciable degree. The regular service on the Bolton-road line was started on the 2nd inst. The takings on the 30th and 31st ult. were £37. 6s. and £36. 14s. 6d. respectively.

St. James's, Westminster.—At a meeting of the Vestry held yesterday a committee recommended that some by-law should be made for the regulation generally of "search" or "flash" light advertisements, and that the London County Council should be informed of the advertising lights which at present exist in the parish. The minutes of the Works Committee stated, amongst other matters, that the committee have further considered the letter from the National Telephone Company, stating that serious inconvenience has been caused to a large number of their subscribers through an interruption in the telephone service owing to the fire which occurred in Heddon-street; that they are experiencing considerable difficulty in replacing the wires overhead; and submitting, for the favourable consideration of the Vestry, a scheme for placing the wires underground, by which it is proposed to lay mains and run wires to distributing stations in a large number of streets in the parish in accordance with plan submitted (referred back by the Vestry to consider proposal of company to pay a rent for the privilege); that they have ascertained that the company are prepared to enter into an agreement to pay the sum of 5s. per annum for every separate exchange subscriber's line whose premises are situated within the parish, and have been informed by the metropolitan superintendent and district manager, who attended the committee, that there are about 360 subscribers in the parish, and recommending that, subject to the company submitting an amended plan and application, in accordance with the suggestion made to the company's representatives by the committee, omitting the condition contained in their present application relating to further extensions, and agreeing to pay the sum of 7s. 6d. in lieu of 5s. for each separate exchange subscriber's line, the Vestry do consent to the said application so far as they lawfully can, on condition that a

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proper agreement, to be prepared by the Vestry's solicitors at the company's expense, embodying these and the usual conditions, is entered into. Also that the attention of the committee has been called to the desirability of erecting a ventilating shaft on the electric lighting station, Carnaby-street, for the purpose of preventing the nuisance from smells arising from the sewer in that thoroughfare, and having obtained the consent of the electric light company for the said shaft to be fixed on their premises, they recommend that the lowest tender received—viz., that of Mr. C. J. Smith, to provide and fix a 6in. by 4in. strong galvanised cast-iron ventilating pipe, with all necessary bends and offsets, etc., on the wall on the south side of Carnaby-court, for the sum of £10. 15s.—be accepted. Also that no objection be offered to the St. James's and Pall Mall Electric Light Company proceeding with the laying of mains and constructing street boxes, in accordance with the various notices given, subject to the usual conditions.

Leeds.—The Tramways Sub-Committee and the Highways Committee of the Corporation have recommended the City Council to accept the tender of Messrs. Dick, Kerr, and Co. for the supply of 50 cars, the price being £468. 10s. per car. Delivery has to take place within seven months from now; 12 of the cars, in fact, must be ready in four months. Messrs. Clayton and Co.'s was the tender selected as far as boilers are concerned. Four boilers will be needed. The amount of the tender is £3,415. These also have to be delivered in four months' time. They will be fixed at the generating station, which will be enlarged accordingly. Which of the new routes chosen for electric tram service will be first taken in hand has not yet been settled. The probability is that Headingley and Hunslet will be dealt with together. Operations in Dewsbury-road are likely to be delayed a little on account of street and bridge work which is necessary before the tramlines can be properly laid. At the last meeting of the City Council, Mr. Smithson said that the receipts from tramways during June were £10,202, as compared with £5,929 in June of last year, an increase of 72 per cent., a very satisfactory result. The return of payments was unsatisfactory, because it did not really give them the true cost of maintenance for the month, mixing up as it did cash payments of the month with the credit payments of the previous month. The gross profits were £12,865, and the interest and sinking fund charges amounted to £12,521, leaving a surplus profit of £343, as against a profit for the previous year of £5,999. That was largely accounted for by additional interest and sinking fund charges on increased capital expenditure. This became more serious when they compared the present account with that for the half-year ended Sept. 29 last, which showed a profit of £3,650. As the surplus profit was now reduced to £343, it followed that the working of the tramways during the past six months had entailed a loss of £3,306 He had on previous occasions criticised freely the adoption of electrical traction, but he did not wish to attribute the loss he had referred to to the introduction of electrical traction. What he would like to impress on the Council was the importance of exercising considerable care and caution. Their capital charges were largely increasing. They had made considerable extensions of electrical traction, and that would involve in years to come a largely increased expenditure on interest and capital account. It was only possible by economy of capital and expenditure to make their electric tramways pay. The loss of £3,306 which they had had in the last six months was diametrically opposed to the estimate supplied to them when they were discussing the advisability of extending electrical traction. That estimate contemplated the possibility of an allowance of 7½ per cent. for depreciation. In the accounts for the last six months of electrical traction, working partly half and partly full power, the total charges against the account for depreciation on electrical extension account were only £787, or less than ½ per cent. on the capital expenditure on the overhead line from Roundhay to Kirkstall. If the full 7½ per cent. estimated had been debited against this account, the half-year's working would have resulted in a deficit larger by a few thousand pounds than that actually shown.

Blackpool.—Saturday witnessed the formal opening of the new tramroad between Blackpool and Fleetwood. The *Manchester Guardian* gives the following report: "The Board of Trade sanctioned the use of the road two or three weeks ago, and the next day the cars began to run, but the official opening was deferred until Saturday last. A special saloon car, containing the directors of the company, representatives of the contractors and electrical engineers, and of the two municipalities of Blackpool and Fleetwood, left the Blackpool terminus, Dickson-road, soon after two o'clock, and ran to the end of the line at Fleetwood. On the way the visitors had the opportunity of seeing the generating station and accumulator houses. The day was exceptionally fine, so that at times the resources of the company were heavily taxed to meet the public demand for seats. It is obvious that the car service between the two towns meets the public taste. The cars are open at each side. Running very smoothly they cover the 9½ miles of road in half an hour with ease. Lytham, St. Annes, Blackpool, and Fleetwood are now united by a capital system of tramways. From Lytham to South Shore the motive force is gas. Then from South Shore to the North Shore the cars are drawn by the electric conduit system. The new company have adopted the overhead trolley system. The work of constructing the tramway was begun and ended in 12 months. Within the borough of Blackpool, and again on entering the Fleetwood bounds, the rails are laid in the usual tramway style, but in the open country the work has been done on the light railway system. When in the precincts of either town the car speed must not exceed eight miles an hour, but in the open a speed of 20 miles is reached. Each car has accommodation for 48 passengers. It is recorded that one of the cars yesterday week carried no less than a thousand passengers, inclusive of in and out journeys. On Saturday the reserved car left Fleetwood at 5.10, and reached the Imperial Hydro Hotel at 5.35, having occupied only 25 minutes. In the evening the directors entertained a number of guests at dinner at the Imperial Hotel. Mr. G. Richardson (chairman of the company) presided. Among those present were Mr. James Ward (ex-mayor of Blackpool), Mr. R. C. Ward (chairman of the Fleetwood Urban Council), Mr. A. Bennie, Mr. G. Readman, Mr. R. B. Barningham, Mr. C. Hopkinson, Mr. John Greenwood, Mr. J. E. Prestwich, Mr. R. H Prestwich, Mr. T. S. Turnbull (solicitor to the company), Dr. Hopkinson (consulting electrical engineer to the company), Mr. A. Haworth (chairman of the Salford Corporation Electrical Committee), Mr. James Brodie (chairman of the Blackpool Electric Light and Tramways Committee) Mr. T. Loftus (town clerk of Blackpool), Dr. Kingsbury, Mr. J. Tildsley (Fleetwood), Mr. John Cameron (secretary and manager), and others. After dinner three toasts were proposed—'The Queen,' 'Success to the Undertaking,' and 'The Corporation of Blackpool and the District Council of Fleetwood.' The loyal toast was, of course, given from the chair. Mr. A. Bennie submitted the second toast, and in so doing congratulated the company on the successful completion of their work. He regarded the new roadway as adding to the attractions of Blackpool in a marked degree, and as affording a very agreeable outlet for the crowds who go there in quest of health or pleasure. At the same time it helped to open up Fleetwood, and would be beneficial to the residents in that town."

PROVISIONAL PATENTS, 1898.

JULY 25.

16135. Improvements in electrical heating apparatus, also applicable for use as electrical resistances. Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, Strand, London.

16155. Improvements in the globes of electric incandescent and similar lamps and lamp shades or chimneys. English Industrials, Limited, and George Edward Heyl-Dia, 55, Market-street, Manchester. (Complete specification.)

16164. Improvements in telephone exchange systems. Daniel Sinclair and William Aitken, Oxford-court, Cannon-street, London.

16172. A voltaic battery cell with hot-air depolarisation. Henri de Rufz de Lavison, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JULY 26.

16245. A new or improved electric sounding device. John Patrick Buckley and William Augustus Croffut, 55, Market-street, Manchester. (Complete specification.)

16257. Improvements in starting switches and regulators for electric motors. Joseph Richardson Garner, 2, Garner-street, Clayton, near Manchester.

16263. Improvements in and connected with the laying of electric cables. Arthur Cleaver, 78, Fleet-street, London.

16267. Electric communicator for use as a means of communication between passengers and guards or drivers of trains. George Armstrong, 1, Kendal-street, Carlisle.

16282. Improvements in bends or connections for the rails of electric railways. George Adam Weber, 45, Southampton-buildings, Chancery lane, London. (Complete specification.)

16291. Improvements in alternating-current transformers. Léon Marie Joseph Clément Levasseur, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

16299. An alternating-current transformer for induction coils. Max Kohl, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 27.

16351. Improvements in or connected with dynamo-electric machines. James Marr, 3, St. Nicholas'-buildings, Newcastle-on-Tyne.

16352. Improvements in or connected with incandescent electric lamps. William Hardie Macfadyen and James Ferguson, 3, St. Nicholas'-building, Newcastle-on-Tyne.

16376. Electromagnetic bearing for shafts subjected to end thrust. Ellen Naomi Stoney and Archibald Sharp, 47, Victoria-street, Westminster, London.

16385. Improvements in electrical fire alarms. Herman Ansgarius Olsson, 1, Church-court, Old Jewry, London.

16396. Improvements in and appertaining to the working of incandescence electric lamps. Donald MacLagan, 73, Stephen's-road, Upton Park, London.

JULY 28.

16460. An improved automatic device specially applicable to three-wire or balanced systems of electric distribution generally. Veritys, Limited, and Louis John Steele, Plume Works, Aston, Birmingham.

16464. Improvements in the construction of electrodes for secondary batteries. Alfred Henneton, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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16469. Improvements in the manufacture of electric telegraph and telephone cables. Llewellyn Traherne Bassett Saunderson, 53, Chancery-lane, London.

16473. Improvements in gearing for electric motorcars. Georges Réne Blot, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

16485. Improvements in axles and steering gear for electric and other motor carriages. Henry William Headland, Henry William Headland, jun., James Thomas Robson, and Charles Henry Marsden, 77, Chancery-lane, London.

JULY 29.

16488 Improvements in the method of and apparatus for starting and controlling electric motors. Thomas Preece and John Alfred Edmondson, Kirkstall-road, Leeds.

16522. Improvements in electric arc lamps. Richard Hoope Cunningham, 321, High Holborn, London.

16552. Improvements in electric arc lamps. Hugo Bremer, 70, Chancery lane, London. (Complete specification.)

16553. Improvements in electric arc lamps. Hugo Bremer, 70, Chancery-lane, London. (Complete specification.)

16556. Improvements in galvanic batteries. Arthur Judson Benedict, 53, Chancery-lane, London. (Walter Scott Doe, United States.)

JULY 30.

16590. Improvements in and relating to secondary batteries and the like. Charles Levetus, 37, Vittoria-street, Birmingham.

16595. Improvements in electric heaters. Henry Lyon, 121, West George street, Glasgow.

16599. Improvements in and relating to electric tramways and railways. James Robson, 3, Devonshire-place, Selly Park, Worcestershire.

16602. Improvements in drums for holding electric cables and in covers to be used with such drums. Thomas Oxley, 15, St. Ann-street, Manchester. (Complete specification.)

16659. Electrolytic process for extracting metals from their halogen combinations. Dr. Emil Stilberg, 166, Fleet-street, London.

SPECIFICATIONS PUBLISHED.

1897.

16139. Method and apparatus for electrical signalling by means of split or divided currents more particularly applicable to cable transmission. Abel. (La Société Industrielle des Téléphones (constructions electriques, caoutchoucs cables)

17776. Wheels for mechanically-propelled carriages. Clubbe, Southey, and the Electric Motive Power Company, Limited.

17837. Apparatus for the electro-deposition of metals. Holloway.

18118. Plug switches or couplings for electric circuits. Marsh and Vandam.

18272. Manufacture by electrolysis of sheets or objects of polished metal. Dessolle.

18450. Cut-outs for electric lighting and other uses. Watson.

20583. Electric arc lamps. Brockie.

27385. Manufacture of electric incandescent lamps. Wierre. (Date applied for under International Convention, Sept. 25, 1897.

30347. Electrical arc lamps. Mors and Pottier. (Date applied for under International Convention, Nov. 3, 1897.)

1898.

2999. Transmitters of Morse telegraphic apparatus for continuous and alternating currents. Rossi and Forcieri.

3569. Electrical apparatus for indicating or recording at a distance the positions of an index hand or analogous movable object. Custodis.

4435. Electric signalling apparatus for use on railways. Davy.

4468. Conduits for wires carrying electric current. Howard and Sclater.

5062. Incandescent electric lamps. Thompson. Lister and Chamberlain.

6357. Electric motors for cars or other vehicles and brakes therefor. Thompson. (Von Zweigbergk.)

10270. Alternating-current induction motors. The British Thomson-Houston Company, Limited. (Steinmetz.)

10585. Electric resistances. Thompson. (The Chemische Elektrische Fabrik "Prometheus" Gesellschaft mit beschrankter Haftung.)

11438. Electrical furnaces. Siemens Bros. and Co., Limited. (Siemens und Halske Actien Gesellschaft.)

12019. Manufacture of active material for accumulator batteries. Tobler and Graeber.

12241. Multiplex and duplex printing telegraph. Silbermann.

12321. Electric batteries. Edwards. (Emanuel).

12351. Portable telegraphic apparatus. Siemens Bros. and Co., Limited, and Ebel.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended July 31 were £1,733, as compared with £1,555 in same week of 1897, being an increase of £178.

Birmingham Tramways.—The traffic receipts for the week ending July 30 were £3,888. 15s. 8d., as compared with £3 736. 14s. 10d. for same week in 1897 being an increase of £152. 0s. 10d.

Dover Tramways.—The traffic receipts for the week ending July 30 were £204. 19s. 5d. The total receipts for the year 1898 are £4,039. 0s. 3d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending July 29 were £3,021. 1s. 3d., compared with £2,752. 19s. 5d. for same period of last year, being an increase of £268. 1s. 10d.

South Staffordshire Tramways.—The traffic returns for the week ending July 29 were £644. 9s. 2d., as compared with £645. 11s. 1d. in same week of 1897. The aggregate receipts for the year are £18,390 13s. 0d., as against £18,683. 10s. 4d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended July 31 were £994, compared with £851 for same week of 1897, being an increase of £143. The total receipts for the half-year amount to £4,757, compared with £4,517 for the same period last year, being an increase of £240.

Dublin S.D. Tramways.—The traffic receipts for the week ending July 29 were £1,070. 5s. 9d., as compared with £792 9s. 4d. in the corresponding week in the previous year, being an increase of £277. 16s. 5d. The number of passengers carried was 149,223 in 1898 and 112 795 in 1897. The aggregate returns for the half-year are £4 332. 1s. 0d., as compared with £3,441. 5s. 11d. last year, being an increase of £890. 15s. 1d. The mileage open is 9 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	£	10½
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	16½-17
—— 6 p.c. Cm. Pf., 30,001-40,000 (1s. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9¾-10½
——	6	5¾ 6½
—— Pref. Half-Shares	1	1¼-1¾
—— " "	5	4¼-4¾
Charing Cross and Strand	5	12½-13½
—— 4½ per cent. Cum. Pref.	5	5¾ 6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	25½-26½
—— Prov. Cert. 90,001-100,000	5	25½-26½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	0	67-70 xd
—— Ordinary	3	2¾-3¼
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½ 15½ xd
—— " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— " " "	6	9½-10½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	89 94
Crystal Palace District, Ordinary 5 per cent. Stock	100	127-132
—— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	5	2¼-2⅝
—— 5 per cent. Debentures	5	4-6
—— 4 per cent. Deb. Stock, Red.	100	101-103
Elmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	4-5
Electric Construction, Limited	2	2¼-2⅜ xd
—— 7 per cent. Cumulative Pref.	2	3-3¼ xd
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅜ ⅝
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	21-22
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	112 117
House-to-House Company, Ordinary	5	9-10 xd
—— 7 per cent. Preference	5	9½-10½ xd
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5¾-6 xd
—— 6 per cent. Cum. First Pref.	10	15-17 xd
—— 6 per cent. Cum. Second Pref.	10	15-17 xd
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5⅝ xd
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-1¾
—— £5 Shares	5	7½ 7¾
—— £4½ shares	4	6-6½
Oriental Telephone and Electric Company	1½	⅝-¾
Royal Electrical Company of Montreal	—	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	2	3-3½
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½ xd
—— 7 per cent. Pref.	5	9-10 xd
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	38-39
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	117-122
Westminster Electric Supply, Ordinary	5	15¾-16½
Yorkshire House-to-House	5	8¼-8½

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NOTES.

Paris.—The electric lighting of Paris still rests on an insecure basis. The lengthy report of Mr. Charles Bos has been received by the Municipal Council, but the discussion on the same has been deferred for three months. The Council has not, it is reported, any time to consider electric lighting matters, so the present high price and lack of extensions on the part of the electric lighting companies will go on for a time.

Institution of Junior Engineers.—Liverpool is this year's centre of the summer excursion of the Institution of Junior Engineers, and during the present week the members have been paying visits to various works and places of interest in and around the city. The members reached Liverpool on Monday afternoon, and proceeded to the Adelphi Hotel, which are their headquarters during their stay in Liverpool.

An Open Tramcar in London.—A new tramcar has just been introduced for the short length of line between Rye-lane, Peckham, and Lordship-lane, Dulwich, where it is attracting much attention. It is a capital summer car, with open sides, and can be boarded at either side and at any point along either side. The cars are at present drawn by horses, but this type of electric car has found much favour on the Continent.

Women Tramway Conductors. — The *Electrical Review* of New York gives a picture of the seven lady conductors of the Chillicotte tramway. It seems from the description that there were 100 applicants for the seven posts, and that "personal attractiveness" was the subject of the competitive examination by which these candidates were reduced to seven. The result is a pleasing group of conductoresses, and a 30 per cent. increase in the gross takings of the tramcars. As they can marry the passengers the remaining 93 may have a chance.

Electricity on the Underground.—At the half-yearly meetings of both the District and Metropolitan Railways the respective chairmen referred to the experiments they are about to make with electric traction. Doubtless, as Mr. James Staats Forbes says, caution is necessary in selecting the final scheme and system of conductors, but we trust that "caution" is not another word for endless delay. Mr. Preece and Sir J. Wolfe Barry have held the commission of advising the joint companies for some time, and we trust that the preliminary work will soon be put in hand.

"Cassier's Magazine."—The August number of this magazine contains many items of interest to electrical men. The best is, perhaps, a good biographical sketch of Mr. W. H. Preece, C.B., President of the Institution of Civil Engineers, by Mr. J. W. Curra. No better man could be selected to write the biograraphy, as Mr. Curra is intimately connected with all Mr. Preece's work at the Post Office. The sketch is supplemented by a good steel engraving of Mr. Preece. An article on English high-speed engines by Mr. J. C. Peache is another item of interest, and the author describes fairly well all our leading types of electric lighting engines. Dr. Louis Bell also contributes an article on the use of electric motors in paper making.

Long-Distance Telephony.—The use of the inter-urban telephones in Great Britain is much hampered by the want of more trunk lines, and the consequent difficulties of getting the necessary connections often makes it cheaper to telegraph. The *Railway Gazette* is, however, responsible for the statement that this is not so between New York and Chicago, but that the telephone service between these two towns is so good that it has seriously affected the railway traffic between the two towns by the limited trains. One of the definite objects of these 25-hour trains between New York and Chicago was the accommodation of brokers and business men who demanded quick time. Their business can now be transacted over the telephone, conversations running to £3 and £4 for calls being not uncommon.

Cost of Provisional Orders.—The actual cost of a provisional order varies with the opposition met with in promoting the same. The following low figures of actual cost at Barking have been forwarded to us by Mr. W. C. C. Hawtayne, the consulting engineer to that town. They were extracted by the town clerk, Mr. Lister. The items are: Board of Trade fees, £50; advertising, £33; printing orders, etc., £45; and sundry expenses, £7. These make a total cost of £135, but we see no item as to the cost of the enquiry held before the order was granted. It will be remembered that the Gaslight and Coke Company, who have works there and are the largest ratepayers in the Barking district, opposed the granting of the order. Do any of our readers know of a provisional order costing less than the above?

A Long Electric Railway.— The Chicago and Milwaukee Electric Railway Company, which now connects Evanston and Waukegan, is, says the *Street Railway Journal*, being completed, and will soon be in operation. It will be about 40 miles in length, and will connect 15 towns, those of the most importance being Evanston, Highland Park, Fort Sheridan, Lake Forest, and Waukegan. The power station is at Fort Sheridan, on the line of the Chicago and North-Western Railroad. The company proposes to use the three-phase system of transmission, establishing sub-transformer stations at different points on the line. The road extends along the west shore of Lake Michigan, a well-populated section of the country, which contains the residences of many wealthy families. The road will carry a large pleasure traffic, although the business travel will be also quite an item, it is thought. F. O. Rusling, formerly manager of the Rochester Railroad Company, has recently been appointed general manager of this road.

Electromotive Behaviour of Cadmium Amalgams.—Mr. W. Jaeger's article in the *Ann. Phys. Chem.* on the behaviour of cadmium amalgams in batteries is abstracted as follows in the *Journal* of the Chemical Society: "As cadmium cells are employed in place of zinc cells as standards in E.M.F. measurements, it is of importance to ascertain in how far their behaviour depends on the composition of the cadmium amalgam they contain. Direct measurements show that amalgams containing from 5 to 15 per cent. of cadmium exercise the same influence on the E.M.F., as this is not found to vary within one-hundredth of a millivolt. Amalgams containing more than 15 per cent. of cadmium do not give constant results, the E.M.F. rising gradually to that given by cadmium alone. An amalgamated cadmium rod is at first found to give the value obtained for the weak amalgams, but in a short time the E.M.F. rises in the direction of that of pure cadmium. This is evidently due to the diffusion of the mercury into the cadmium.

A Municipal Multiphase Plant.—We understand that the Corporation of Manchester have lately placed a large order for three-phase machinery with Messrs. Thomas Richardson and Sons, of Hartlepool, and Messrs. Brown, Boveri, and Co., of Baden, Switzerland. The order comprises rotary converters of an aggregate capacity of 1,200 units with three-phase static transformers of the same

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output, and also the necessary high and low tension switchboard for the control and regulation of the above. This machinery is required for the supply of electrical energy from the municipal electric lighting station in Dickinson-street to various outlying urban districts. Continuous current will be taken from the omnibus bars of the central station switchboard and transformed by means of the rotary and static transformers to three-phase current at a tension of about 5,000 volts. This will be distributed by means of high-tension triple-conductor cables to the different sub-stations, where it will again be converted into continuous current and be distributed to the consumers on the three-wire system with 400 volts between the outers.

The Zipernowski-Deri Patent Case.—The Municipal Electrical Association held a meeting on Friday last at the Westminster Palace Hotel, under the presidency of Mr. A. H. Gibbings, of Bradford, to consider their course of procedure with reference to the action commenced against the London Electric Supply Corporation by Mr. Martin D. Rucker for an alleged infringement of the above patent for the alternate-current system of supply. Some 50 corporations and other bodies throughout the country are concerned, and it is understood that if the present test action is successful, proceedings will be taken against each of the other local authorities owning electric lighting undertakings. Representatives were present from Cardiff, Bristol, Exeter, Portsmouth, Cheltenham, Blackpool, Huddersfield, Bolton, Halifax, Brighton, South Shields, Kingston-on-Thames, Hampstead, etc. The proceedings were conducted in private, but we are officially informed that a resolution was passed agreeing to combine to assist the London Electric Supply Corporation in defending the action being taken by Mr. Rucker, and, if necessary, to carry the case to the House of Lords.

The Resistance of the Human Body.—Mr. Dubois, of Berne, presented a note to the Académie des Sciences on the duration of the variable period of current flow when a potential difference is applied to the human body. He used a condenser connected to a battery through the resistance to be compared, and then made the circuit for a very short period by the fall of a steel pencil against a mass of steel. In this way the circuit was broken before the steady state was reached, and by measuring the charge on the condenser one point of the curve of rising pressure could be obtained. From this and the fixed potential difference the period of variable flow of current can be obtained. From comparative experiments, the author concludes that the human body during the period of variable current presents a reactance much smaller than the ohmic resistance. In fact, its capacity partially annuls the resistance. The resistance, however, of the body during the period of variable current is constant. The resistance increases with the length of the parts of the body in circuit, and depends also on the surface of the electrodes. Finally, he concludes that the body acts as a condenser with a liquid dielectric, having a capacity equal to about 0·165 microfarad.

Electrical Work in Africa.—The columns of the *British and South African Export Gazette* show that plenty of orders are to be had for work in South Africa. Thus we learn that the following additional electric lighting plant is part of the public works to be undertaken by the Johannesburg Town Council: Two sets 300-kw. three-phase generators, direct coupled to compound condensing engines, £14,000; two direct-coupled exciters of 30 kw., £1,500; switchboards, instruments, etc., £1,000; special tip-up transformers, £2,400; transformers and spare coils, £3,000; poles, cables, meters, and sundries, £3,500; three motors for arc lamp machines, £750; also that the various tenders for the electric lighting installation at Port Elizabeth, estimated by the Board's London agents (Messrs. Davis and Soper) to involve an expenditure of above £91,000, are being considered hy the Electric Lighting Committee; and, finally, the Bill empowering a company to lay down an electric tram installation at Howick having passed its second reading in the Natal Legislative Assembly, tenders for the necessary material may be expected to be shortly called for. We also note that of machinery actually delivered, two English firms are responsible for a large proportion.

A Rival to Edison.—A Cardiff man has been pulling the leg of a reporter of the *Western Mail*. A report comes out, in consequence, with the headlines, "Progress in the Science of Man-Killing," "Terrible Invention by a Cardiff Man," "Wholesale Destruction Made Easy and Instantaneous." The inventor tells the reporter that he guarantees that "with the aid of his electric gun it is absolutely possible to blow up any man-of-war, any navy or fleet, and submarine mine or torpedo-boat, any fort, any magazine store, providing each contains sufficient explosive material of any kind to wreck itself, and that the whole are within 15 or 20 miles' range. It does not matter whether the armour is thick or thin, as that would not be any bar to the full effective working of the gun. The effect of the gun would be absolutely certain and instantaneous. The electric gun is without a shadow of a doubt the most destructive, most terrible, and most instantaneous weapon that could be used in any land or sea up-to-date warfare. The inventor explained that the gun deals destruction by firing electricity at the explosive material, and that the gun will be used every time with the absolute certainty of exploding the explosives. The inventor asks Lord Wolseley to provide facilities for a test." This is dreadful, and we wonder what the inventor had for supper before he dreamed his dream after having read up the Marconi literature.

Waterloo and City Railway.—This line, which was opened officially some weeks ago, was thrown open to the public on Monday last. So far it has met with extensive patronage, although it will be some weeks before the travelling public settle down to use this new convenience. We have made some trips by it, and find the running all that can be desired, except, perhaps, as regards speed. The time taken on an average journey is a little over the five minutes. It may not be generally known that the Board of Trade are responsible for the length of time taken over the journey. The reason is as follows: The tunnels are constructed so that the lowest part of the line is under the river, and the rise in each direction was intended to enable the trains to gain speed easily, and also to mount a grade as they approached the stations. In this way the maximum speed would be at the centre of the line. Unfortunately a sharp S-curve was required at the lowest points of each tunnel, and the Board of Trade at the inspection limited the speed on these to about 15 miles per hour. This completely alters the method of running, as the trains have to be braked before reaching the lowest point, and then after the curves have to climb the grades without any momentum to help them. Hence more power is required to maintain the slower schedule. We understand that about 16,000 people used the line last Monday and 23,000 on Tuesday, and from what we saw of the comfort of the carriages all would be satisfied, and agree that the new line merited support.

Colombo Electric Lighting.—*Indian Engineering* gives details of the new contract between the municipal authorities at Colombo and the electric lighting company. The street-lighting contract practically provides for the entire replacement of gas in the streets. Previously gas

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was obtained for this purpose at from 8s. to 9s. per 1,000 cubic feet; now some 30 10-ampere arc lamps and 1,800 incandescent lamps are to be fixed. The arc lamps will be charged for at the rate of 3d. per hour, or 6d. per Board of Trade unit. In the principal streets where arc lamps are not used the 12-c.p. gas lamp will be replaced by 60-c.p. incandescent electric lamps. These lamps will be lighted 2,400 hours per annum for 62s. 6d. per annum. It is further agreed that the firm shall supply private consumers at the rate of 6·9d. per Board of Trade unit, reducible to 6·25d. as soon as the monthly load (exclusive of Government or municipal lighting) reaches 15,000 units, with a further reduction to 5½d. when the monthly load reaches 20,000 units. It is computed from the above that with the same number of pillars for street lighting as at present the total candle power in the streets will be increased from 22,000 to 144,000, or, say, 6½ times. The lighting hours will also be increased by 60 per cent., while the cost is only increased from about £6,080 to about £6,500. This is a wonderful bargain for the inhabitants, and we trust that the electric light company will be able to make a profit at the figure obtained, in spite of the cost of coal at Colombo. We may add that the private consumer pays 11s. per 1,000 cubic feet for gas in Colombo.

Summer and Winter Cars.—One of the most crying necessities of the times in tramway work is a thoroughly sound, well built, and "practical" car that can be converted at five minutes' notice from an open car to a closed one, and *vice versâ*. To say nothing of the cost of duplicating motor equipment, and interest upon the waste investment involved in keeping open cars housed and completely out of service during six or seven months of the year, and closed cars partially out of service during the remaining months, the difficulties of providing suitable cars for all kinds of summer weather, or preventing annoyance to passengers in open cars during summer showers, have never been completely solved, certainly on a large scale. The *Street Railway Journal* considers that the method employed on some of the Californian roads and elsewhere in building cars part open and part closed, so that choice of accommodation is allowed the passenger, is only a partial solution of the problem, though it could be made in many places a good one. The St. Louis cars, with their cross seats and large windows, afford another partial solution presenting many advantages. But more than one car-builder, and perhaps more than half the street railway managers, are convinced that the types of cars in general use are by no means final or fully satisfactory, and that development may be expected along lines which will minimise the investment cost for equipment and provide the greatest possible convenience under all weather conditions to the passenger, who pays the nickel or does not pay it according to his estimate of the convenience or pleasure of riding.

Patent Lawsuits.—The fights in the law courts over patent rights have been most costly and unsatisfactory in the past. This is largely due to the fact that the judges have, as a rule, to be instructed fully in the technical details of the subject with which the patent in question deals, and even then, for want of first-hand knowledge, are much hampered in giving their decisions. The introduction of expert evidence brings in another item of cost without, perhaps, an equivalent return, and the judgment, when given, is too often the subject of appeal. Some think that the patent law itself wants revision, and that only valid patents should be granted. This would entail the American and German systems of officialdom by which the Patent Office staff is made to decide what is new and what is practicable. The cost of a patent is by this much increased, and many cases of want of correct knowledge, and, hence, of incorrect decisions, are on record. Our system of cheap patents is open to the poor man, and if his invention is a good one there is every chance of his obtaining financial aid to develop and fight for his rights. In such matters a good patent agent to draw up the specification and claims is invaluable, as faulty claims and often too general claims invalidate a patent. The best solution of the whole matter lies in our opinion in the appointment of one or more patent judges chosen from the ranks of the barristers noted for their technical learning, and who would not require to learn the whole subject *de novo* when a case was laid before them. Such a man as Sir Fletcher Moulton, Q.C., for instance, would as a judge save the contracting parties an enormous amount in fees from the fact that he is an expert first, hence could as a judge dispense with much of the expert witness's evidence.

Primary Battery Puffs.—Press notices of the New Electric Syndicate's system of electric lighting are now appearing in the country Press, so that all may be ready for a big flotation in the autumn. The last we have seen reads as follows: "Revolution in Electricity.—More than a common interest should attach to a new system of electric lighting, which is likely to bring about as complete a revolution in electricity as did the introduction of steam in locomotion some 70 years ago. The new generator consists merely of a series of cells, contained in a number of earthenware boxes, the elements being carbon and iron. From this it will be seen that all machinery, such as engines, dynamos, etc., will be completely done away with. The public will note with interest that the capital outlay will thus be completely reduced, while a great economy of space will be attained by this new system. The invention applies more particularly to shops and private residences both in town and country. The new generator claims three great innovations in electric lighting — namely, simplicity, safety, and automatic working. It also applies with equal force to motive power. The invention, which has been working for some time past, has been thoroughly tested by well-known experts, who approached it in a sceptical spirit, and whose reports bear witness to its practical usefulness in everyday life. More complete details of the new system will be brought to public notice at an early date." Unfortunately, these experts did not bring their sceptical spirit to bear on such everyday matters as the cost of the material employed, but accepted figures which make their report misleading. We regret that neither Prof. S. P. Thompson or Mr. Haydn T. Harrison care to correct their figures after we have called their attention to the error in question. We can only hope they will do so before the prospectus of the big company is issued to the public.

German Lightning Statistics.—The *Elektrotechnische Zeitschrift* recently gave an editorial *résumé* of a recent report by Kassner, giving statistics for Saxony and Anhalt for the 11 years ending 1897; the report is accompanied by a chart. The districts are indicated by the density of the buildings. It shows that in general the number of bolts of lightning which were observed is somewhat greater in the denser districts than in the more sparsely settled, but this is only approximately true; he also endeavoured to find how far the frequency of the bolts depends on the condition of the soil, and what the effect of water in the neighbourhood is. In general, the bolts are less frequent the greater the distance from running water, but it does not follow that there is greater danger nearer the water; in general the number of bolts increases with an increased extent of water. It may be considered as demonstrated that at

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least in that district the presence of forests has no apparent effect on the number of bolts. The number of bolts per square mile varies greatly in the different districts, from 1·2 to 10·4 (this apparently refers to the whole period of 11 years). Buildings on flat land are struck more frequently than those in a city. The number of bolts which produce ignition is greater on flat lands than in the cities. For 1,633 "cold" bolts on the flat land there were 458 which produced ignition, which is about 28 per cent., while in the cities the numbers were 464 and 60, or 12·9 per cent. The number of observed bolts in those 11 years has increased, it being 33·7 per cent. greater in the last five than in the first five years, the increase being greater on the flat lands; formerly the bolts which did not produce ignition increased more than those which did, but this relation is now reversed. Comparing the periods of five years with each other, the number of igniting bolts on the flat lands increased 45·7 per cent., and those which did not ignite 32·7 per cent., while in the cities these proportions are 42·9 per cent. and 25·5 per cent. The maximum number of bolts on one day was 99 and on another 96; the worst month was May, 1890, when there were 25 days on which there was lightning. The number of bolts per day on which there was lightning varies from one in December to 5·8 in June, the mean for the whole year being 4·3. The distribution over the different hours of the day is also shown. The above abstract is from Mr. Carl Hering's digest.

The Proper Ratio between Engine and Generator Capacities.—It is usual in selecting generators for direct coupling to steam engines to take the rated power of the engine, multiply it by three-fourths, and choose a generator with a capacity in kilowatts as nearly as possible approaching that figure. This practice is based on the simple reasoning that if the engine will generate a certain amount of power, the dynamo which it drives should be of a size to absorb that power. Sometimes a dynamo is chosen a little smaller, allowance being left for the internal losses. The following considerations are given by the *Electrical World* to show that this practice is not always correct: "Engines are, as a rule, rated at the power which they will generate at the most economical point of cut-off, this being but a small fraction of the stroke. For this reason they are capable of giving a far greater power when necessary, and this greater power may be demanded from them with, of course, decreased steam economy, continuously without any injury to the engine whatever. Dynamos, on the other hand, are rated, as a rule, on the output which they will give continuously without heating beyond a point endangering their insulation, or a margin of safety below that temperature. What ratio their most economical load bears to this rated load depends entirely on the design of the machine. It may be the same, it may be far less, and in some cases even more. For generating units used with steady loads, as with storage batteries or in large stations where the number can be varied to fit the load, the dynamo and its corresponding engine should certainly give their greatest economy at one and the same load, and the load should be maintained as near this point as possible. For units intended to carry highly fluctuating loads, as, for example, small railway or isolated plant elevator loads, the considerations involved are a little different. It is customary to run such units at an average load considerably below that at which they are rated in order that the fluctuations shall not rise much or any above the rated load, although this is hardly necessary with the improved commutation and ventilation of the latest machines. Such being the case it would probably be better to reduce the size of the engine to a rated output considerably below that of the dynamo, since the former is far more readily capable of carrying overloads without danger than is the latter. An increased economy of steam would be the result of such a change."

Cataphoresis.—Dr. William James Morton has written a book on "Cataphoresis, or Electric Medicamental Diffusion as Applied in Medicine, Surgery, and Dentistry," which is published in New York. The *Lancet* in reviewing this volume makes the following notes: "The action of electrical currents in promoting the passage of salts through animal membranes has long been established and some of the applications of this property to medical practice have also been long known. Dr. Morton confers a benefit upon the medical profession by giving us a book in which the subject is treated in a practical way, with descriptions of the apparatus, the methods and the formulæ which the author has found to be the best. He tells us that 'since 1853 the peculiar property of the electric current of driving medicines into living tissue has hung suspended in the air, so to speak, and has never been brought down to practical bearings in spite of continuous and ingenious effort on the part of numerous individual experimenters.' This book seems to meet the requirements of the case very well, for it gives a properly worked-out sketch of the history of cataphoresis and of the work done by previous investigators, and then goes at length into the practical details of the modern modes of application, to the working out of which Dr. Morton has largely contributed. The account of the experiments of Sir B. W. Richardson with solutions of aconite and chloroform for producing local anæsthesia and of the opposition which his work aroused are very interesting. We are told that Richardson was attacked so fiercely that he felt obliged to abandon his experiments. The production of local anæsthesia by cocaine introduced electrically through the unbroken skin is in some ways the more immediately interesting part of cataphoresis, and a considerable part of the book is devoted to its applications in surgery and in dentistry. The easy production of a small area of anæsthesia offers peculiar advantages in dental work. In the United States the use of cataphoresis by dentists seems to be gaining ground, and in this country also enquiries are being made into its value by dental surgeons. Dr. Morton states quite confidently that his methods can produce complete local anæsthesia in from four to eight minutes. The subject quite deserves to be taken up by those who are interested in it."

More Power from Niagara.—All who have seen Niagara itself, and even those who have only seen photographs of the gorge below the falls, must have been impressed by the stream of water falling over the cliff. These were outlets from the canals of the Niagara Falls Hydraulic Power and Manufacturing Company which distributed power through the township. This power was obtained from low falls in the canals leading water from above the great falls, but most of the potential energy in the water was wasted by discharging it over the cliff into the gorge. New works are being established below these cliffs, and the electrical energy is distributed through the town for general purposes. A vertical steel penstock, 11ft. diameter and 200ft. high, has been erected to receive the waters from the canal and to convey them to the turbine-house below. An available head of about 210ft. will be obtained. We gather from Mr. Orrin E. Dunlap's description in the *Electrical Engineer* of New York that one dynamo is already at work furnishing current for the operation of the National Electrolytic Company. Another will add to the supply of the Buffalo and Niagara Falls Electric Light and Power Company. The generator for the service of the first-named company has been

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installed by the General Electric Company. This machine has 14 poles, and will make 250 revolutions per minute. Its output will be 5,000 amperes at 175 volts, or a capacity of 875 kw.—nearly 1,200 h.p. A few words must be added with special details of the aluminium conductors used to convey the power to the works. From the power-house to the top of the bank these conductors are in bar form. The bars are 25ft. long, ½in. by 6in. in thickness and width, and four are placed in parallel. The bars are rivetted and bolted every 25ft., and they extend from the power-house to the top of the bank along the side of the big new penstock, the erection being on brackets. At the top of the bank they are connected to the aluminium cables. In diameter the aluminium part of the cables is about 1¼in., covered with rubber insulation, The size of the wire in the cables is about No. 10. The bars are connected to the cables by castings, which contain sockets, just holding the ends of the cables. These ends are placed in the sockets and melted tin is poured about them, making a solid permanent joint. The total amount of aluminium used in the installation is about 22,000lb. The same work in copper would call for about 48,000lb. The conductivity of aluminium as compared with copper in same section is 63 to 64 per cent., and more than double for the same weight.

Alternate Currents for Traction Work.—Messrs. C. H. Davis and H. C. Forbes contribute to the current number of the *Engineering Magazine* an article on the application of alternating currents to electric traction. These gentlemen are hard on alternate-current motors, but admit that the two-phase and three-phase "induction" motors to a certain extent offer improvements over direct-current motors. Thus they require less attention, they give less trouble from dirt, dust, or water, they have no commutator, they have no moving electrical contacts (except in special cases), there is less danger of burning out armatures, they require renewal of parts less frequently. The disadvantages in their use are summarised thus: They do not readily start with overloads, their speed cannot readily be controlled, their efficiency is lower. Moreover, the authors say, there are two other reasons against the present use of "induction" motors, which should have more or less weight, according to the conditions, but which cannot be charged against the motors themselves. They refer, first, to the effect on water pipes due to electrolytic action by currents returning in the ground from the rails to the power station. With the single-trolley alternating-current system, the injury to the pipes spreads over the whole area surrounding the tracks, while with the direct-current, by running the current from the generator into the trolley wire (trolley positive), and back through the track and ground returns, the deteriorating effect on the water pipes can be confined to a comparatively small area in the vicinity of the power station, where they can be easily watched and taken care of. Second, with the single-trolley system the effect of induction is likely to cause considerable trouble on the telephone lines. The use of a double-trolley system to overcome these difficulties would lead to other and greater disadvantages in construction and insulation, which would to-day be insurmountable. It seems, therefore, that the direct application of alternating-current motors to railway systems is not feasible to-day from a practical standpoint, mainly for the reason that we cannot satisfactorily control variations in speed. Irrespective of the motors, however, the alternating current can be used indirectly in operating railway lines. The authors write confidently that a double trolley presents difficulties which are insurmountable, but they must have done so from want of perusal of current literature. Messrs. Brown and Boveri, of Baden, have erected several three-phase tramway plants, using two wires overhead and a double trolley. Again, this firm have proved that for mountain railways three-phase motors have very many advantages. One of these is the almost invariability of the speed whereby the motors brake the trains on the down grades. Again, we should like to hear the authors' facts about the greater earth effects with alternate current, as we know of no records which show this.

Counter E.M.F. Methods of Car Motor Regulation.—Our New York namesake has devoted considerable space lately to counter E.M.F. methods of regulating car motors so as to avoid losses in resistances. One of the methods described is called the Henry regenerative system. For it shunt motors instead of series ones are used, and the regulation of the speed is effected by means of resistance in the field magnet circuit. Another system of control has been devised by Mr. Rudolph M. Hunter. This system requires no resistances, and controls the speed of the motors by delivering to them a current of constant potential, varying the current, and interposing a varying counter E.M.F. independent of the counter E.M.F. of the motor in advance of changes in the speed of the motor. This is done in such proportion that the sum of the counter E.M.F. of the motor and the independent E.M.F. shall bear such relation to the initial E.M.F. of the current at constant potential as will offer the requisite resistance to the current desired. Mr. Hunter's invention is claimed to be of great importance in the operation of large motorcars, locomotives, or trains where the motor elements may develop 1,000 h.p. or more. No regulators proper are placed on the passenger cars, but instead the forward part of the train is provided with what may be termed a "pilot" car, upon which are arranged the necessary controlling devices for simultaneously regulating the current to all the motors of the train. The regulator on the pilot car is a counter E.M.F. generator, whose counter E.M.F. is made greater or less to oppose the initial E.M.F. to a varying degree. This generator can be made of a small number of coils of large size and be rotated at a very high speed. The main current is then passed through the generator, thence through all of the field magnets of the motors, thence back to the pilot car and through one part of a reversing switch, thence back through the armatures of all the motors on the cars, and finally returned to the other terminal of the reversing switch on the pilot car and back into the line. The regulator consists of two parts, a counter E.M.F. generator and a hand-switch device for varying the counter E.M.F. at will. Both the arrangements seem to us to have flaws in them, and the faults are largely hidden by the language employed. In the first case, with the regulation of the fields conditions occur in which large currents are transmitted through the street motors when their fields are weak. Hence unlimited sparking at the commutator, which does not show on the paper scheme, but would in the repairs bill. The last method is somewhat vaguely described, but we gather that the counter E.M.F. is obtained by transformation. This may mean little waste of power, but to get a varied E.M.F. from a motor transformer the field magnets have to be varied in strength. Here, again, at starting the sparking troubles may occur unless heavy machines are used. In either case the starting power obtained by the series-parallel controller, coupled by its power of giving high speeds with all the motors in parallel, is not obtained. In fact, it seems to us that the Ward-Leonard arrangement is about the best that can be in the way of E.M.F. controllers, and it has objections, as we predicted in 1892, which have prevented its general adoption.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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Erratum.—In the second formula for $\mathfrak{W}$, given in Section CXVI., the values w and w_1 should be divided by 2. The equation should thus be :

$$\mathfrak{W} = \left[\frac{w}{2} + \frac{w_1}{2} + \left(p_1 + \frac{p}{2}\right) \times 2{\cdot}2 + s_1 + \frac{s}{2}\right] a\,(n-1).$$

CXXIV.

The following table exhibits the most striking points of contrast between the traction cell specified under Section CXIX. and the Q and V type portable storage cells of the E.P.S. Company, for which Mr. J. W. Barnard has been appointed sole agent. In both cases the containing vessel is supposed to be one of ebonite only. In regard to the much higher specific rates of discharge and capacity of the first-mentioned cell, it should be observed that this has not yet stood the test of time, whereas the E.P.S. portable cells referred to have a fair reputation for durability. In regard to the extraordinary difference in the comparative weights of electrolyte, these being in the ratios of 1 to 2, 5·4 and 5·94, it should be considered that the E.P.S. Company doubtless have reasons, which in their experience may be sufficiently valid, for employing as the electrolyte a dilute sulphuric acid of a density not above 1·190. Moreover, whilst we may hold that a density of 1·264 is perfectly safe in the case of a traction battery which is continuously in process of being charged or discharged, or left standing for short periods in a fully-charged condition, we may admit that in the use of a *waiting* battery—to which category the P and Q types of the E.P.S. cells may be said to belong—the lower density is preferable. But in view of the importance of diminishing by every allowable means the weight of all storage batteries which are not intended to remain stationary, we should, if acid of specific gravity 1·190 were used, generally allow of a final density considerably below the calculated densities constituting the three last entries in the last column of the table. The effect would be a great reduction in the total weight of the electrolyte per ampere-hour, as specified in column four. If, for instance, the final density specified in column six were in the three last entries reduced to 1·107, corresponding to 15 per cent. of H_2SO_4 in the spent electrolyte, the conductivity of the latter would, it is true, be diminished by about 30 per cent.; but the corresponding entries in column four would by calculation from the formula for $\mathfrak{W}$, given in Section CVI., be reduced from 1·48oz., 4oz., and 4·4oz., to 1·05oz. Such an enormous reduction in the weight of the fluid would, in the case of a traction or any transportable battery, usually be a far more important consideration than the diminished final conductivity of the electrolyte.

Type of cell.	Rate of discharge. Normal. Amp. / lb.	Rate of discharge. Maximum. Amp. / lb.	Capacity at low rate of discharge Amp.-hr / lb.	Electrolyte. Weight per amp.-hr.	Electrolyte. Initial density.	Electrolyte. Final density.
Road traction cell	·36	1·82	4·7	·74oz.	1·264	1·162
E.P.S.—						
Q type.....	·23	·46	2·5	1·48oz.	1·190	1·134
P type { T plates	·20	·40	1·6	4·00oz.	1·190	1·170
P type { C plates	·10	·20	1·2	4·40oz.	1·190	1·174

CXXV.

We may be called upon to calculate the bulk, as well as the weight, of a cell yielding a given number of ampere-hours under certain given conditions. The volume formula corresponding to the equation for weight, $\mathfrak{W} = [w + (2\,p_1 + p) \times 1{\cdot}6]\,a\,(n-1)$, in Section CXVI., is

$$\mathfrak{V} = (t + 2\,\tau + l)\,a\,(n-1) \text{ cubic inches};$$

where t is the thickness of the lead supports;
τ is the thickness of the layers of active material;
l is the "length" of electrolyte or distance between the plates;
a is the size of the plates, or the area in square inches of one side of a plate;
and n is the number of plates.

The terminal spongy-lead supports are supposed to be—as they should be—only half as thick as the intermediate spongy-lead supports. When this condition does not obtain, the aggregate thickness of the spongy-lead supports will be $t \cdot \frac{n+1}{2}$ instead of $t\,\frac{n-1}{2}$, and the difference between these two values $= t$ or the thickness of one plate, which is to be added to $t\,(n-1)$ and multiplied by a to make up the additional bulk. More briefly, the volume of one lead support has to be added to that indicated by the formula.

The volume formula corresponding to the second equation for total weight of the contents of a cell—viz.:

$$\mathfrak{W} = \left[\frac{w}{2} + \frac{w_1}{2} + \left(p_1 + \frac{p}{2}\right) \times 2{\cdot}2 + s_1 + \frac{s}{2}\right] a\,(n-1).$$

(applicable when the thickness of the peroxide supports and layers differs from that of the spongy-lead supports and layers) is :

$$\mathfrak{V} = \left(\frac{t}{2} + \frac{t_1}{2} + \tau + \tau_1 + l\right) a\,(n-1) \text{ cubic inch},$$

where t is the thickness of the peroxide supports,
t_1 " " " spongy-lead supports,
τ " " " peroxide layers,
τ_1 " " " spongy-lead layers.

In the above formulæ, as in the preceding ones, the thickness of the terminal supports is supposed to be $\frac{t_1}{2}$. Otherwise $\frac{t_1}{2}$, in the formula, should be multiplied by $a\,(n+1)$, instead of by $a\,(n-1)$. The difference between these two values is $2\,a$; and $\frac{t_1}{2} \times 2\,a = t_1\,a$ has to be added to the value of $\mathfrak{V}$ given by the formula to make up the correct bulk. In other words, the volume of one additional spongy-lead support is to be added to the above value.

A similar correction, in like case—*i.e.*, when the rule that weight should be proportioned to capacity is carelessly or ignorantly neglected, should be made in the formulæ for weight. The weight of one spongy-lead plate, and, if this be perforated, that of the spongy lead required to fill the perforations, should be added to the weight indicated by the formula.

Of course, since the weight of a cubic inch of any substance is the product of its specific gravity into the weight of a cubic inch of water, or ·577 × sp. g. (oz.), the volume, $\mathfrak{V}$ (in cubic inches), corresponding to the weight, $\mathfrak{W}$, can be found by dividing the weights w, $2\,p_1$, p, or $\frac{w}{2}$, $\frac{w_1}{2}$, p, $\frac{p}{2}$, etc., by ·577 × the specific gravity in each case. It will, however, in most cases be found most convenient to apply the above formulæ for the total volume of the contents of a cell.

ELECTROLYTIC THEORIES AND THEIR RELATION TO COMMERCIAL ELECTRO-CHEMISTRY.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

(Continued from page 178.)

An important relation between the E.M.F. of a reversible cell, its temperature coefficient, and the maximum amount of energy obtainable from the purely chemical reactions which take place, has been obtained by Helmholtz ("Die Thermodynamik chemischer Vorgänge" *Wissenschaftliche Abhandlungen*, II., p. 958). It must be remembered that the reasoning about to be employed applies only to *reversible* elements as previously defined, and therefore will not apply to a large number of cells in common use. On the other hand, the theory is extremely suggestive, and leads naturally to the consideration of a number of most important phenomena connected with electrolysis.

Let us suppose that a reversible cell is placed in an enclosure which is maintained at a constant temperature,

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T, whilst unit electricity passes through it in the direction in which its E.M.F. acts. Further, it is assumed that the resistance of the cell is negligible; this condition can always be realised very approximately by making the external resistance in the circuit great, so that only an inconsiderable fraction of the total electrical energy generated will be utilised in overcoming the resistance of the cell, and thus heating it. Let Q be the total amount of energy which might be obtained from the purely chemical reactions which take place whilst one unit of electricity passes through the cell. Then, according to Thomson's law,

$$E = Q.$$

We have already seen that under these conditions there should be no temperature coefficient to the E.M.F. of the cell. Let us therefore provisionally assume that during the passage of unit quantity of electricity through the cell the latter must be supplied from external sources with a quantity of heat, q, in order to maintain it at the constant temperature, T—that is, the generation of the unit quantity of electricity at the E.M.F. = E would cool the cell but for the supply of the heat, q, from the enclosure. The conditions of supply of this heat are therefore similar to those which obtain in problems connected with ideal heat engines.

Now remove the cell and place it in another enclosure which is kept at the constant temperature $T - dT$. Let w be the "water equivalent" of the whole cell—*i.e.*, w = the quantity of heat necessary to raise the temperature of the cell by 1deg. C. Then a quantity of heat, $w\,dT$, will be removed at the average temperature $T - \frac{1}{2}dT$. In consequence of this cooling the E.M.F. of the cell will now be equal to $E - \frac{dE}{dT}dT$. If, now, unit quantity of electricity is forced through the cell in a direction opposed to the E.M.F. generated, an amount of work equal to $E - \frac{dE}{dT}dT$ will be performed on the cell by external agencies, and a quantity of heat equal to $q - \frac{dq}{dT}dT$ will be given up to the enclosure. If the cell be now returned to the enclosure maintained at the temperature, T, an amount of heat, $w\,dT$, will be reabsorbed at an average temperature, $T - \frac{1}{2}dT$, assuming that the water equivalent of the cell has not been changed by the chemical reactions which have taken place. The cell is now restored to its initial condition, and we may summarise the processes which have taken place as follows:

1. An amount of external work equal to E has been performed by the cell, whilst an amount of work equal to $E - \frac{dE}{dT}.dT$ has been performed on it by the action of external agencies. This leaves a surplus of work equal to $\frac{dE}{dT}dT$ which has been performed by the cell.

2. An amount of heat equal to $w\,dT$ was given out at the average temperature, $T - \frac{1}{2}dT$., and reabsorbed at the same temperature.

3. An amount of energy in the form of heat, equal in value to q, was absorbed by the cell at the temperature T.

4. The cycle is reversible—*i.e.*, we might have started by allowing the current to flow in the direction of the E.M.F. of the cell at the temperature $T - dT$, and subsequently forcing the same quantity of electricity through the cell in a reverse direction at the temperature T.

Hence the cell acts as a reversible heat-engine, and its efficiency, numerically equally to that fraction of the heat, q, which has been converted into the work, $\frac{dE}{dT}dT$, will be given by $\frac{\frac{dE}{dT}.dT}{q}$, where both numerator and denominator are measured in dynamical units. If now T represents the *absolute* temperature of the hotter enclosure, then, just as in the case of a reversible heat-engine, the efficiency must be equal to the ratio of the difference between the temperature at which the heat was taken in and given out, by the absolute temperature at which q was absorbed. Hence

$$\frac{\frac{dE}{dT}dT}{q} = \frac{dT}{T}.$$

$$\therefore q = T\frac{dE}{dT}.$$

Hence, from the nature of the problem,

$$E = Q + q = Q + T\frac{dE}{dT} \quad . \quad . \quad . \quad . \quad (1)$$

Some very interesting conclusions follow from this relation. Since T must always be positive, when a cell possesses a positive temperature coefficient—*i.e.*, when the E.M.F. of a cell increases with an elevation of temperature, $T\frac{dE}{dT}$ must be positive, and, therefore, E − Q is positive.

The meaning of this is that more electrical energy is supplied by the cell than can be accounted for by the chemical reactions which take place within it. In fact, a certain amount of heat absorbed from surrounding bodies is converted directly into electrical energy. Thus in the modification of Daniell's cell cited above, about ·8 per cent. of the total electrical energy obtainable at a temperature near 15deg. C. is due to the absorption of heat by the cell from surrounding bodies. A rough analogy may make this clearer. If a quantity of compressed gas is allowed

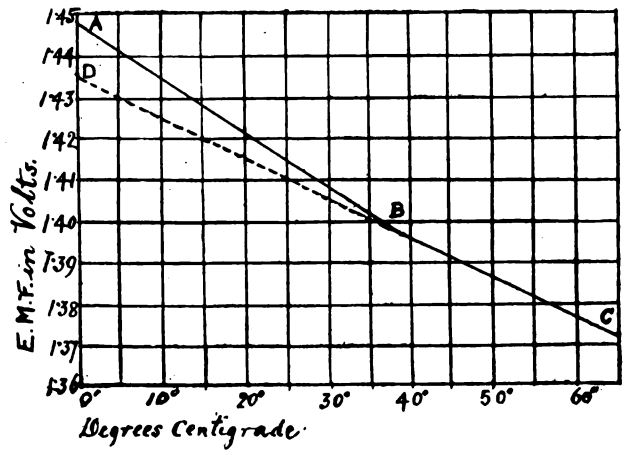

FIG. 1.

to expand adiabatically from one volume to another, a certain amount of work will be obtainable. If, however, the expansion had taken place isothermally—*i.e.*, accompanied by an absorption of heat from surrounding bodies—a greater amount of work would have been obtained.

In a reversible cell possessing a negative temperature coefficient, E − Q is negative—*i.e.*, the E.M.F. is less than that which would correspond to the energy evolved by the chemical reactions taking place whilst unit quantity of electricity passes through the cell.

Both the above forms of cell are known. A Daniell's element, in which the dilute sulphuric acid bathing the zinc is replaced by dilute zinc sulphate, affords an instance of the first class. The cell represented by

$$Zn \mid ZnCl_2 + 100H_2O \mid AgCl \mid Ag$$

possesses an E.M.F. of 1·031 volt and a negative temperature coefficient equal to about ·00035 volt per degree Centigrade.

Equation (1) has been found to agree very well with the results of experiments performed on a number of reversible elements. A most striking confirmation has been recently published by Herr Jaeger* in respect of the Clark cell. This element, it will be remembered, may be represented by

$$Zn \mid ZnSO_4 \mid Hg_2SO_4 \mid Hg.$$

Its E.M.F. for temperatures between 0deg. and 65deg. is represented by the line A B C (Fig. 1). It will be noticed

* *Ann. Phys. Chem.* 63, pp. 354-365, 1897.

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that the temperature coefficient is negative, the E.M.F. following the straight line, A B, from 0deg. C. to 39deg. C. At this latter temperature a discontinuity occurs, and the E.M.F. subsequently follows the straight line, B C, which is more nearly parallel to the axis of temperatures than is the line A B. Jaeger found that if a Clark cell was cooled gradually from 60deg., the E.M.F. followed the line C B D. If, now, at a temperature below 39deg., when the E.M.F. was denoted by a point on B D, a crystal of zinc sulphate was dropped into the cell, the E.M.F. immediately changed to the corresponding point on B A.

The explanation of this is that below 39deg. zinc sulphate dissolves as $ZnSO_4 + 7H_2O$; at 39deg. this changes into $ZnSO_4 + 6H_2O$, giving up a molecule of water. Also, from (1)

$$\frac{dE}{dT} = \frac{E - Q}{T}.$$

The solubilities, and therefore the heats of solution, Q, are different in the two cases cited above, hence $\frac{dE}{dT}$, which represents the slope of the E.M.F. curve when referred to temperature, is different in the two cases.

Efficiency of a Primary Battery.—Nernst has stated that the efficiency of a reversible cell is necessarily greater than that of one that is irreversible. This statement is unquestionably true when the meaning of the terms employed is strictly attended to. On the other hand, since any confusion between the scientific and the popular signification of the terms used may lead to very erroneous conclusions, a brief consideration of the matter may here prove useful.

In the above instance a reversible cell is used as a heat engine, absorbing heat at a temperature, T, and ejecting it at a temperature T - *d* T. The surplus work obtained on the completion of a cycle is not due to any chemical reaction, but is strictly comparable with that which might have been obtained by using any other heat engine working between the same limits of temperature. No attempt has, however, been made, up to the present, to use a battery in this way, and, what is more, no advantage would seem likely to accrue from so using it.

When contemplating the normal method of usage of a primary battery, a totally different meaning must be attached to the term "efficiency." Purely commercial considerations may now have to be taken into account. Thus, with a given consumption of zinc, more energy may be obtained from a Grove's cell, which is irreversible, than from the previously-mentioned reversible modification of Daniell's cell. The commercial efficiency cannot be stated till the prices of the various constituent parts of the element have been obtained. Enough has, however, been said to show that the utility of any given battery cannot be at once determined by deciding whether it is or is not reversible. As previously stated, about ·8 per cent. of the energy supplied by a reversible Daniell's element is obtained from heat absorbed from surrounding bodies. This, of course, is pure gain. But other reversible elements—such as the zinc-silver element mentioned above—give out less electrical energy than would correspond to the heat which might have been obtained from the chemical reactions. In other words, part of the energy due to the chemical combinations is used in heating the cell irrespective of the ordinary dissipation of energy taking place in overcoming its resistance.

It may be noticed, however, that whilst in a reversible cell the electrical energy obtainable may be either greater or less than that corresponding to the chemical reactions, any change which renders the cell irreversible can only produce a dissipation of energy. For if an irreversible gain of energy, associated with a passage of a certain quantity of electricity through the cell, were possible, on sending the same quantity of electricity in the reverse direction a further gain of energy would be effected, whilst the reversible processes would just neutralise each other in the two cases. Thus a continual gain of energy would be possible without any corresponding expenditure of work, which would lead to perpetual motion.

(To be continued.)

CORK ELECTRIC TRAMWAYS.*

BY BEVERLEY GRIFFIN, A.M.I.C.E.

It is worthy of note that the Cork Electric Tramways and Lighting Company, Limited, incorporated by Order in Council 1897, is the first company in the British Isles supplying electricity for traction and lighting from one central station. The tramways are, for the most part, single lines with passing places. The length of the track is 11 miles. There are 1¾ miles of track beyond the city boundary on the Douglas-road, and this portion is laid with sleepers. The sleepers are rectangular, creosoted, 6ft. long, 9in. wide, and 4½in. thick, and there are 11 to each pair of 30ft. rails. The rails are fastened down to the sleepers by 30 dog spikes and 14 fang-bolts and clips. The steepest grade is 1 in 14, and the sharpest curve is 27ft. radius. The passing places are three chains in length, and the space between each pair of rails is 4ft. 6in.; but when centre poles are used the space between the tracks is 6ft. 6in. The gauge is 2ft. 11½in., and was determined with a view to the probable use of the tramway for conveying the trucks of the Muskerry Light Railway Company to and from the quays, and for interchange of traffic with the Cork and Passage Company. The Muskerry Company's gauge is 3ft., and that of the Cork and Passage Company is being converted from 5ft. 3in. to a 3ft. gauge. The rails are of the girder type, of steel, weighing 83lb. per yard, and are of American

BEVERLEY GRIFFIN, A.M.I.C.E., ELECTRICAL ENGINEER, CORK TRAMWAYS.

manufacture. They are 30ft. long, 6½in. deep, and are slotted for the tie-bars, and drilled for the fish-bolts and electrical bonding. The fishplates are of steel, 26in. long, weighing 56lb. per pair, and the outer plate is the larger, giving support to the rail head. The tie-bars are of wrought iron 2in. by ⅝in., weighing 10½lb., double nutted at both ends, placed at 8ft. centres and 3ft. from the ends of the rails. The points are of chilled steel, and were supplied by Messrs. Miller and Co., of Edinburgh, and Messrs. Dick, Kerr and Co., London. The crossings are built up as the work proceeds, and the rails are cut and scarfed for this purpose by one of Hill and Son's cold steel cutting saws. The scarf is held to the crossing rail by specially made fishplates, forged to suit, and a plate 6ft. long by 1ft. 6in. by ½in. is placed beneath and bolted up to the rail flange with 10 bolts 2½in. by ⅝in. The crossing is completed by cutting a groove through the head of the crossing rail. The rails are laid upon a continuous bed of Portland cement concrete (5 to 1), 6in. deep and 7ft. wide. The roadway between the rails, and 18in. outside each rail, is paved with Welsh granite setts 6in. deep and 3½in. wide, laid on a ½in. bed of sand, and grouted with Portland cement mortar (3 to 1) well swept into the joints.

The city of Cork is built on an island formed by two branches of the River Lee. The tramway has to cross the

* Paper read at the meeting of the Municipal and County Engineers, Cork.

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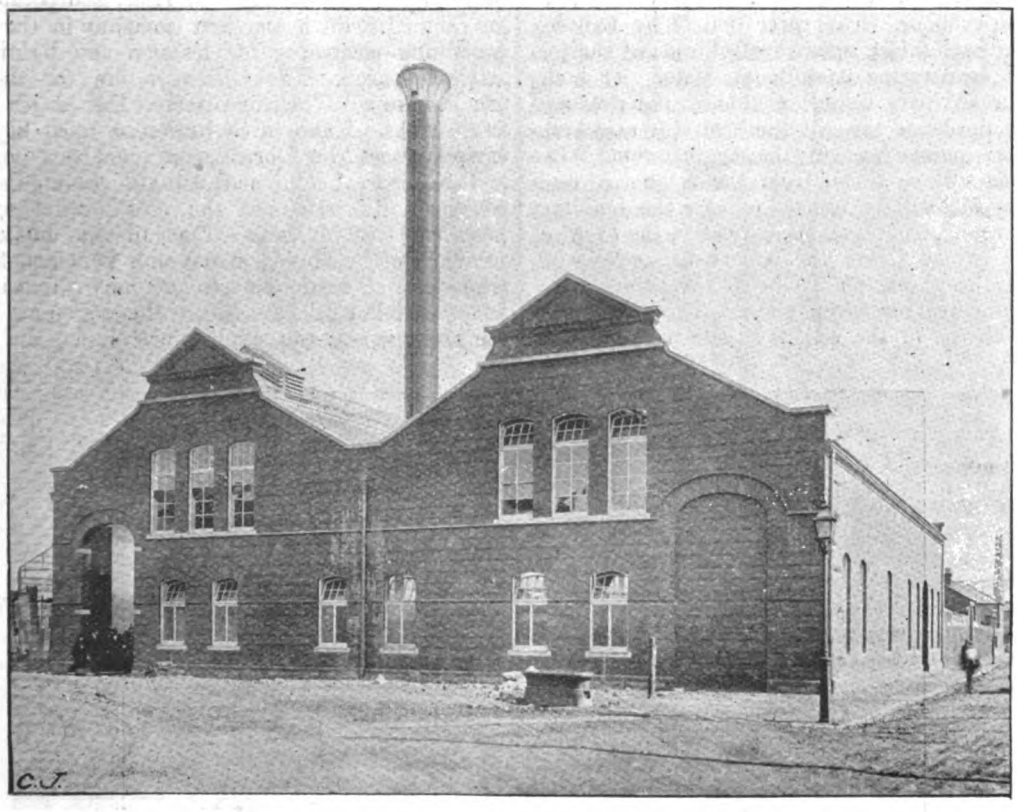
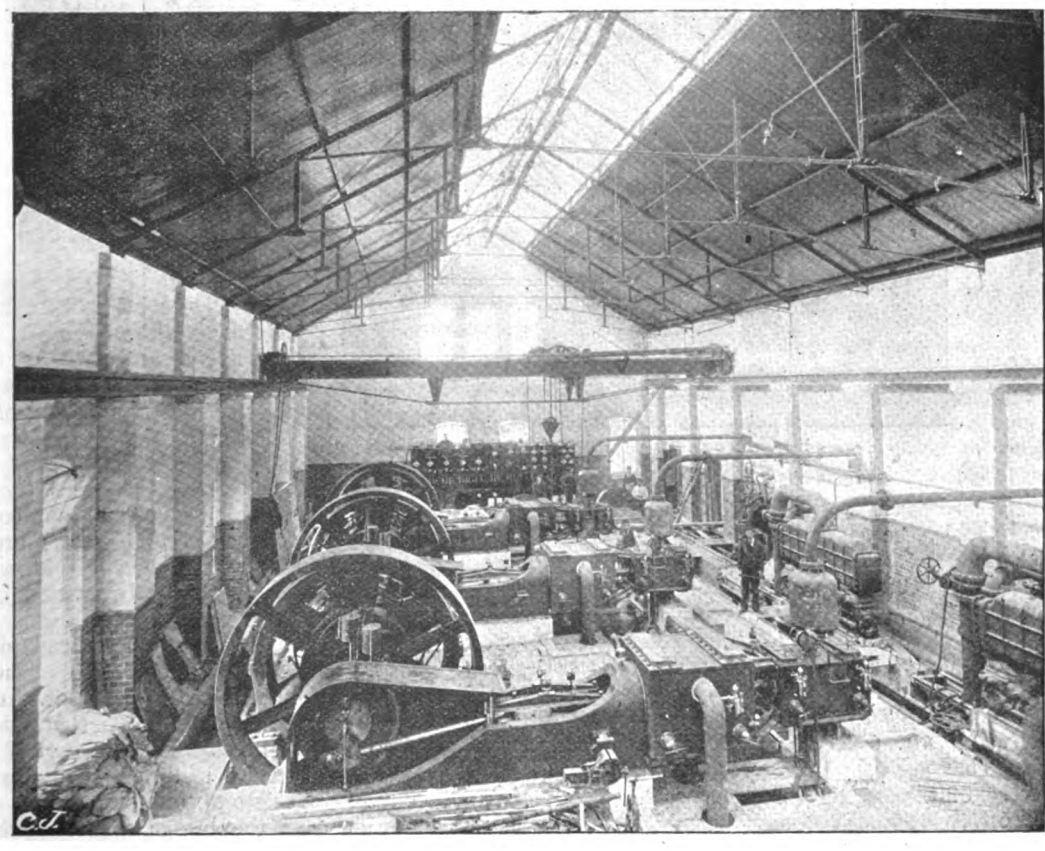
river twice, first by Parnell Swivel Bridge, a steel structure, and again on Patrick's Bridge, which is of stone. At both points the track is double, and in order to facilitate the running of the cars, two short tracks of single line have been laid along Marlborough-street and Robert-street, thus giving an up and down way. These streets have been paved throughout with wood block paving laid on Portland cement concrete 6in. thick, and a double junction formed at each end of the streets to be used in case of obstruction in either street.

The power station is conveniently situated near the Cork and Passage railway terminus. The site upon which the station is built was once a slob, and to obtain a foundation 137 pitch-pine piles, 12in. by 12in., were driven 37ft. below the surface-level of the street, at 5ft. centres, placed zigzag, and upon these concrete 6 to 1 was laid. The walls are of 18in. brickwork, with pilasters for carrying the overhead gantry crane, carried up at 10ft. intervals. An additional pile was driven under each pilaster. The station is 100ft. long by 104ft., and consists of engine and boiler



The Power House at Cork.



The Engine and Dynamo House, Cork.

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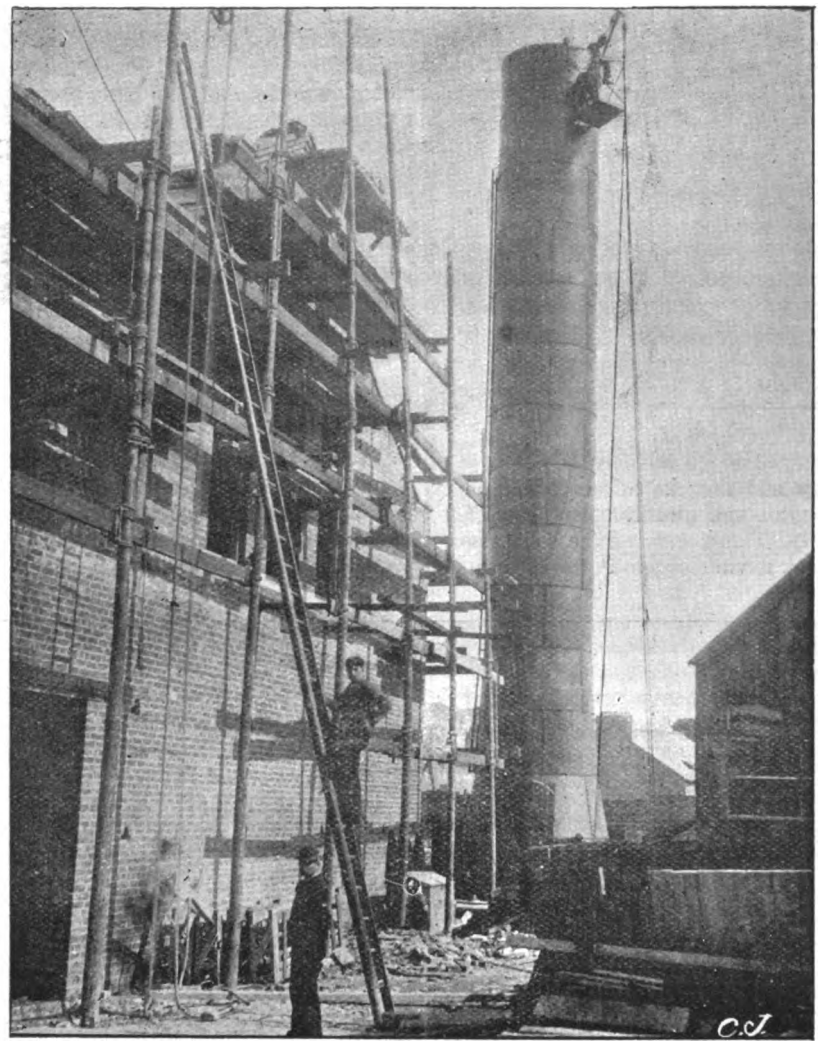
rooms, with battery-room. The plant comprises three tandem horizontal compound condensing McIntosh and Seymour engines, directly coupled to 220 kw generators, running 150 revolutions per minute. The Wheeler standard condensers have each a capacity of from 8,000lb. to 12,000lb. steam per hour. The three boilers by Babcock and Wilcox have each 2,531 square feet of heating surface, and capable of evaporating 8,000lb. of water per hour. There is also an auxiliary heater, combined hot well and filter tank, and duplicate set of Edmiston filters. Compound feed-water pumps are in the engine-room. The condensing water will be taken from the river. A tank 20ft. by 11ft. by 8ft. will be erected outside the building, holding a reserve of 10,000 gallons, for use in the event of the city supply, which serves the boilers, being shut off. The battery room contains 256 Tudor cells, capable of discharging 110 amperes for seven hours. The booster for regulating the charge of the cells is situate in the engine-room. The switchboard consists of a combination of tramway and lighting panels, the same machines being interchangeable in either service. The engine beds are of 6 to 1 Portland cement concrete, 8ft. in depth, laid upon 96 pitch pine piles, 12in. by 12in., driven at 5ft. centres. The chimney is of steel, and was built by Messrs. Keeler and Co., of Williamsport, Pa. The height is 130ft., and the diameter at base is 12ft., curving in to 7ft. 6in. at 12ft. above ground, and finishing 7ft. 6in. at top. The stack is built of riveted plates 4ft. 6in. in height, three plates forming a course. They are $\frac{7}{16}$in. thick at bottom, decreasing $\frac{1}{16}$in. for every 32ft., and finishing $\frac{1}{4}$in. thick. The breeching nozzle, 6ft. wide and 7ft. high, connecting the brick flue, is reinforced by the addition of a 2ft. 6in. angle iron, forming an arch up the sides and over the top of the nozzle. The stack is lined with 4$\frac{1}{2}$in. radial firebricks, set in fireclay. A water guard is fixed at the top of the chimney, made of 3in. angle iron turned down to cover the brick lining. The base-plate is of cast iron, 2in. thick and 15ft. diameter, in eight parts, strongly ribbed and joined by 1$\frac{1}{2}$in. bolts. The base, 21ft. square, is of Portland cement concrete 6 to 1, and built upon a foundation of 25 pitch-pine piles 12in. by 12in., and anchor bolts 14ft. long by 2$\frac{1}{2}$in. diameter were placed in position before the concreting commenced. The advantages claimed for the steel shaft are saving of time in the erection and cost in the structure. The time occupied in erecting was about five weeks, and the brick lining occupied 20 days. The saving in cost over a brick stack was about 25 per cent.

The electrical equipment is of the trolley type, overhead construction, carried on the pole bracket system. The poles are built in three sections of 5in., 6in., and 7in. best tubular steel, made by overlapping joints, shrunk together while hot. The double bracket pole, placed in the streets where double tracks are laid, will carry an arc lamp besides the trolly wires; the single bracket pole the trolly wires only. The poles are placed about 120ft. apart where the line is straight. The cars (18 in number) are built to carry 20 passengers inside and 24 outside, and will be electrically lighted. The car shed, 125ft. long by 70ft., built on ground adjoining the power station, will contain pits for inspection and cleaning the cars and a repair shop. The rails are efficiently bonded with two Chicago bonds to each joint, and also cross bonded at short intervals. Where the track approaches Parnell Swivel Bridge the rail ends will be held in a casting, acting as a kerb to both sides of the opening portion. The kerb will be bolted down to the structure, and prevent lateral motion or jumping when the cars enter or leave the bridge. Span wires will only be used in one or two instances, where there are double curves in the street. A tramway station has been laid out at Father Mathew's Statue in Patrick-street, where four lines of track have been laid with double cross-over roads, and here the cars can meet for interchange of passengers.



The Shaft of the Power House at Cork.

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DISCUSSION.

Mr. CUTLER said the thanks of the members were specially due to Mr. Griffin. With regard to the subject matter of the paper, he preferred that the grouting should be of pitch rather than of cement, as followed in Cork by the author of the paper. When cement was used it necessitated the stoppage of the traffic, and too frequently the stoppage could not be over enough time to allow the cement to set properly, and if this was not done the grouting was of little use. Another point he considered questionable practice was in the laying of the rails on sleepers, as the decay of sleepers and other matters connected therewith led to unnecessary breaking up of the roads.

Mr. DORMAN did not agree with Mr. Cutler upon the question of using cement grouting. He thought it preferable to pitch, though his own experience was gathered from the South of England, where cement was almost invariably used, and not from the North, where pitch grouting was so common. He really thought that with a good foundation cement was the better, but it must have the necessary time to set properly. He agreed with Mr. Cutler on the question of cross sleepers, and asked a question with regard to the difference of ½in. width at two points in the tramlines.

Mr. WARDLE (Longton) stated that the North Staffordshire trams were originally laid with Vignole's rails on creosoted sleepers, and after 10 or 12 years parts of the line were relaid and the sleepers found in good condition, but when the extensions were sanctioned, at the instigation of the authority they were required to be laid on solid concrete. Respecting cement grouting in North Staffs, the setts were originally grouted with cement, and it was found when relaying that there was absolutely no cohesion between the grouting and the setts.

Mr. BUCKLEY mentioned that in part of the tramways near Dublin the line was laid on sleepers. The question was solely one of estimated return upon capital expenditure.

Mr. KIRBY said that tramways on sleepers, laid longitudinally or transversely, would not be commended as perfect, but in certain districts the question was one of expense only. In the particular case under discussion the promoters would have been stopped had concrete been insisted on. A part of the tramway they would see that afternoon was laid on transverse sleepers, and those had fairly stood the test of time. The sleepers were laid several inches lower than ordinarily, with concrete blocks upon them, and they had had to carry heavy traffic. When economy was paramount, and the sleepers were well laid, packed, and drained, transverse sleepers would be all right.

A vote of thanks was given to the author of the paper, on the proposition of the PRESIDENT, seconded by Mr. COOKE, and Mr. GRIFFIN, in reply, mentioned that the difference of gauge was on account of experiments made to see if the Muskerry Light Railway stock would run over the line, and, in fact, to provide that it should.

SELF COOLING AND WATER COOLED TRANSFORMERS.*

Other conditions being the same, the temperature of a transformer depends upon the surface exposed to the cooling medium. As the capacity of a transformer is increased its external or radiating surface increases much more slowly than does the loss, so that the dissipation of the heat generated becomes a more and more serious problem as the capacity of the transformer is increased. In order to obtain a radiating surface which should increase in a somewhat more adequate proportion to the capacity of the transformer, the Westinghouse Electric and Manufacturing Company several years ago changed the design of its transformer from the long type, in which a great portion of the coils was enclosed by the iron, to a type having a short length of iron and a great portion of the coils outside the iron. The idea was then conceived of dividing the winding into several thin parallel coils, and spreading these apart outside of the iron. This method of spreading the coils, which gives an enormous increase in radiating surface, not only makes a remarkable difference in the temperature of the ends, but also in the average temperature of the transformer, and it has been found by careful measurement that where the coils are thin and spread well apart, the temperature of the ends is practically the same as the temperature of the interior of the transformer. This is what would be naturally expected, as the coils being thin, the portion in the iron being short and the copper an excellent conductor of heat, the heat generated in that portion of the coils under the iron is conducted to the ends, from which it is readily dissipated into the surrounding medium. The converse of this is also true. Where the coils are thick and are not separated or spread, there will be some portion of the coil which will be at a temperature very considerably higher than that indicated by the increase in the resistance of the windings, which necessarily gives the average temperature of the windings. The maximum and not the average temperature is the dangerous one.

The great advantage of the spread-coil method of ventilation is that the gain in radiating surface is obtained without increased weight and without sacrificing the efficiency of the transformer. Where the spread coil is not used there are only two ways of increasing the radiating surface—one is to separate the coils from one another by spacing strips, the other to so proportion the shape of the transformer that there will be a large amount of radiating surface exposed to the air. The adoption of either of these plans means lower efficiency or increased weight, or both. Where the coils are separated by air or oil spaces all the ventilating space is lost so far as the electrical performance of the transformer is concerned, and as this space is extremely valuable, its loss affects directly the efficiency of the transformer. Where the design of any but very small transformers is such that the outside surface is sufficient for radiating the heat without separating the coils, the shape of the transformer must be so great a departure from the best proportions that high efficiency is obtained only by an excessive amount of material, and the point is very soon reached where the most radical departure from the best design does not give sufficient cooling surface.

Oil in a transformer plays several important parts; it materially strengthens the insulation; it prevents oxidation of the insulation, and, being an excellent conveyor of heat, tends to equalise the temperature, preventing any one spot from becoming seriously hotter than the rest of the transformer. A very fluid oil having a high fire test and high insulating qualities has been adopted by the Westinghouse Company for use in its transformers, for it has been found that where a heavy viscous oil is used much of the good effect of the oil as a cooling medium is lost, as the heavy oil is very sluggish in its movement even when hot, and therefore does not circulate rapidly. It also tends to clog up any small openings which may be left for its circulation.

In addition to the advantages enumerated above, the oil transformer is the only one that has been made self-cooling in large sizes without enormously increasing the amount of material used. When a transformer has once been placed in position in its oil case, it is no longer subjected to danger from moisture or from mechanical injury of any kind. On the other hand, the transformer cooled by an air blast is likely to have blown into it damp air, dust, dirt, and foreign substances of any kind which happen to be drawn into the blower. That the oil-insulated type of transformer is rapidly gaining ground is shown by the fact that the smaller companies which have been free to choose their own type are gradually adopting the oil-insulated transformer for their standard.

All oil transformers manufactured by the Westinghouse Company may be divided into two classes—self-cooling and water cooled. The self-cooling type is used on all sizes up to and including 500 kw.; the water-cooled type on larger sizes. Both classes have the coils spread at the ends, both are oil insulated, both are without moving parts and require no attention after being once installed. Typical examples of these two types of transformers so closely resemble each other that when a transformer is seen outside of its case it is impossible to tell whether it is designed to be self-cooling or water cooled. The only difference is in the case. The self-cooling case is made of heavy sheet iron

* From the *Electrical World*, New York.

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mounted in a rigid angle-iron framework, which serves as a protection from mechanical injury and as a support for lifting. The surface of the sheet iron is broken into numerous deep, narrow corrugations, which increase very greatly the surface exposed to the air. The cover is in two portions, the terminals being brought through the lower part. The upper part is easily removed, and allows an examination of the terminals. This transformer requires absolutely no extraneous cooling devices, thus avoiding all loss in efficiency due to power required for blowers, pumps, motors, etc. It requires neither special foundation nor air-chambers, and no attention whatever after being installed.

The popularity of this type of transformer is shown by the fact that since Jan. 1, 1898, over 34,000-h.p. capacity has been sold; 26,750 h.p. is for 10,000 volts or higher; 9,730 for 20,000 volts or higher; 130 h.p. for 60,000 volts.

The water-cooled type is used only on sizes too large for the application of the self-cooling method. Its use is therefore quite restricted, it being employed only in very large installations where large transformer units are required and where there is a cheap supply of water. The case is of boiler iron, circular in form, with a light cast-iron cover. Just inside the case and close to the sides is placed a spiral of iron pipe, through which the cooling water is passed. This coil extends only part way down the case, usually to about the top of the coils. The position of the cooling oil is such that it is in the very best place for cooling the heated oil as it rises to the top, so that the maximum amount of heat is carried off with a given amount of water. An exceedingly small amount of water is required for cooling a transformer, a 100-h.p. transformer requiring about one gallon per minute. The ends of the cooling coil may be connected directly to the water-supply mains; or in a water-power plant, a pipe may be led from some point in the flume to the transformer, a head of a few feet being ample for forcing sufficient water through the cooling coil. While the water-cooled transformer is not so ideally simple as the self-cooling one, it resembles the latter in requiring no pumps, blowers, or motors, no special foundation or overhead oil tanks, and in requiring no attention after being once installed.

SPARKLESS REVERSAL IN DYNAMOS.*

BY H. N. ALLEN, B.SC.

(Continued from page 175.)

Inductance of a Ring Winding.

In order to compare the inductance of a ring winding with that of a drum, two bent pieces of copper bar were soldered to the drum coil, D. These bars passed through the central hole of the core, the wooden spindle being cut away to allow this, and were of such a shape that they lay close to the iron, from which they were insulated by tape. In Fig. 2, A B C D E F is the rectangular drum coil. The

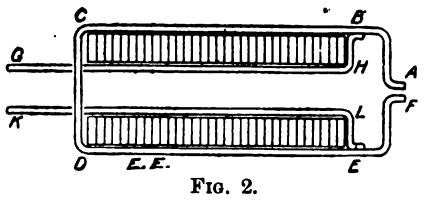

Fig. 2.

ends, C D and A F, were bent upwards, so as to clear the wooden spindle, and allow the coil to be placed on the core, which is shown in section in the figure, in a plane passing through the axis. The two extra bars are indicated by G H B and K L E, and were soldered on at B and E. The terminals of the drum coil are A and F, and of the ring winding G and K. The ring winding, G H B C D E L K, represents two coils, of one turn each, on opposite sides of the armature. In an actual dynamo two such coils might be commutated at the same instant, the currents flowing in them being in the same relative directions as in this experimental winding. The following are the values obtained for the inductance, the corresponding value for the drum coil and the difference being given in each case:

Table VI.

Condition of experiment.	Inductance of ring winding.	Inductance of drum winding.	Difference.
Armature out of field	0 00000139	0·00000093	0·00000046
Field closed by thick wire.	0·00000145	0·00000104	0·00000041
Field closed by 0·1 ohm ...	0·00000150	0·00000102	0·00000048
Field open	0·00000203	0·00000159	0 00000044

To get some idea of the effect of the rods K L and G H alone—that is to say, of the field in the interior of the armature core—the terminals A and F were soldered together, and the inductance of the circuit G H B A F E L K was determined. The points B and E were, of course, also connected by B C D E, but the inductance of this is great as compared with that of B A E, so that very little current will flow this way. The value obtained for the inductance was 0·00000072, which is rather larger than the average difference between the inductances of the ring and drum windings. The inductance of B A E is included in this measure, as it is also in the inductance of the drum. If twice the inductance of B A E is subtracted from 0·00000072, the remainder will probably not differ much from 0·00000045, the average difference in Table VI. The inductance of the ring coil is, in this case, about 1½ times that of the drum. It must be remembered, however, that the core had not the proportions which are usual in a ring armature. The length was 8in., the outside diameter 3¾in., and the inside diameter 2in. In this type of armature the diameter and the length are generally more nearly equal.

Measurement of Inductance with the Secohmmeter.

The inductance of coil C was measured with the secohmmeter, and the following values were obtained. The results of the alternating-current experiments are tabulated in the last column.

Table VII.

Condition of experiment.	Inductance with secohmmeter.	Inductance with alternating current.
Field open ...	0·000159 (slow), 0·000132 (fast)	0·0000151
Field closed...	0·000082 (slow), 0·000070 (fast)	0·000076
On core	0·000070	0 000077
No iron.....	0 000051	0·000054

It follows that a very fair approximation to the value of the apparent inductance, at frequencies of about 200, can be obtained by running the secohmmeter at a medium speed. The actual speed of the secohmmeter was not measured, but it was run as slow and as fast as possible by means of a small motor.

The inductance of a number of actual armature coils of different types might easily be measured with the secohmmeter, as, for example, ring and drum armatures with ordinary winding and with cord winding, with smooth cores and toothed cores of different forms.

The inductance of the whole armature between the brushes of the Immisch motor was found by the secohmmeter to be 0·0023 henry when the field circuit was closed. The armature was wound with 24 sections of six turns each. The inductance of one of the sections was found to be 0·000034 when it was in the median plane. There does not appear to be any way of deriving one of these numbers from the other.

Power Absorbed in the Circuit.

Experiments made by the three-voltmeter method to determine the power absorbed by an armature coil in which an alternating current was flowing were not very satisfactory. This was partly due to uncertainty with regard to the resistance of the hot copper conductor at the instant at which the measurement was made, and partly to difficulty in obtaining a small non-inductive resistance of sufficient carrying capacity. The observations made with the drum-wound coil showed that when the field was short-circuited very little power was required to send an alternating current through the armature coil in the median plane, beyond

* From the *Journal* of the Institution of Electrical Engineers.

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that required to overcome resistance in the coil itself. The total power as measured was 21 watts, of which 19·5 were expended in the primary, or armature coil, and 0·5 in the secondary, or field-magnet winding, leaving an apparent loss of one watt in the iron. The iron loss will certainly be small in this case, since very few tubes pass round through the field magnets. When the field circuit was open, on the other hand, the total power absorbed with the same current was found to be 28·5 watts, and since 19·5 watts were lost in the copper of the coil, nine were lost in the iron. When the coil was at right angles it appeared that the total power required is 36 watts, making 16 5 watts lost in the iron. In this position of the coil the induction tubes pass round mainly through the pole-pieces, and not through the field-magnet limbs and yokes. The total flux is much larger, so that the induction density in the core is increased, and as hysteresis losses vary as the 1·6th power of the induction density, it is possible that, in spite of the smaller volume of iron affected, the loss of power may be greater.

Power Absorbed in Ring Winding.

Some previous experiments made with the ring winding were unsatisfactory, as the resistance used in series with the armature coil had some inductance. The effect of neglecting this in the calculations was to increase the apparent loss of power. Table VIII. shows the results obtained for the drum and ring windings. In the second and fourth columns of figures are given the results of subtracting the watts needed to send the current through the copper of the coils from the total watts.

Table VIII.

Condition of experiment.	Drum winding.		Ring winding.	
	Total watts.	Watts in iron and field.	Total watts.	Watts in iron and field.
Open circuit	28·5	9·0	45	17
Field short-circuited by 0 1 ohm.....	30·0	1·5	35	7
Field short-circuited by a thick wire.....	21 0	1·5	32	4
Armature out of field	—	—	31	3

The watts lost in the copper of the armature coil are 19·5 for the drum and 28 for the ring. The effect of the inside conductors will be to increase the induction density in the core, and thus to produce an increased hysteresis loss.

When the field is short-circuited the loss outside the coil itself is small. In an actual dynamo the resistance of an armature coil is often much larger than in these experimental coils, and the proportion of the loss due to resistance to the remaining losses, when an alternating current is sent through it, will be even greater than that observed. It seems to follow that when, as in the case of a dynamo that is sparking, a rapid variation of the flux in a coil takes place, a very small proportion of the resulting loss of energy is caused by hysteresis or eddy currents in the iron, or induced currents in the field circuit. The energy is changed into heat mainly in the armature coil itself, in the brushes, and in the spark. It must be remembered that the field circuit of a shunt-wound dynamo or motor is always short-circuited through the armature.

Calculation of the Inductance of a Drum Armature Coil.

The next section of the paper shows how the value of the true inductance of the coil can be easily found approximately from the dimensions in the different cases experimented on, and how the apparent inductance with an alternating current depends on the true inductance.

1. *Coil Removed from Core.*—The inductance of a long, narrow rectangular coil, without iron, can be calculated by means of Maxwell's formula for parallel cylindrical conductors, conveying equal currents in opposite directions, with sufficient accuracy for present purposes. The formula is $L = l\,(2 \log_\epsilon \frac{d^2}{a^2} + 1)$, where d is the distance between the axes of the two conductors, a the radius of each wire and l the length. Assuming $a = 0{\cdot}015\ d$, we obtain $L = 17{\cdot}4\ l$ for the inductance of a long rectangular coil, of one turn, the length of which is l, and which is not in the neighbourhood of iron. The action of the ends of the coil is here neglected. The ratio of a to d is about that which often obtains in practice. A large change in the ratio does not greatly change the value of L.

2. *Effect of the Iron Core.*—The following considerations will help in understanding the action of the iron core. In Fig. 3 are shown the magnetic equipotential surfaces, and the boundaries between the tubes of magnetic induction due to two such wires as are considered above. The latter are indicated by full and the former by dotted lines. The diagram consists of two sets of circles, cutting one another orthogonally. The sections of the two wires are represented by the two circles, A B C and D E F. A certain number of tubes of induction are indicated as existing within the section of the wire. These are in reality not strictly circular, but the difference in the two diameters is hardly large enough to appear in a small diagram. There is no magnetic potential within the wires, and so no equipotential surfaces can be shown there.

It is possible to construct the tubes and surfaces in such a way that each of the cells into which they divide up the space about the wires represents a unit of energy, stored up in the medium, and ready to be given up to the circuit when the current diminishes. A certain amount of energy is also stored in the wire itself, but this cannot be represented in the same way; if the wires are small enough, and far enough apart, it may be neglected. The total amount of the stored up energy is in any case $E = \frac{1}{2} L C^2$, where C is the current flowing. This equation gives a more accurate definition of the inductance, L, than the ordinary

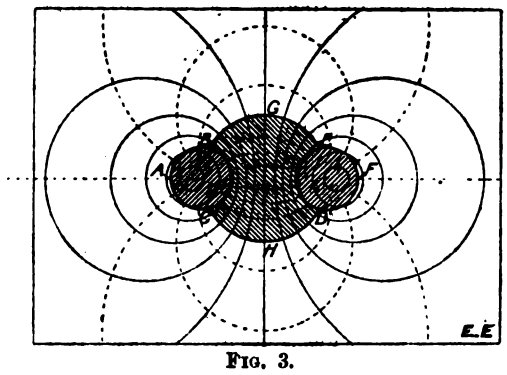

Fig. 3.

one, which makes it equal to the total number of tubes linked with the circuit when unit current flows through the wires. If only the tubes outside the wires are taken, the value obtained is too small, while if all the tubes are counted the result is too large. In the majority of practical cases, as in the present one, the difference can be neglected.

Let the circle B G E H, in Fig. 3, represent the section of a cylinder, grooved at the sides to receive the wires, and filled with some material of very high permeability. The wires in an actual armature coil will, of course, be very much smaller, as compared with the armature, than those shown in the drawing. The magnetic potential will be very nearly the same throughout the permeable cylinder, and there will be practically no equipotential surfaces inside it to divide up the induction tubes into energy cells.

Now before the introduction of the permeable material the cylinder contained half of the equipotential surfaces, and practically half of the energy cells. Even with the thick wires drawn, there are 48 cells inside the cylinder to 57 outside. On introducing the cylinder half the magnetomotive force—that is, half the current—will produce the same flux as before. There will be half as many equipotential surfaces, but they will all be outside the iron, and the outside portions of the diagram will remain unchanged. The number of energy cells with current $\frac{1}{2}$ A, and using the permeable cylinder, is half the number with current A, without the permeable cylinder. Doubling the current doubles the number of tubes of force, and also the number of equipotential surfaces, so that each energy cell is divided into four new ones. Thus current A, with the permeable cylinder, gives twice as many energy cells as without it. Thus the inductance is doubled by the action

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of the permeable cylinder. This can also be seen from the fact that the number of induction tubes is doubled. It follows from this that the inductance of a coil of one turn on a drum armature outside the field is approximately, neglecting the action of the ends,

$$L = 2\,l\,(2\log_e \frac{d^2}{a^2} + 1);$$

or if, as before, $A = 0{\cdot}015\,d$, the inductance will be $L = 35\,l$. For such a coil on the armature of the Immisch motor this gives 0·00000071, while the observed value for coil D, including the ends, was 0·00000093. The conductor was of square section, and considerably thicker than is assumed above.

3. *True Inductance on Core in Field.*—When the armature is in position in the machine, the true inductance of a coil will be twice the energy stored up when unit current flows in the coil. With a coil of one turn this is practically equal to the magnetic flux through the coil. The flux can be calculated from the dimensions of the magnetic circuit. As the greater part of the flux will pass through the air-gap between the pole-faces and the core, and as the reluctance of the air-gap is in most machines rather high, as compared with that of the rest of the magnetic circuit, the true inductance will be nearly the same in all positions of the coil, and its approximate value can be obtained from the dimensions of the pole-faces and air-gap. The total flux equals $4\,\pi$ times the number of turns in the coil, n times the area of the pole-face, s, divided by the length of the double air-gap, g, $= \frac{4\,\pi\,n\,s}{g}$, and the true inductance is

$$L = \frac{4\,\pi\,n^2\,s}{g}.$$

With a polar angle of 135deg. and the air-gap one-tenth of the diameter of the core, $L = 15\,\pi^2\,n^3\,l$. This is about four and a half times the value, found above, for the inductance of the coil on the armature core outside the field, n being equal to unity. A certain amount should be added to this for tubes which pass round through the air without penetrating the pole-faces. Neglecting this leakage, the inductance of a single turn on the armature of the Immisch motor was found to be 0·00000227.

EXPERIMENTAL DETERMINATION OF THE TRUE INDUCTANCE.

In order to measure the true inductance of a coil, in the median plane, on the armature of the motor, the flux through the pole-piece was measured when a continuous current was flowing in the coil. A test coil was used, wound on a suitable frame, and connected with a slow-swinging, undamped D'Arsonval galvanometer. The test coil enclosed all the tubes which passed through one of the pole-faces of the motor, and could be pulled out of the field in a very small fraction of a second. A standard mutual inductance was made use of to find the number of tubes corresponding to the observed swing of the galvanometer. The secondary was put in series with the galvanometer and test coil. Since the mutual inductance was 0·01 henrys, a change of one ampere in the primary would give the same E.M.F. in the secondary that would be produced by a change of one million lines in a coil of one turn. Thus, by finding the current in the primary which would give, on break, the same galvanometer swing as was produced by the test coil, the number of tubes cut could be determined. In this way, neglecting magnetic leakage as before, the inductance of an armature coil with one convolution was found to be 0·00000232.

4. *Apparent Inductance.* — The ratio of the virtual potential difference between the terminals of the coil, to the current flowing through it, may be called the apparent impedance of the coil, $I_a = \frac{E}{C}$. This may be resolved into two components, at right angles to one another—the resistance and the apparent reactance. If the apparent reactance is divided by p, which is $2\,\pi$ times the frequency, the apparent inductance is obtained, $= L_a$. $I_a = \sqrt{R^2 + p^2\,L_a{}^2}$. This is the method made use of in the observations with alternating currents which have been previously recorded. Since the true inductance of the coil depends mainly on the dimensions of the air-gap, it seems that the apparatus, when the armature coil is in the median plane, can be treated to some extent like a transformer with an air core; the iron of the field magnets acting like a secondary with a high resistance in its circuit, while the field-magnet coils, when short-circuited, form a secondary of very low resistance.

In a transformer with an air core and a short-circuited low-resistance secondary, the current in the primary, at any instant, is, if p is large,

$$c = \frac{E\,L'\sin(p\,t - \epsilon)}{\sqrt{(L\,L' - M^2)^2\,p^2 + L'^2\,R^2}};$$

or $c = C\sin(p\,t - \epsilon)$;

where
C = maximum current in primary;
E = maximum E.M.F. in primary;
L = inductance of primary;
L' = inductance of secondary;
M = mutual inductance of the two coils;
R = resistance of the primary.

The current in the secondary is

$$c' = \frac{M\,E\sin(p\,t - \epsilon - \pi)}{\sqrt{(L\,L' - M^2)^2\,p^2 + L'^2\,R^2}}.$$

It lags behind the current in the primary by half a period, and exactly opposes the tendency of the primary current to produce a flux through the secondary.

The apparent impedance is

$$I_a = \frac{E}{C} = \sqrt{R^2 + \frac{(L\,L' - M^2)^2\,p^2}{L'^2}}.$$

Thus the apparent reactance is $\frac{(L\,L' - M^2)^2\,p^2}{L'^2}$, and the apparent inductance $L_a = \frac{L\,L' - M^2}{L'}$.

The maximum magnetic flux through the primary is $\frac{C}{n}\left(\frac{L\,L' - M^2}{L'}\right) = \frac{C}{n}\,L_a$, n being the number of turns in the primary. Thus in this case the apparent inductance is measured by the number of tubes that pass through the coil with unit current, multiplied by the number of turns.

It is also true that the magnetic flux, N, at any instant is equal to $\frac{c}{n}\,L_a$; so that if n times the ratio of the instantaneous flux to the instantaneous current is called the instantaneous inductance, L_i, it follows that in this case $L_a = L_i$.

The maximum magnetic flux through the secondary is $\frac{C\,M\,R'}{n'\sqrt{L'^2\,p^2 + R'^2}}$, where n' is the number of turns in the secondary, and R' is its resistance. If R' is small this quantity will be small. If the transformer is constructed in such a manner that $L = L'$, the apparent inductance is $L_a = \frac{L^2 - M^2}{L}$. Thus it appears that if $L = M$—that is, if there is no magnetic leakage—the apparent inductance will be zero.

CALCULATION OF MAGNETIC LEAKAGE.

Suppose the armature coil is in the median plane, and consists of one turn. If the copper in the field coils is used to form a closed coil of one turn about each yoke, the effect of the short-circuited field on the primary will not be altered. Suppose, also, that the inductance of this field coil is the same as that of the armature, as will be the case if magnetic leakage can be neglected. The observed steady flux through the poles, with unit continuous current through the armature coil, may be taken as the mutual inductance of the two coils, $M = 0{\cdot}00000232$.

The apparent inductance with the field short-circuited by 0·1 ohm is 0·00000102 henrys. Hence, since $L_a = \frac{L^2 - M^2}{L}$, it follows that $L = \frac{L_a}{2} + \sqrt{M^2 + \left(\frac{L_a}{2}\right)^2} = 0{\cdot}00000288$ henrys. The difference between this and the mutual inductance gives the magnetic leakage about the ends of the coil and between the pole-tips. This difference is 0·00000056, which appears rather high, as the whole inductance of the armature coil without iron was found in one experiment to be only 0·00000062 henrys.

Another method used to obtain some idea of the leakage

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was to measure the current induced in the field coil. The number of turns in the field coil could not be determined with any great accuracy without unwinding them, but it appeared that 163 ampere-turns in the armature coil produced 146 ampere-turns in the short-circuited field coil. This makes $L = 0{\cdot}00000259$ henrys, and the magnetic leakage, measured in henrys, 0·00000027, or about half the value previously obtained. No doubt the assumption that $L = L'$ if the number of turns is the same is not quite correct. In any case the two values are of the same order.

EXPERIMENTAL INVESTIGATION OF THE FIELD PRODUCED BY AN ALTERNATING CURRENT IN AN ARMATURE COIL.

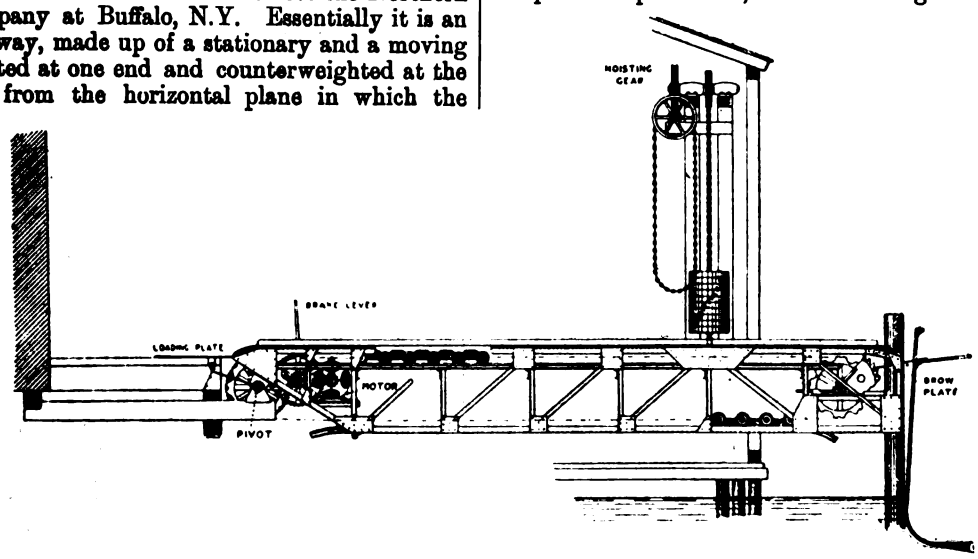
A narrow rectangular coil of five turns was wound of No. 16 wire, which could be laid on the armature parallel to the axis. An alternating current of 27·7 amperes was sent through coil C, of 11 turns, wound like an ordinary drum winding on the armature, which was removed from the field, the 11 wires on each side being bound together into a solid bunch. When the narrow coil lay on the armature, as near as possible to one side of C, 0·172 volt was induced in it, while when it was moved to the position on the armature where it was equally distant from the two sides of C, 0·145 volt was induced. This shows that there is no very great difference in the number of tubes per square centimetre proceeding from different parts of the surface of the armature This tends to show that the field, in this case, is like that shown in Fig. 3.

It would be interesting to continue the experiment with the armature in place in the short-circuited field, and see how far the magnetic distribution sketched on the right side of Fig. 1 is correct.

(To be continued.)

ELECTRICALLY-DRIVEN FREIGHT RAMPS.*

There has recently been devised a comparatively new application of electric power, in connection with an interesting labour-saving and labour-assisting device, known as a travelling freight ramp. This machine is designed for the economical and rapid loading and unloading of freight to and from vessels, and the accompanying illustration is a detailed side view of one of six installed for the Northern Steamship Company at Buffalo, N.Y. Essentially it is an adjustable gangway, made up of a stationary and a moving part, being pivoted at one end and counterweighted at the other; so that from the horizontal plane in which the



sketch shows the machine it may be raised and lowered to have its outboard end meet the ports of vessels of different heights. The travelling, or carrying, portion of the ramp consists of an endless apron composed of metal-covered planks attached to two strands of chain running around head and foot wheels, the apron being carried on its upper and lower runs by small wheels travelling on T-rail tracks, as the sketch will make clear. At either side of the foot projects an arm for the reception of one end of the brow plate connecting the ramp with the vessel to be loaded or unloaded. It will be noticed that this arm has a series of recesses, so that in whatever position the ramp may be placed the brow-plate is readily made to form an unbroken path from the vessel to the travelling apron.

The ramps at the Northern Steampship Company's pier are about 25ft. long, the moving portion of each running at the rate of 108ft. per minute, and the direction of travel being reversible the same machine will carry freight either to or from the vessel. Supposing, for instance, that a vessel is to be unloaded, and that its port is below the level of the wharf, the hand-chain shown in the cut is operated to raise the counterweights, and so correspondingly lower the outward end of the ramp, which is locked in the desired position by the worm-gearing of the hoisting arrangement. The brow-plate is then adjusted, and the men push their loaded trucks on to the moving apron. Instead of requiring the assistance of several others to get the freight up the incline (we will say it is 20deg.), the wheels of the trucks are allowed to rest in the recesses formed by the metal-covered planks, and thus each man is relieved of his load until he arrives at the warehouse end of the wharf, where he unloads, and then returns to the vessel by way of the stationary part of the machine. Not only is a decided economy in labour effected by the use of this apparatus, but the time required to handle a fixed amount of freight is materially reduced; a valuable consideration, in that the vessel's detention at the pier is of much shorter duration, and the pier is accordingly enabled to accommodate a greater number of vessels in a given period. To operate each of these machines there is used a 5-h.p. alternating-current motor, which, it will be observed, is located between the upper and lower runs of the travelling apron, an arrangement that puts the motor in an out-of-the-way and easily-accessible place and utilises an otherwise useless space. By means of a friction clutch the travelling portion of the ramp is readily started or stopped, and through the medium of a brake it is prevented from running down hill when the clutch has been thrown out of gear. At the Metropolitan Steamship Company's Boston pier four similar machines are in operation. At this point, on account of the salt-water waves, the motors are placed overhead, under the roof of the wharf. The ramp design is one that can readily adapt itself to the conditions found at different harbours. At New Orleans, for instance, where the rise and fall of the river is from 30ft. to 40ft., the Southern Pacific Railway Company has installed a number of these machines, each about 100ft. long. Here the ramps are in pairs—*i.e.*, one for loading and the other for unloading—the stationary gangway being dispensed with, and are run at a speed of 240ft. per minute. A great deal of the freight (canned goods, barrels of molasses or sugar, etc.) is transferred to or from the vessels without using trucks. Where trucks are employed no one, as a rule, accompanies them on the ramp, the men at the discharging end taking care of them as they arrive, unloading them and returning them on the machine travelling in the opposite direction.

The construction of the ramps is such that the wear and tear upon them is practically nothing, and one company using a large number of these machines reports that they saved their cost in less than a year.

The Link-Belt Engineering Company, of Philadelphia and New York, made the installations referred to above.

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TELEPHONE COMMITTEE'S REPORT.

The Select Committee appointed by Parliament to consider the general questions connected with the granting of licenses in Great Britain for the establishment of telephone exchanges which will compete with the National Telephone Company have decided on their report. Although the terms of this report are fixed it has not yet been published, and the forecasts of the daily Press are all that we have to guide us in placing its final contents before our readers. Hence we propose to refrain from criticism till the actual report is before us, and to state simply the lines on which future extensions may be possible. In drawing up this *résumé*, we are indebted to the *Times* and to the *Manchester Guardian* for many statements made. The chairman of the committee, Mr. Hanbury, after the numerous witnesses had been examined, invited his committee to answer various questions. The first three were as follows: (1) Is the telephone service now, or is it calculated to become, of general benefit; (2) is the Post Office in any way hindered by legal agreement or by good faith from competing itself or through licensees with the National Telephone Company in exchange areas; and (3) ought competition to take place? The committee decided practically unanimously that the telephone service is not at present of general benefit, either in the United Kingdom at large or in those limited portions of it where exchange areas exist. Thus they consider that the tendency of the present arrangement of having the trunk lines in the hands of the Post Office is not equitable. It is found that one tendency of this system is to limit the use of the telephone service as a whole, and especially of the trunk lines of the Government, to the company's subscribers, to the exclusion of and at the cost of the general taxpayer. In other words the lines are engineered and erected out of public funds, and only a limited number of taxpayers, who also subscribe to the National Telephone Company, are able to get any benefit from the expenditure. Next comes the question as to whether the Post Office is entitled to compete in any area, either itself or by means of licensees, and on this point the contradictory evidence given by the company's officials and by the Government's representatives had to be considered by the committee. The committee, however, finally arrived at the unanimous conclusion that the Post Office has a right to so compete. The committee add that competition of some sort is both expedient and necessary, provided certain precautions are adopted. This competition will, the committee consider, tend to extend and popularise the service, and will also avoid a danger, which is by no means remote if no alternative system is in operation, that a purchase of the company's undertaking at an inflated price may be forced on the Government at the expiration of the period of the present license. The reservation is made, however, that the licenses of both the company and any municipality should lapse together, so that the Post Office may have the opportunity of acquiring all telephone systems if it should choose in 1911. The committee insist in

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granting new licenses to municipalities upon other conditions, such as a complete metallic circuit, the payment of a 10 per cent. royalty to the Post Office, the prohibition of any desire to carry on the service at a profit with a view to lightening the burden of local taxation; a minimum rate should also be imposed to protect the Post Office against a reduction of rates to a point which would involve an unremunerative service after 1911, etc. That municipal authorities shall be at liberty to compete with the National Telephone Company upon these conditions is said to have been established by the unanimous vote of the committee.

THE ZIPERNOWSKY-DERI PATENT.

As there is a probability of a fight over the patent granted in 1885 to Carl Zipernowsky and Max Déri, of Budapest, for a system of transformer distribution, we give below the full text of this patent, with both the provisional and complete specification, so that our readers may be able to look up the facts of the case. It is interesting to know also that the system described, with a high-tension parallel distribution connected to the primaries of the transformer, was used largely at the Budapest National Exhibition, which opened in May, 1885. Some 97 arc lamps and about 1,060 incandescent lamps were supplied in this way over distances up to $1\frac{5}{8}$ miles from the station. The generator used was rated at 60 kw., and the field magnets were compound wound. The compounding was done by means of a commutated current, which was obtained proportional to the main current by transformation. From this it will be seen that the inventors describe a perfected system in specification, and not what might be done. We understand that eminent experts have given opinions favourable to the validity of the patent in question, and also state that back royalties can be enacted. Hence a keen fight is likely to result, and we are glad to see the electric lighting undertakers combining in common defence.

We notice from one of our contemporaries that Mr. Rankin Kennedy is now reiterating his claim to have published a description of the system in 1883, but we can hardly agree with him in this respect. An interesting letter of his appearing in the *Electrical Review* on June 9, 1883, clearly shows the imperfections of the Gaulard and Gibbs series-transformer system, and the last sentence reads as follows: "In parallel, however, the secondary generator is a beautiful self-governing system of distribution, but what about the size of the conductors for such a system? Prodigious!" Our reading of the last part of the sentence, is that the author had no idea of a high-tension primary circuit for the transformers in parallel, and it must be remembered that the Gaulard and Gibbs transformer had nearly always a transformer ratio equal to unity.

The following are the Blue Books:

PROVISIONAL SPECIFICATION, No. 3379*, March 16, A.D. 1885.

Improvements in Distributing Electricity, and Apparatus therefor.

I William Phillips Thompson Fel. Inst. P.A. of the Agency for Foreign Patent Solicitors 6 Lord Street Liverpool in the County of Lancaster and 323 High Holborn in the County of Middlesex Civil Engineer do hereby declare the nature of the said invention for IMPROVEMENTS IN DISTRIBUTING ELECTRICITY AND APPARATUS THEREFOR (a communication from abroad by Carl Zipernowsky and Max Déri both of Budapest in the Empire of Austria engineers) to be as follows:—

This invention relates to improvements in means for distributing electricity.

The induction bobbins consisting of two insulated wire coils and a common core of iron wire, like the Ruhmkorff apparatus, have already been used since a certain time in combination with alternating currents, to transform electricity

By means of this transformation the electricity may be transmitted in a cheap way in large distances, and employed in several local circuits for lighting and other purposes.

It has not been possible hitherto to effectuate the distribution of electrical currents by these means in such a manner as is necessary for practical application, that is to say, that the number of the places of consumption may be optionally increased or diminished without altering the functions of the other places. Furthermore it has not been possible hitherto, to obtain a satisfactory result of the mechanical effect of the transformation in proportion to the power applied, when the consumption of current in the different places, as lamps etcetera is at one time a large one, and at another time a small one.

In order to obtain this important result, that it is say, to make the different places independent of each other and to make the mechanical effect of the transformation as favourable and as constant as possible, even when the working is variable, the following proceeding for the application of induction-bobbins has been devised.

The induction bobbins are grouped in secondary distributing stations, and the primary bobbins of such a station of second order are intercalated either successively in series or parallelly. In the first case the secondary or induced bobbins of all the stations must form only one local circuit, the induced bobbins may be grouped in quantity or in series. In the other case, when the primary bobbins are arranged parallelly, each induced bobbin may form a special secondary circuit, or, as in the first case all the induced bobbins of such a station may be united to one common local circuit. The places of consumption are intercalated in the local current, in all cases, in a parallel manner. The main rule is, that the several groups of induction bobbins or the different stations of second order form, in reference to the main distributing line of the primary current, always only branch circuits. A distributing net consisting of an optional number of parallelly arranged branch stations and of an optional number of local circuits separated from one another is thus obtained.

The stations of second order are made independent from one another by maintaining invariable the tension of the primary current, where it enters into the secondary stations. To obtain an automatic regulation of alternating currents in a satisfactory manner, that is to say, to receive an invariable tension of the current in certain points of the net, even if the effect of the generator and the resistances in the circuit are variable, the following new and simple means are applied.

The excitement of the reversed current machine is usually effectuated by a current of a determined invariable electromotive power, either by the current of a special dynamo-machine or by a current of the same direction, which is taken from the alternating current generator itself. In reversed current machines with permanent magnets the magnetizing is invariable by itself. To obtain a constant intensity of the current or of the tension, the magnetizing ought to be invariable and depend directly on the main current.

This purpose is attained by the following proceeding.

The main current to be regulated is made circulating through the bobbins of a so-called alternate-current second generator or inductor, before it reaches the working place. The second bobbin, which is wound parallelly to the first round, a common iron core is intercalated in the exciting circuit. The alternating current indirectly produced by the second spire, that is to say, secondarily induced by the main current, is turned into the same direction by a commutator adapted to the shaft of the machine.

If the secondary spire is intercalated in the exciting current in such a way that the current induced therein is added to the exciting current, the magnetising will change in the same sense as the intensity of the main current. The magnetizing will change in the contrary sense, when the secondarily induced current is circulating opposite to the exciting current.

The first arrangement serves for regulating the tension of the current, the second arrangement for regulating the intensity thereof. The principle of the automatical regulating method is therefore to excite the electromagnets by the combined action of two currents of different origin,

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One current continuous or turned into the same direction, is constant in consequence of its derivation, this is the true exciting current, the other secondary induced current, which is produced indirectly by the main current, and consequently dependent on it, must be variable according to its nature. The first mentioned current is usually preponderating so much the more as the variations to be compensated in the main current are less important. If the variations are very important, the constant exciting current may be less important; it may even entirely be spared unless it is without that superfluous, as it is the case in generators with permanent magnets.

The new regulating method may be further illustrated by the following example.

Fig. 1 shows in a diagram a reversed-current machine, in which the electromagnets S are rotating and the wires of the armature fixed. The magnetising current is taken from a separate wire *a b* and turned into the same direction by the commutator C. A and B are the points where the working current leaves the armature of the machine, *a* and *b* the points where the exciting current exits. D E is the wire bobbin of the inductor intercalated in the main circuit and *d e* the wire bobbin intercalated in the circuit of the exciting current.

The main current flows from A over D E to M and from M back to B. The exciting current flows from *a* to *d*, reinforces itself here with the secondarily induced current of the bobbin *d e*, goes then to the commutator C and after having circulated as a direct current through the bobbins S it returns to *b*.

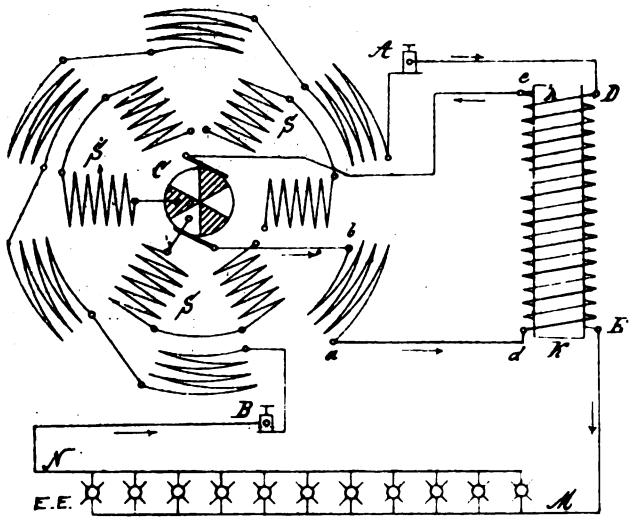

FIG. 1.

Supposed the potential difference between M and N shall be maintained constant. The arrangement is now made in that way, that the desired tension between M and N, will be obtained at the smallest intensity of the current in the main line, and that at a normal or greatest allowed intensity of the current, the secondary induction in *d e* may be exactly great enough, to maintain, under otherwise the same conditions, the tension between M and N the same as formerly, and that only in consequence of the reinforced magnetizing.

Rather exactly the same tension will then exist in the interposed intensities of the current. Besides the possibility of giving the induction bobbins the necessary dimensions the movableness of the iron core K may also serve for obtaining the necessary effect of the induction.

Fig. 2 shows in a diagram how the secondary generator A is employed for regulating the current in such a case, that the excitement is produced from the exterior at D by a continuous current, by a separate dynamo-machine for instance by a primary or secondary battery, etc.

The main current S flows through the primary windings of the secondary generator A and hence to the several applying places. The secondarily induced current goes from A to the two contact brushes b^1 and b^2 of the commutator C, which is fixed upon the shaft of the reversed current machine. To the same shaft is also connected a collector B, consisting of two contact rings r^3 and r^4 and two contact brushes b^3 and b^4. These contact brushes are in conducting connection with the constant current source, that is to say, with the two pinching screws b^5 and b^6. One end of the coil M is attached to a system of sectors c^1 of the commutator the other end to the contact ring r^3, while the contact ring r^4 is in communication with the other system of sectors c^2 of the commutator. The exciting current follows now the way from b^6 to b^4 and from r^3 to c^2 as a continuous current, from c^2 b^2 over A until b^1 and c^1, a variable current of an uniform direction comes in addition to it (resp. is to subtract from the first current) the exciting current is a continuous one from *c* over M to r^4 and further from b^3 until b^5.

In the two examples the electromagnets are supposed movable and the armatures fixed. The arrangement can of course be carried out also in the inversed manner, small modifications in the intercalation are only necessary for that purpose. The essential of the regulation with the aid of secondary generators is sufficiently explained by the above examples.

A great number of combinations of the disposable currents for the purpose of exciting the electromagnets is possible. The constant exciting current can be taken

(1) from an exterior current source,

(2) from the armature itself of the reversed current generator, namely, from separate wires of the armature, or as a branch current of the closing circuit, if a constant tension is to be obtained, or as a portion of the main current if a constant intensity of the current is desired, or

(3) from a secondary generator, where it is induced by any one of the currents mentioned under 2.

The variable exciting current is taken from the armature

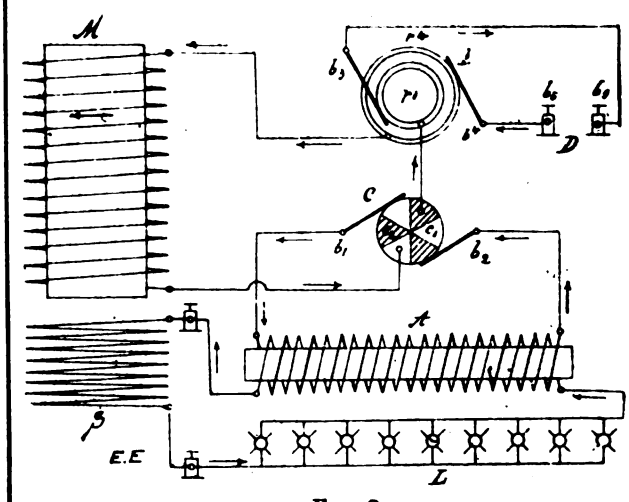

FIG. 2.

of the reversed current generator as branch current of the closing circuit, when a constant intensity of the current is to be obtained or as a portion of the main current, when the tension shall be a constant one. These currents are taken therefore also either directly or indirectly by secondary generators, the current being secondarily induced by one of the above-mentioned variable alternating currents.

Thence follows, that sometimes two secondary generaters or one secondary generator with three coils are employed, in such cases, namely, where the constant exciting current as well as the variable one are indirectly produced.

An important advantage of this regulating method, especially in reference to such cases, where alternating currents of a considerable tension are to be regulated is, that in consequence of the transformation it will easily be avoided, that currents of a high tension must be used for exciting the electromagnets. It is given on the contrary, a comfortable mean for placing the currents which are to be commutated and must serve for excitement, in any desired condition. It is thus obtained, that in the current generators of the main station the force of the exciting magnets changes always automatically in such a way, that the tension in question must rest invariable at the entrance into the secondary stations.

The several places of consumption in the local circuits are independent from each other in consequence of their distribution as branch lines of the secondary circuit line, if only the interior resistance of the induced bobbins is pro-

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portionally small and if the primary tension of the station does not change.

If the independence of certain lamp groups from each other shall be still more complete, it is advantageous to supply these groups from a separate line; for an optional number of secondary circuits insulated from each other can be taken from a bobbin.

This system of distributing electricity is therefore based upon the circumstance, that the tension of the current must remain invariable in the primary distributing net, as well as in all the local circuits.

To supply in the local circuits places of consumption of different tension, different lamps for instance, the secondary station is subdivided, where it is necessary, in several groups of bobbins, which form with their induced bobbins a tension series.

On the commencement and on the end of the induced series of bobbins, and also on the points of subdivision (Fig. 3, the roman numbers I. to IV.) pinching screws are applied. These pinching screws represent then different potential differences, and in conducting a circuit from each pinching screw I II III and IV a local net is produced, from which lamps, etc., with different tension may be supplied. The tension for instance between I and II or between II and III, or between III and IV is 30 volts, between I and III or between II and IV—60 volts, and between I and IV—90 volts.

In a thus arranged distribution of currents a different and variable intensity of current will reign in each branch

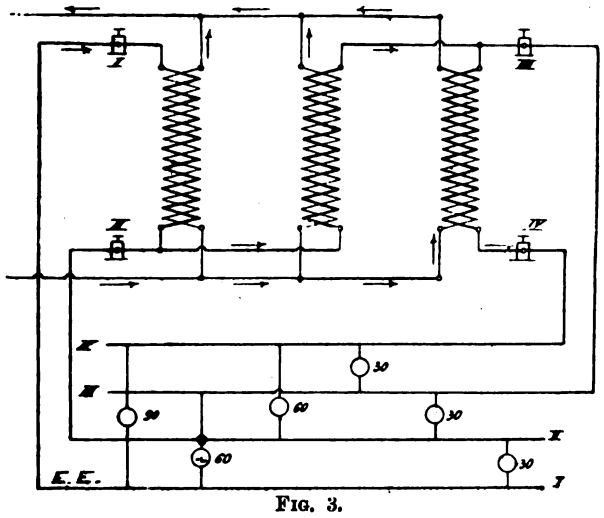

FIG. 3.

line of the large primary net, in contradiction to the systems hitherto known, where also such induction apparatus for distributing electricity have been proposed, but with a constant intensity in the entire distributing circuit. The primary intensity changes in each branch circuit proportionally to the increasing or decreasing of the number of places of consumption in the corresponding branch stations. This comes from the increasing of the electromotive counter-force of the induction bobbins, when the intensity of the secondary current decreases and *vice versâ*. Thence follows, that the consumption of energy changes for each secondary station in a similar proportion as the consumption of the current in the corresponding local circuit. The whole expense of power and the consumption of current is thus regulated in the whole distributing net. In order to regulate still more exactly, if necessary, the primary current in any branch, or the secondary current in a local circuit, or to modify intentionally the intensities of the current in certain circuits the ordinary rheostats or resistances are not employed, instead thereof special arrangements, consisting of induction bobbins as represented in figure 4, are made.

One of the spires A B conducting with itself the current to be regulated, is subdivided longitudinally. The points of subdivision are 1 to 11. The second spire *a b* produces induced currents. This spire is also subdivided from 12 to 21. In the interior of these two spires is the iron core K. The points 1 to 21 are provided with connecting wires which are successively put into connection with a contact C or separated from it. The body C is moved either by hand or automatically according to the circumstances. The more wire points from 21 downwards are touching the body C, the more windings of the spire *a b* are short circuited, and the more points are touching C from 11 downwards, the more the way of the current from A to B will be shortened. The short circuiting of the windings from 21 to 12 effectuates a successive reduction of the electromotive counterforce in the primary spire A B and the shortening of the current way from A to B reduces also the resistance opposed to the current. This arrangement offers therefore a very simple mean for changing the intensity of the current in a given circuit. The efficacious mean is caused by the circumstance, that the electromotive counterforce of a spire wound round an iron core is for alternating currents considerably stronger than the proper resistance of the wire from which the spire is made.

Not only insulated copper wires are used for the spires A B and *a b*, but also insulated wires made from another badly conducting metal.

Fig. 5 shows in a diagram how the branch stations are supplied from the main circuit. O is the central station, between the two circuits of the main line M and N reigns an invariable tension. There may for instance three secondary stations be represented. Station I consists of

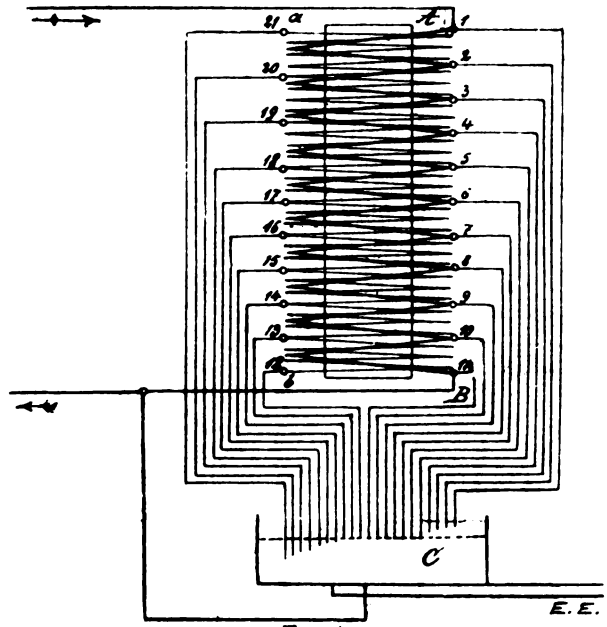

FIG. 4.

a single induction bobbin, station II has two induction bobbins, the primary spires whereof are arranged parallel to each other; the secondary spires are disposed in the same way. Station III consists of three induction bobbins, the primary spires are intercalated in sequence, but the secondary spires parallel to each other. A regulating device is intercalated at C into the local circuit of the third station, it is of a similar construction as described in fig. 4.

All the secondary stations of the distribution shown in fig. 5 are parallelly branched off from the main circuit line M N.

It will especially be understood that the inventors claim these improvements as their invention whatever may be the shape and form of the employed induction apparatus or secondary generators.

Dated this 14th day of March 1885.

WM. P. THOMPSON AND CO.
Agents for the Applicant.

COMPLETE SPECIFICATION (AMENDED).

Improvements in Distributing Electricity.

I WILLIAM PHILLIPS THOMPSON of 6 Lord Street Liverpool do hereby declare the nature of this invention (a communication from Carl Zipernowsky and Max Déri of Budapest, Hungary) and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

For sometime past induction coils consisting of two coils or layers of insulated copper wires with a common iron core

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similar to the Ruhmkorff apparatus, have been used for the transformation of alternating electric currents.

By means of such transformation electric energy can be cheaply conveyed over lines of considerable length and be utilised in a number of local circuits for lighting and other purposes.

The distribution of electrical energy by such means, has however not succeeded in such a manner as to satisfy the requirements of every-day practice, because it was not possible to increase or diminish the number of points of consumption in operation, without effecting the working of the others in a marked degree, and it was therefore necessary to use mechanically acting regulating devices at the different points of consumption, to compensate for the variations caused by the changes in the quality of electrical energy used.

In the same manner the efficiency of the systems hitherto used was greatly dependent upon the number of points of consumption in activity.

Now the object of this invention is to make all individual points of consumption of electrical energy quite independent from one another, all necessary regulation being made by or at the generator of electricity.

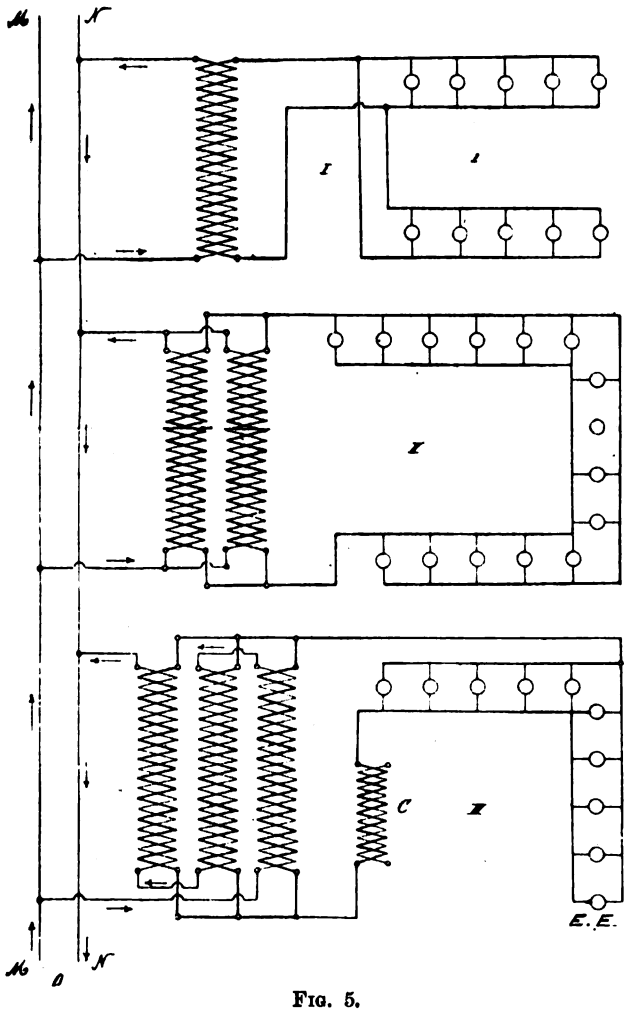

FIG. 5.

We group the induction coils or transformers so as to constitute secondary distributing stations or local centres. The primary coils of the several transformers of such a local centre may be arranged either in series or in multiple arc circuits. In the former case the secondary or induced spires of all the transformers of the respective station form a single local circuit irrespective of whether these induced spires are connected up in quantity or in series. In the second case, however—i.e., when the primary coils of the several transformers constituting a local centre are connected up in multiple arc, either each individual induced coil may form a separate secondary circuit or any number or all of the induced coils of the transformers of a local centre may be connected to form a single local circuit.

The apparatus for the actual utilisation of electricity, as incandescent and arc lamps, electro-motors etc, are in all cases connected up in multiple arc in the local secondary circuits.

But the distinctive feature of our system of distribution is, that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current i.e. the primary circuits of the several local centres, any one of these being taken as a whole, are connected in multiple arc.

In this manner we have conductors distributing the primary (high tension) current in as many branch circuits as there are local centres and any desirable number of secondary (low tension) circuits.

Now the electromotive forces of the two coils of a transformer bear a constant ratio to one another—Therefore if the internal resistance of such an apparatus is very low, the secondary tension will remain almost unaltered, if we only have a constant difference of potential at the terminals of the primary coil.

The individual points of consumption in the several local circuits are independent of one another by reason of their distribution as branch circuits derived from the secondary line (i.e. connection in multiple arc), provided only that the internal resistance of the transformers be relatively low, and the primary tension at the station invariable.

If the independence of individual groups of lamps must be still more perfect, it will be advisable to feed such a group by an independent line, as any desired number of secondary circuits may be derived each separately from one transformer.

It follows from the foregoing that our system of distributing electrical energy by means of alternating currents and induction coils or transformers is based upon having a constant difference of potential in the primary conductors as well as in the secondary ones.

In a distribution of current according to our system there will be a variable intensity of current in the main line as well as in every branch circuit of it, in contradistinction to the systems of distribution by inductional transformers hitherto known or proposed, all of these being based upon constant intensity of the primary current—In our system the intensity of the primary current varies in the same way as the number of points of consumption in activity. This is caused by the counter-electromotive-force of the transformers somewhat increasing when the intensity of the secondary current diminishes and vice versâ. The consumption of energy for each local station varies in the same manner as the current in the corresponding local circuit and consequently the total consumption of power varies in accordance to the total supply of current in the secondary circuits.

The drawing is a diagram showing the manner in which we supply local centres from the main line. At O is the central station—Between the main lines M and N the tension is invariable.—Three local centres or secondary stations are shown—Station I consists of a single transformer; at Station II there are two transformers with their primary as well as their secondary coils connected up in multiple arc; at station III there are three transformers, with their primary coils in series, the secondary ones in multiple arc—As it will be seen all the branch circuits leading to the several local centres are derived as parallel circuits from the main line; i.e., connected up in multiple arc.

We desire it distinctly to be understood that the form of the induction apparatus or transformers used may be of any kind whatever, without departing from the principle of our invention.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed as communicated to me by my foreign correspondent I declare what I claim is:

In the application of induction coils or transformers for alternating electric currents the arrangement of several stations of second order as branch circuits of the main line, i.e. connecting up the local centres with the main line in multiple arc, to which main line is supplied an alternating electric current of a tension as constant as possible, substantially as described and shown in the drawing.

Dated this 12th day of December, 1885.

W. P. THOMPSON.

Per his Agents, W. P. Thompson and Boult

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GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE II.

(Continued from page 182.)

Another patent, referring to the cleansing of guttapercha, was likewise taken out by Charles Hancock in his own name (No. 11,032* O.L.), on Jan. 12, 1846, under the title "Manufacture and Application of Guttapercha." In this specification a method is proposed for purifying guttapercha by straining it in the hot and plastic state through wire gauze under pressure; but mention is here already made of cleansing the raw material by dissolving it in oil of turpentine or other suitable solvent, and filtering the solution through wire gauze, flannel, or other fabric, afterwards distilling off the solvent to recover the guttapercha.

star-shaped section, enclosed in a cylindrical shell provided with one or two projections or ribs, against which the guttapercha is forced in going round. The difference between the modern washer and that proposed in Brooman's patent specification, is that it has only a single-fluted roller, whereas the old machine had two smooth ones, working against each other. As shown in Fig. 22, the cylindrical shell is enclosed in a large iron case, which is filled with water, heated by means of direct steam. The dirt, which is washed off, falls through the lower part of the shell into the outer case, whence it is from time to time withdrawn through one of the little doors shown in the illustration. The washing process is carried on until samples taken from the charge appear sufficiently clean.

The straining machine is shown in Fig. 23. The guttapercha in the plastic state as it comes from the washer is put into a strong iron cylinder with a perforated bottom, on which a number of discs of fine-wire gauze have previously been placed. The piston is then driven down by means of an hydraulic

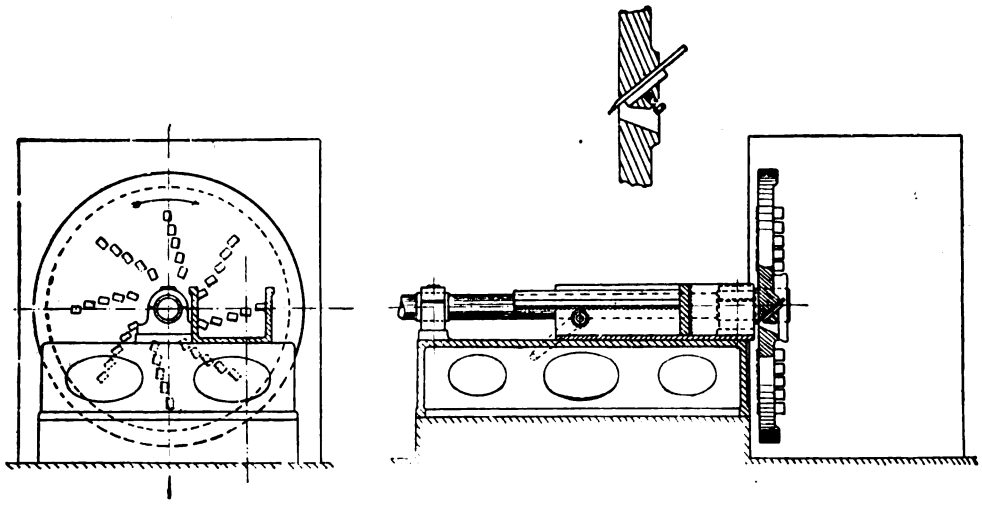

FIG. 21.

Those were the early machines used for cleansing guttapercha. At the present day various systems are employed by different manufacturers, but generally speaking it may be said that the raw guttapercha is either first cut up in a slicing machine and then softened in hot water, or the lumps are directly placed in hot water and the soft material transferred to the washing machine. There it is washed with plenty of hot water for a longer or shorter time, according to circumstances, and passed through a strainer. After straining it is mostly washed once, then put into the kneading or masticating machine to consolidate it and remove the mechanically-enclosed water, and finally it goes to the rolling-mill, where it is made into sheets of

cylinder and force pump, and the soft guttapercha squeezed through the fine meshes of the gauze into a collecting tray underneath. Considerable pressure is required for this operation, varying between 14cwt. and 18cwt. per square inch, according to the stiffness of the material.

The kneading machine or "masticator" is illustrated in Fig. 24. In general appearance it resembles the washer, but the roller has a smaller diameter, and the flutings are more numerous and not so deep. The hinged lid can be kept down by means of a bar and suitable catches. The guttapercha is kept hot during mastication, and the water escapes in the form of steam through the large openings at the top.

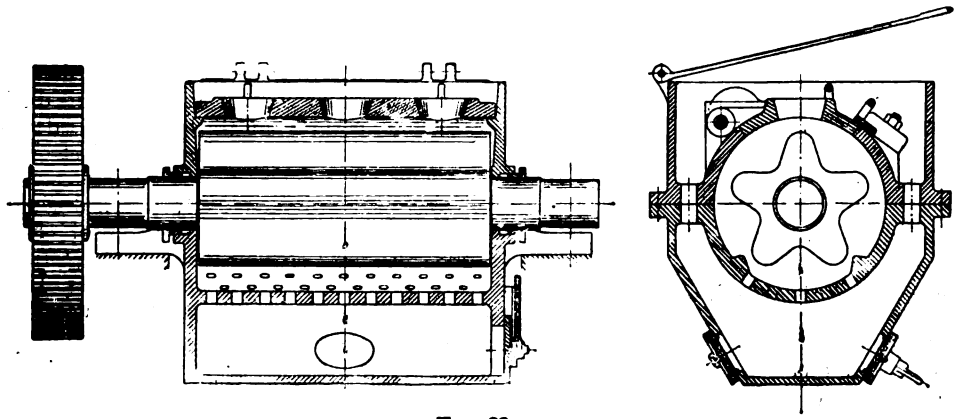

FIG. 22.

various thicknesses. I will now show you these different machines on the screen.

The slicing machine or chopper (Fig. 21) at present in use is pretty much the same as that proposed by Hancock 50 years ago, except that it is provided with a greater number of fluted and serrated knives instead of only three plain ones. The enlarged section shows how the knives are fixed in the slots of the heavy iron disc. The blocks of raw guttapercha are packed into the trough, shown in the illustration, and are then forced against the rotating disc by the piston, which is advanced by a rack and pinion. The slices cut off by the knives fall into the rectangular box shown in outline in the drawing. I have here a basket filled with this sliced material, and I purposely selected a guttapercha containing a large amount of wood and bark.

The washing machine (Fig. 22) consists of an iron roller of

The washers usually hold about ½cwt., the masticators 1cwt., and the strainers ¼cwt. of guttapercha.

(To be continued.)

* Cantor Lectures delivered before the Society of Arts.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness

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of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

88. Give full particulars of methods of measuring the distance (1) between the carbons of an ordinary arc lamp when running, (2) between the carbons of a Jandus arc lamp?—J. C. R.

89. Is it advisable to run two alternators of different design in parallel, and on what does the smooth running of alternators in parallel chiefly depend?—A. B.

ANSWERS.

Question No. 82. Give a drawing of a good form of insulator for outdoor use which will stand a pressure of 2,000 volts, and will carry a a weight of 50lb. Give the resistance of this insulator both when wet and dry?

Best Answer to No. 82 (*awarded* 10*s.*).—Fig. 1 shows in elevation and in section a double-shed oil insulator of white china, which was used for carrying a three-phase power line in the Transvaal. So far as is recollected, the dimensions of the insulator were 6in. in height by 5in. in diameter. The stalk was of galvanised rod iron 1in. in diameter, and was cemented into the china head by means of sulphur. The insulator, as will be seen, consists of two parts, an upper, which is fixed to the stalk, and a lower, which is removable by the withdrawal of the pin at A. The lower insulator, which is cup-shaped at B, is partly filled with

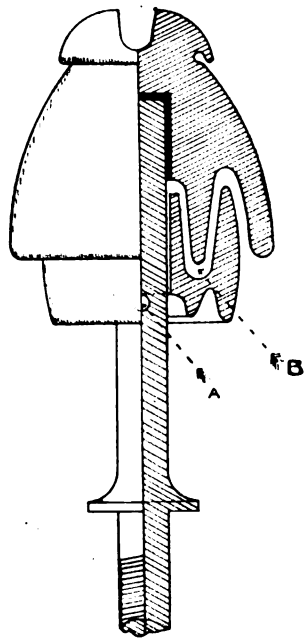

FIG. 1.

resin oil, into which the lower lip of the inner shed of the fixed insulator dips. The insulators were mounted upon Karri wood cross arms, and were staggered in order that the line might be continuously corkscrewed. The cross arms were bolted to steel and cast-iron poles fixed 120ft. apart. The line consisted of three $^{19}/_{16}$ bare hard-drawn copper cables.

The following results were obtained by means of a small testing transformer when the line was equipped, though it should be stated that the tests were taken merely to satisfy curiosity and not for official purposes:

Mean of six tests: Clear, bright, sunny day. Temperature, 85deg. in shade. Ins. Res. = 58,500 megohms.

Mean of eight tests: Early morning, heavy dew. Temperature, 55deg. in shade. Ins. Res. = 3,620 megohms.

Mean of six tests: Afternoon of third day of continuous rain, temperature 78deg. in shade. Ins. Res. = 5,105 megohms.

That the insulation resistance should be higher when a heavy rain had been falling for some time than it was when the insulators were merely moistened with dew is rather singular, though I believe that a similar state of affairs has been noticed in telegraph work. The insulator shown above is a slightly modified form of the insulator designed by Prof. Mengarini for the Rome-Tivoli power line.—F. STOTT.

Question No. 83.—What tests should you make to determine the value of a primary battery for lighting purposes.

Best Answer to No. 83 (*awarded* 10*s.*).—For lighting purposes it is essential that the current taken from the cell remains constant, for as the voltage falls more batteries must be switched in or resistances cut out, but whatever is done the lamps always take a constant current if they are to burn uniformly, and hence a constant current is taken from the batteries. Suppose then we had to test a carbon zinc cell with a single exciting fluid. We have chosen this cell for convenience of reference, but the following method is a general one. We should first of all require certain data: (1) cost of zinc; (2) cost of mercury for amalgamating ditto; (3) cost of the electrolytic fluid; (4) cost of the carbon.

The following apparatus would be the best for performing the electrical tests on the cell: (1) potentiometer (Crompton's form preferred); (2) a sensitive suspended-coil galvanometer (d'Arsonval's); (3) a standard Clark cell; (4) platinoid rheostat; (5) an accurate ammeter (Siemens' or Weston's).

Test.—The zinc plate is first carefully weighed after having been amalgamated and rubbed with clean waste to get rid of any of the loosely adhering mercury. The cell is then set up, and its open circuit E.M.F. (V) noted by means of the potentiometer. The quantity of electrolyte used must also be observed. The rheostat is then connected in series through the ammeter with the terminals of the cell, and adjusted until the current (A) is the same as that which will be demanded of it in practice. The closed circuit E.M.F. (v) of the cell is then observed, and the initial resistance of the cell can be deduced by the formula

$$r = \frac{V - v}{A}.$$

The rheostat is adjusted every 10 minutes or so, and the value of v after adjustment is noted. The zinc plate should be withdrawn every three hours, washed with clean water, and then dried and weighed. The difference between the weights will give the consumption of the zinc, and dividing this by 3 A we get the consumption of zinc per ampere-hour. Dividing this by 1·213grm., which is the theoretical consumption per ampere-hour, we get the *electrical efficiency* of the battery for the first three hours. This electrical efficiency is always greatest for the first three hours, and falls off as the time of the test is increased.

Again, by taking the mean of all the observed values of the terminal volts (v) for the first three hours, and multiplying this by A we can find the mean external watt-hours for a given consumption of zinc. Hence, for every Board of Trade unit (1,000 watt-hours) given to the external circuit, we can find the cost of the zinc dissolved. Similarly, we can find the cost of zinc per unit during subsequent three-hour periods until the zinc needs to be replaced. We must also note how often the electrolyte needs to be changed.

Taking the average cost of a unit during the life of the zinc, which must include the labour of changing the electrolyte, we have now all the data to determine its value as a primary battery for lighting purposes. If the open circuit volts (V) fall off rapidly after the battery has been in use for some time, then we need a larger number of them in reserve to switch in as the voltage falls, and so the interest and depreciation on those reserve cells has to be separately calculated.—J. C. R.

Answer to No. 83 (*awarded* 5*s.*).—The first test should be E.M.F., which should not be less than two volts, and the higher the better. It should be compared with a cell or battery of known E.M.F., such as the Clark standard, by any of the well-known methods, such as the potentiometer, condenser and ballistic galvanometer, or quadrant electrometer. The best is the potentiometer, which can also be used to measure its resistance and the current it is supplying to any circuit. The resistance should be measured very carefully, both when first set up and when it has been in work for some time. To do this set up the potentiometer as for comparing E.M.F.'s, and take the Clark cell as 1·435 volts. Now connect across the terminals a known resistance, so that a current is allowed to flow, and then compare the P.D. at terminals with the E.M.F. of

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standard cell. Then if R is known resistance, and b the battery resistance, we have

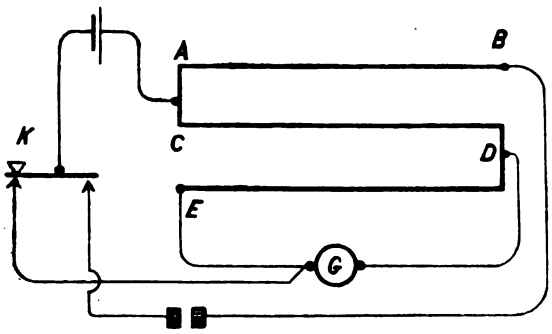
$$P.D. : E :: R : R+b \quad \therefore \quad b = \frac{E \times R}{P.D.} - R.$$

This should be tested with various values of R to find out whether the resistance of the battery is constant, or varies with the current. The internal resistance generally increases with age, and if carbon is used there is very often faulty connections between the carbon and the terminal, and this increases the resistance enormously, and if a large current is passing it will become heated, and this means so much waste, as the energy used there cannot be used in the lamps for lighting purposes. This resistance should be very low, or the battery is very little use for lighting.

If r = resistance of battery,
R = resistance of lamps,

then the efficiency = $\frac{R}{R+r}$.

Another great fault with primary batteries is polarisation. This is best tested with a D'Arsonval galvanometer. The E.M.F. on open circuit is first read, and then it is joined up to a resistance, and the P.D. at its terminals is read every one or two minutes for about half an hour. Then a less resistance used, and another set of readings taken, and from these curves can be plotted showing the polarisation of the battery for different



current strengths. The sketch shows the arrangement for testing this with Post Office resistance box and D'Arsonval galvanometer. A, B, C, D, E represents the box, connected up to battery, galvanometer, Morse key, and plug switch. A B is low-resistance arm in series with battery, C D is high-resistance arm in series with galvanometer, and D E are the ratio arms, used as a shunt to galvanometer. The galvanometer is first calibrated by adjusting C D and D E with a battery of known E.M.F., so that one volt produces 1,000 divisions or other suitable number on the scale. The battery to be tested is then put in, and the time noted when switch is closed, and key pressed, say, every minute, and the deflections noted. If the battery is of very low resistance, a suitable coil must be placed in position A B for carrying the heavy current.

To test for local action, weigh the zinc before being put in, set up the battery, and leave it on open circuit for some time, and then take it out, dry, and weigh it again. If there is any loss in weight, then there is either local action or a short-circuit; the latter can generally be found by examination. If local action occurs the zincs must be lifted out when not in use, and this is very undesirable for lighting, especially if the battery is large. It should also be watched for creeping and for poisonous gases being given off while working, and if it is a so-called dry battery, with outer case of zinc, for cells bursting. The freezing point should be tested with a thermometer, which should be low, so that it will not get frozen in the winter if placed in an out of the way and cool position. The watts given out by battery should be measured, and the cells weighed, so that the output in watt-hours per pound can be calculated from when battery was first set up to its total discharge. The space in cubic feet can be measured for output in watt-hours. Then try recharging, and note the time this occupies.

Last, but not least, the cost per B.T.U. I will take the Daniell cell as an example. This gives a pressure of about one volt, therefore to get one B.T.U. we must have 100 ampere-hours. Leaving out the first cost of battery, there will only be zinc and $CuSO_4$ used up, and we shall have copper set free, which is saleable. One ampere requires ·0003364 grm. of zinc per second, and ·00066 grm. of $CuSO_4$, and sets free ·000329 grm. of copper. Therefore, the zinc used for 1,000 ampere-hours will be

$$·0003364 \times 1,000 \times 3,600 = 1,211 \text{ grm.} = 2·67\text{lb.}$$

The $CuSO_4$ used will be

$$·00066 \times 1,000 \times 3,600 = 2,376 \text{ grm.} = 5·24\text{lb.}$$

Copper set free

$$·000329 \times 1,000 \times 3,600 = 1,184 \text{ grm.} = 2·61\text{lb.}$$

Now,	d.
2·67lb. of zinc at 4d., costs	10·7
5·24lb of $CuSO_4$ at 3¾d., costs	19 7
Cost of materials used	30·4
Proceeds from sale of 2·61lb. of Cu at 8d.....	20·9

This leaves cost of one B.T.U. as 9½d. But all the zinc cannot be used, as some of it is above the liquid, and some of that in the solution is used when not at work by local action. Then there is the efficiency $\frac{R}{R+b}$, say, 75 per cent., brought down by local action and waste zinc to about 50 per cent., and we have cost of B.T.U. 1s. 7d., to which must be added cost of labour and first cost of battery. It will be seen that any primary battery in which zinc is used, even if working at 100 per cent. efficiency—which is impossible—the cost per B.T.U. will be a little over 10½d. for zinc alone.—J. GILHAM.

[N.B.—Will the gentleman whose question was inserted last week under the initials C. P. kindly forward his name and address.—ED. *E.E.*]

SCIENCE AND TEACHERS' CLASSES.

The following classes have been arranged in conjunction with University College, King's College, and Bedford College for the session 1898-9:

(A.) EVENING SCIENCE CLASSES.

Electro-chemistry, University College, Gower-street, W.C.—A special course of 12 lectures will be given during November and December, 1898, and January, February, and March, 1899, at University College, London, by Profs. T. Hudson Beare, Fleming, and Ramsay. The lectures will deal with the generation of power and its cost, the generation of electric currents and their application in electro-chemical processes, and the chemistry of the various processes now adopted. Full details are given below. The course will begin on Nov. 24, 1898, and the lectures will be given from 5.30 to 6.30 p.m. Fee for the entire course, one guinea.

Portion of the course on electro-chemistry to be conducted by Prof. T. Hudson Beare on Thursday evenings: Nov. 24, 1898—The generation of steam, the modern boiler and its accessories. Dec. 1, 1898—The testing of boilers, superheating. Dec. 8, 1898—Classes of steam-engines suitable for electric work; types of the best modern engines. Dec. 15, 1898—Testing of engines, cost of power under various conditions.

Portion of the course on electro-chemistry to be conducted by Prof. Fleming on Thursday evenings: Feb. 16, 1899—The generation of electric currents for electro-chemical purposes. Feb. 23, 1899—The measurement and control of electric currents for electro-chemical purposes. March 2, 1899—The electro-chemical production and deposition of metals, and the industrial processes in use for the purpose. March 9, 1899—The electro-thermal reduction of metallic ores, and the development and use of the electric furnace.

Portion of the course on electro-chemistry, to be conducted by Prof. Ramsay on Thursday evenings: Prof. Ramsay will deliver four lectures, commencing in March, 1899, in which he will deal with the practical application of electro-chemistry to chemical processes—for example, alkali manufacture, metal deposition, and the manufacture of chlorate from the electrolysis point of view, and with the manufacture of carborundum, phosphorus, calcium carbide, and cyanide of potassium from the heat point of view. These lectures will probably form the last of a course of 12 on chemical technology generally, which will be called "The Principles of Chemical Technology." Further details as to these lectures will be given later on.

Electrical measurements, University College, Gower-street, W.C., Monday evenings, 7 to 9.30: Prof. Fleming will arrange for the electrical laboratory to be open on Monday evenings from 7 to 9.30 p.m. from Oct. 10, 1898, to Dec. 19. Electrical

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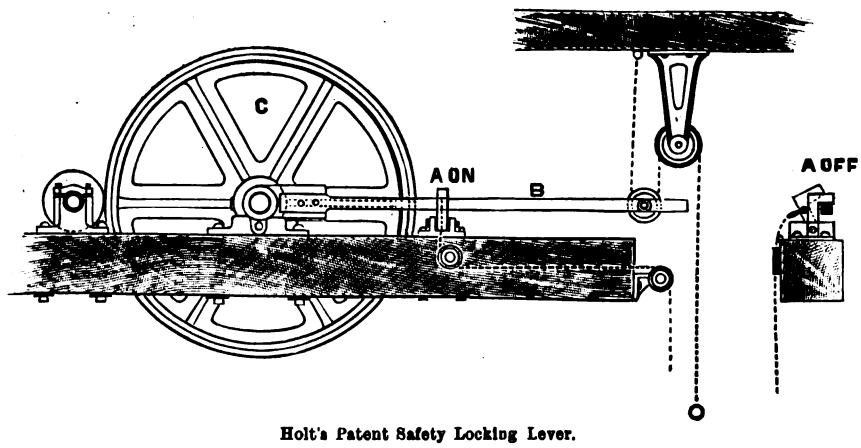
engineers, practically engaged during the day in some work or practical occupation connected with the electrical trades, and who have already acquired an elementary knowledge of the subject of electrical measurement, can be admitted to work under the direction of the professor and assistants at some department of advanced electrical testing work which will be arranged by the professor. This class is only open to those practically engaged during the day in an electrical trade or business, and is limited to 16 in number. Applications for places in this class should be made by letter to Prof. Fleming, and applicants should state their present occupation and previous training.

(B.)—Saturday Morning Classes for Teachers.

Magnets and electric currents, University College, Gower-street. A course of 10 lectures will be given by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., on magnets and electric currents, on Saturday mornings, 10 a.m., beginning Saturday, Jan. 14, 1899. This class is intended for headmasters and assistant masters in London Board schools and for science masters in elementary science schools, who will be admitted free. The object of the course is to give instruction in modern methods of science teaching. It will consist in the delivery by the professor of a model lecture to exhibit methods of dealing with the subject, adapted for science teachers and teachers in Board schools who, having some knowledge of the subject, desire to receive instruction in the scientific construction and use of experimental apparatus and the improvements of methods of teaching. Each meeting of the class will begin with a lecture lasting one hour, to which any number of teachers up to 40 can be admitted. Subsequently a series of practical laboratory exercises will be worked by teachers on the above subject to which the first 20 applicants for places in the class will be admitted. Applications should be made by letter to Prof. Fleming. Applicants should state their teaching experience and present position.

HOLT'S SAFETY LOCKING GEAR.

The use of electric motors off mains supplying light as well is attended with some difficulties, as the motors are not to affect the pressure of supply. One of these arises from loading up a motor before it has attained speed. The accompanying illustration shows an arrangement of a locking lever invented and patented by Mr. C. E. B. Holt, of 10, Piece Hall-yard, Bradford, to overcome this difficulty. The invention consists of an apparatus for locking electrical lifts, cranes, etc., to prevent the lift or crane being set in motion until the moter has attained its full speed. To accomplish this, the locking lever, A, is fixed to the bearings of the crane, and is also attached by a chain to the main starting switch of the motor, the lever being locked and unlocked by the moving of the switch to "on or off" as required, thus preventing the crane or lift from being set in motion until the resistance has been cut out of circuit. When this has been done it pulls the locking lever, A, from the lifting lever, B. By this action the lifting lever, B, will be prevented from bringing the two friction pulleys into gear until the motor has attained its full speed, thereby avoiding a severe strain on the motor and sparking at the commutator. It should be added that there is no current whatever used to work this apparatus, it being simply attached to the main starting switch of the motor. We understand that Mr. A. H. Gibbings has inspected the apparatus, and reports that it successfully performs its work.



Holt's Patent Safety Locking Lever.

HASTINGS ELECTRIC LIGHTING.

REPORT ON THE PURCHASE OF THE ELECTRIC LIGHT COMPANY'S UNDERTAKING BY PROF. HENRY ROBINSON.

The following is the main portion of Prof. Robinson's report on the present value of the undertaking of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited:

In accordance with your instructions, I have made a careful examination of the works and undertaking of the electric lighting company, and beg to report the result. I have received from the secretary (Mr. Burton) and the engineer and manager (Mr. Andrews) every facility whilst pursuing my enquiries, and I desire to acknowledge the assistance that was afforded me by them. I have made my valuation in accordance with the directions contained in section 2 of the Electric Lighting Act, 1888, with the addition of a sum for goodwill during the remainder of the 42 years covered by the company's provisional order, which was obtained in 1890.

1. *Lands, including Law Charges.*—The site acquired at the outset in 1883 consisted of a piece of land having an area of about 5,050 square feet, held on a 99 years' lease dating from 1871. The price paid for this is stated at £480 in the balance-sheet for 1883, and at £579. 16s. 6d. in the report for 1884. The company's figure of £606. 16s. 4d. is stated to include sundry small expenses in connection with the purchase which were not so allocated in the earlier balance-sheets. Accepting the figure £606. 16s. 4d. as the value of the lease in 1883, when there remained 87 years unexpired, and deducting 1-87th part of that sum for each year since expired, reduces the value approximately £510 in 1897. The three adjoining premises, consisting of warehouses, covering an area of 5,920 square feet in all, were purchased in 1894, and a new lease of the whole site was arranged with the ground landlords, fixing the rent at £43. 14s. per annum. Attached hereto is a plan of works, which show the extent of the original site, and of the new premises purchased in 1894. The price paid for the new premises was £5,500. The three warehouses purchased were of no value as buildings for electric lighting purposes except as temporary storerooms. More than half of one has already been demolished, and it will be necessary to demolish the others and erect new buildings. One is at present let to a tenant for storing timber. Inasmuch as the new premises have not yet been used for the purpose for which they were acquired, I think they should still be valued at cost price, having regard to the fact that the original site could not be extended in any other direction, and therefore it was good policy on the part of the directors to secure them while the opportunity was open, although the price seems somewhat excessive.

2. *Buildings.*—The company's figures of £12,078. 7s. 8d. includes the purchase-money (£5,500) of the three warehouses adjoining the original site, which should be regarded only as land for future purposes, and has been placed under that heading in the summary. The balance of £6,578. 7s. 8d. represents money spent in building operations, but the buildings upon which the money has been spent are not worth that sum, for the following reasons: (*a*) The original building erected by the company was of a most unsuitable design for the present and future purposes of the undertaking; (*b*) the original chimney has been demolished; (*c*) portions of the engine and boiler rooms have also been demolished; (*d*) numerous alterations to the interior of the building have had to be carried out to enable new plant to be erected, and further alterations are necessary and are contemplated by the company; (*e*) the upper part of the building was intended to serve as

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residences for two of the officials. It is in a very bad state of repair, and is not likely to be thus utilised. The two following items appear in the balance-sheet for 1884 : building works, extras, and paving, £3,425. 6s. 7d.; architect's fees, £181. 4s. 6d.—total, £3,606. 11s. 1d. Deducting the cost of the portions already demolished brings down the amount to £3,000 ; the cost of the necessary further alterations, repairs, and depreciation will not be less than £500 ; prime cost of useful portions of original buildings, £2,500 ; a further deduction should be made for the 14 years of the lease (out of 87) expiring from 1883 to 1897, 14-87ths of £2,500, £400 ; present value of remaining portions of original buildings, £2,100 ; cost of second chimney stack erected in 1891 was £150, and present value, £140 ; cost of third chimney stack erected in 1894, with main flue and dampers, was £1,876, and present value, £1,800 ; engine and dynamo foundations (N.B.—boiler setting charged with boilers), etc., £300—total, £4,340 ; two-thirds cost of third chimney, etc., charged in respect of future extensions, £1,200 ; value of buildings in respect of 1897 output, £3,140.

3. *Machinery.*—The company gives £19,266 as the capital expenditure on machinery. On going closely into the past history of the undertaking I find that the original plant has been entirely superseded, and many changes have taken place in various details. It was therefore necessary for me to make an inventory of all existing plant, and value it independently, having regard to the age and condition of the various items. My valuation under the head of "Machinery" is £9,022. The great difference between this figure and the expenditure stated by the company may be partially explained as follows : (*a*) depreciation on plant now in use ; (*b*) loss on sale of old plant (admitted at about £2,000) ; (*c*) probable further loss on disposal of old plant not appearing in any of the balance-sheets ; (*d*) probable exceptional expenditure in erection and alterations of plant, owing to the buildings not being designed to contain the present plant.

4. *Mains and Cost of Laying.*—The company's figure for expenditure is £14,291. 17s. 2d. The total value of these works I estimate at £8,900, of which the sum of £1,400 may be regarded as work done in respect of future increase of output. The high-tension main to St. Leonards appears to be already worked to its full capacity.

5. *Transformers, Meters, etc.*—Company's figure, £3,005. 10s. 2d. The number of consumers is stated as 271, having 280 meters. There are 47 transformers in use, having an aggregate capacity of 404 kw. There are three transformers and seven meters in stock. Cost exclusive of fixing (which is included in cost of house connections) : 50 transformers, £1,500 ; 287 meters, £1,500 ; total, £3,000 ; deduct for average depreciation 15 per cent., £450 ; present value, £2,550. The maximum demand hitherto has been 310 kw.; deduct 20 kw. to public lighting ; maximum demand by private consumers, 290 kw. The aggregate capacity of the transformers must always be in excess of the maximum demand, but not to the above extent. It would be fair to regard the maximum demand in connection with the existing transformers as about 350 kw., and put £150 down to provision for future increase of output, leaving £2,400 as the value in respect of the present maximum demand.

6. *Electrical Instruments.*—The company's figure, £915. 0s. 2d. My valuation of the existing switches, instruments, cut-outs, and cable connections now at work at the central station is £550. It appears from information furnished to me that the switchboard arrangements have undergone several radical changes, which may explain the difference between these two amounts. The existing instruments, etc., appear to be in good condition, but they are only connected up in a temporary way, pending the alterations in the building, which are very much needed.

7. *General Stores, Cables, Mains, Lamps, Tools, etc.*—The company's figure is £738. 14s. 1d. I have made a valuation of the tools and tackle now in use, and the total is £380, but, in addition to this, there are quantities of stores which have not yet been issued, and which should be taken over at cost price on the transfer of the undertaking. The sum of £400 included in the valuation is intended to cover this, but is subject to variation.

8. *License and Order.*—The cost of license and provisional order is stated by the company to have been £812. 13s. 10d.

9. *Special Items.*—(*a*) Office furniture and fittings at station and secretary's office, wiring station for electric lighting, fire appliances, etc., miscellaneous articles in lamp-repairing room, and stores in new premises (not including cables or main work), old iron, etc., £300 ; (*b*) 48 arc lamps in consumers' premises, including wiring to same (N.B.—The company owns and maintains these lamps, but has no written contracts with the consumers to continue the arrangement), £500 ; (*c*) 184 "demand indicators," including fixing 179 in consumers' premises, £450 ; (*d*) allowance for expenses in starting the company and issuing capital, £826 ; total, £2,076.

Summary.—A table summarises the various items of value of the undertaking other than goodwill. The total capital expenditure to Dec. 31, 1896, as per statement of the secretary, is put down at £55,070. Prof. Robinson's valuation of works as at July 23, 1897, totals to £35,040.

Goodwill.—In arriving at the sum to be paid by the Corporation for the goodwill of the undertaking, many things have to be considered, and it is desirable to trace historically what has been the position of the shareholders in the past as a preliminary to determining a price, which will represent what they will be deprived of obtaining in the future by the acquisition of the undertaking by the Corporation. The balance-sheets of the company show that the following dividends have been paid on the ordinary shares : 1888, 3 per cent., £205. 10s.; 1889, 3 per cent., £205. 10s.; 1890 (March), 3 per cent., £205 ; 1890 (December, nine months), 5 per cent., £256. 17s. 6d. ; 1891, 7½ per cent., £517 ; 1892, 5 per cent., £569. 2s. 11d. ; 1893, 5 per cent., £932. 2s. 9d. ; 1894, 1895, and 1896, nil ; 1897, 6 per cent., £1,633. 4s. ; total, £4,524. 7s. 2d. It is a matter of the first importance to consider whether the depreciation of the works was properly provided for before these dividends were paid. It appears that the only contributions from revenue towards depreciation and reserve funds have been the items of £70. 11s. 10d. in 1892, and £383. 16s. 6d. in 1894, or a total of £454. 8s. 4d., against which the following losses appear : in 1887, £188. 5s. 6d. ; in 1890, £215 ; in 1894, £1,989. 11s. 9d. ; in 1895, £11. 17s. ; total, £2,404. 14s. 3d. ; contributions from revenue, £454. 8s. 4d. ; capital, £1,950. 5s. 11d. In 1886 the Hastings Company was enabled to extinguish its indebtedness to the Hammond Company for a cash payment of £200. This should have been regarded simply as a saving from further loss in respect of the early years of the company's operations, and the paper assets should have been written off at once, and not have been regarded as valuable for any future purpose. It is impossible to regard the undertaking as a healthy going concern unless the whole of the money spent in maintenance and renewals, or placed to depreciation and reserve funds, is derived from revenue. The amounts already placed to the debit of the depreciation account are wholly insufficient to cover the real difference between the capital expenditure and the present value of the available assets. The extensions of boiler, plant, condensers, etc., that are being carried out are essentially necessary to enable the undertaking to be economically and efficiently worked in the future. It is important to observe that the station log-book shows that the maximum output reached last winter was 310 kw., including the public lighting, or about 290 kw. for general supply. To meet this demand the plant was being run without an adequate stand-by in engines and dynamos, and with no standby whatever in boilers. To properly provide for meeting the maximum output that was reached last winter the addition of another 50-kw. or 100-kw. engine and dynamo is required, together with the additional boiler, which has since been erected. The cost of fuel at this station had been remarkably high—namely, 1·57d. per unit delivered in 1897. This is not only due to the high price of coal in Hastings, but is mainly attributable to the following reasons : (*a*) the system of distribution adopted involves loss of about 33 per cent. of the electrical energy generated ; (*b*) the engines in use require (according to the official tests of the company's consulting engineer) about twice as much steam per kilowatt as is used by the best engines obtainable in the market ; (*c*) there has hitherto been no condensing plant, but it is now being erected.

Expenditure on Repairs and Maintenance.—The expenditure on repairs and maintenance prior to 1893 has very little bearing on the present plant or works. A summary of the expenditure during the last few years is given, and Prof. Robinson continues : It appears from these figures, and from the condition in which I found the plant, that the ordinary repairs have been duly attended to, and paid for out of the revenue. It is quite clear to me, from a general view of the facts, that the present ordinary share capital would have to be largely written off, so that further capital might be raised to enable the necessary extensions to be carried out, and the undertaking made profitable to the shareholders, inasmuch as the Corporation cannot at present acquire the undertaking except by a voluntary arrangement with the company, it remains to be decided whether the amount named in the agreement of July 23, 1897—namely, £54,200—includes too large a sum for the goodwill. I am of opinion that it does, and consider that £40,000 more nearly represents a fair value.

At the meeting of the Council held last Friday, Councillor Burrell, in the absence of the chairman of the Public Lighting Committee, moved that the report be adopted, and that the action of the committee be confirmed. He said the Local Government Board asked for an independent valuation of the works to be made, and as it must inevitably follow that this should be sent up to the Local Government Board, this had been done. The resolution was to the effect that they should purchase the whole of the undertaking for the sum of £58,000, subject to their getting the sanction of the Board of Trade and the Local Government Board.

The report was adopted and the resolution carried.

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LEGAL INTELLIGENCE.

THE ELMORE WIRE COMPANY AND THEIR MANCHESTER AGENTS.

The appeal of Messrs. G. F. Freeman and Co., who carry on business at Manchester, from an order of Mr. Justice Phillimore in chambers, signing judgment in favour of Elmore's Wire Manufacturing Company, Limited, Leeds, was disposed of on the 8th inst. in the Court of Appeal, consisting of Lords Justices A. L. Smith, Rigby, and Vaughan Williams.

The action was brought, says the *Yorkshire Post*, to recover £59. 1s. 1d. for goods sold and delivered to the defendants, who had been acting as their agents at Manchester. The defendants counter-claimed for commission alleged to be due to the extent of £100. The case came before a Master, who directed that it should be tried in the Manchester County Court, but on appeal to Mr. Justice Phillimore in chambers he signed judgment for the £59. 1s. 1d., but ordered that the counter-claim should be heard in the county court at Leeds instead of in the county court of Manchester. Hence this appeal of the defendants.

Lord Justice Smith, on the conclusion of the arguments, decided that the case should be tried as originally ordered by the Master in the Manchester County Court. Lords Justices Rigby and Vaughan Williams concurred.

JOHN SWAILES AND CO., LIMITED.

At the Chancery Court at Liverpool this week an application was made before Vice Chancellor Hall to reduce the capital of this company, which was formed last year by some electrical engineers for the purpose of taking over and working their business. The capital was £35,000, divided into 7,000 shares of £5 each. Six thousand shares were issued and fully paid up. The company started with assets taken at considerably greater value than they were proved to possess, and it was now sought to reduce the capital by £2 per share. The Vice-Chancellor sanctioned the proposal.—*Financial Times.*

COMPANIES' MEETINGS AND REPORTS.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The half-yearly meeting of the Liverpool Overhead Railway Company was held on the 11th inst. at Liverpool, Sir William Forwood presiding.

The **Chairman**, in moving the adoption of the report, referred to the increase of the traffic during the past six months. They had carried 4½ million passengers, the increase on the 12 months being over three-quarters of a million. During Bank holiday week 238,000 passengers were carried, yielding an income of over £2,000. The receipts for the half-year were £37,220, an increase of £1,135, but working expenses were also larger by £1,100, almost entirely due to the increased cost of labour. The expenditure was equal to 15·47d. per train mile, and the revenue to 24·63d., the expenditure being about ½d. per train mile more than in the corresponding half of last year. The gross receipts for the half-year amounted to £37,220 (against £36,026), the expenditure to £23,376 (against £22,759), and the net receipts to £13,844. Adding balance from previous half-year (£2,878), the total net revenue was £17,013, which is appropriated as follows: prior charges, £3,400; dividend on preference shares, £3,000; dividend on ordinary shares, at the rate of 3 (against 3) per cent. per annum, £6,750; balance carried forward, £3,864. Length of line open, 6 miles 57 chains. The number of passengers carried was: first-class, 637,547; second class, 2,686,651; workmen (special return tickets), 1,148,743—total, 4,472,941 (against 4,269,260). The number of train miles run was 362,690 (against 363,399). The expenditure on capital account has been £745,405, whilst the receipts have been £744,471—viz., ordinary £10 shares, £450,000; preference £10 shares, 5 per cent., £120,000; mortgage debentures, 4 per cent., £170,000; premiums, £4,471. The report was adopted, and the payment of dividends of 5 per cent. on the preference shares and 3 per cent. on the ordinary shares was confirmed, being the same rates as last half-year.

WINDSOR ELECTRICAL INSTALLATION COMPANY, LIMITED.

Directors: M. Drury Lavin, Esq. (chairman); H. L. Prior, Esq. (deputy chairman); Tonman Mosley, Esq.; Edward Riley, Esq.; A. W. Shipley, Esq. (managing director); A. A. Somerville, Esq.; Rev. R. H. Whitcombe. Consulting engineer: Mr. A. H. Preece. Engineer-in-charge: Mr. A. E. Farrow.

Report of the directors to the shareholders (with revenue account and balance-sheet) for the year ended Dec. 31, 1898:

The Board of directors, in presenting their report, are pleased to be able to state that the shareholders will find from the accompanying accounts for the year 1897 that the business of the Company is progressing satisfactorily. The number of lamps installed on Dec. 31, 1897, was equivalent to 4,985 of 8 c.p. Since that date 395 have been added. In the course of the year a new engine, twice the size of the original ones, has been added, and the storage-cell capacity has also been doubled. Extension of mains have been made in St. Leonard's-road, Osborne-road, and King's-road. The net profit for the year is £1,256. 16s. 7½d., as shown on the net revenue account, and out of this sum the directors recommend that a dividend of 4 per cent., free of income tax, be declared on the paid-up capital of the Company, the dividend on the new shares being calculated from the dates of allotment and call. This will absorb £652. 7s. 4d., leaving a balance of £604. 9s. 3½d. to carry forward. The directors have now been in office for two years without any remuneration whatever, and in view of the very satisfactory progress of the Company, they will at the general meeting ask the shareholders for a vote on account of their past services. Mr. A. W. H. Good resigned his position of secretary of the Company in the early part of the year, and your directors did not consider it necessary to appoint another permanent secretary, as Mr. A. W. Shipley, in addition to being a director of the Company, kindly accepted the position of managing director, and the Board consider themselves very fortunate in securing his valuable services. It is proposed to issue the remaining capital, £5,000, during the current year. The directors recommend that the shares be issued at a premium of 2s. 6d. per share, and any shareholders desiring an allotment should apply at the Company's offices for a form of application. The allotment will be *pro rata* to existing holdings, but any shareholder not applying within one month of the date of this report will be deemed to have renounced his right to an allotment. Current is now being supplied at 7d. per unit, but the directors hope to reduce the price to 6½d. when 8,000 c.p. lamps or their equivalent are installed. This reduction in Windsor is equal to 3d. per 1,000ft. of gas. The retiring directors selected by ballot are Mr. Tonman Mosley and the Rev. R. H. Whitcombe, who, being eligible, offer themselves for re-election.

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	463	4	2			
Oil, waste, water, and engine-room stores	83	9	11			
Wages and gratuities at generating station	182	14	9			
Repairs and maintenance as follows: buildings, £28. 19s.; engines and boilers, £14. 15s.	43	14	0			
				773	2	10
Distribution of Electricity.						
Wages and gratuities to linesmen, fitters, labourers	3	14	9			
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	1	3	7			
				4	18	4
Rents, Rates, and Taxes.						
Rents payable	35	8	4			
Rates and taxes	27	6	0			
				62	14	4
Management Expenses.						
Directors' remuneration	0	0	0			
Proportion of salaries of managing engineers, secretary, accountant, clerks, and messengers as certified by the chairman	177	5	3			
Stationery and printing	26	18	11			
General establishment charges	30	10	4			
				234	14	6
Law and parliamentary charges				7	0	9
Special Charges.						
Insurance, etc.	30	12	9			
Fees to auditors of Company	15	13	0			
Cost of temporary plant (see *contra*)	62	11	8			
				108	17	5
Total expenditure				1,191	8	2
Balance carried to net revenue				541	17	9
				£1,733	5	11

Cr.	£	s.	d.
Sale of current per meter (52,095 units) at 7d. per B.T.U., less discount and bad debts	1,435	5	10
Sale of current under contracts	117	13	5
	1,552	19	3
Rental of meters and other apparatus on consumers' premises	33	11	10
Rents receivable	52	9	8
Transfer fees	0	18	6
Pupil's premium	33	6	8
Amount refunded by contractors against cost of temporary plant (see *contra*)	60	0	0
	£1,733	5	11

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	19,969	15	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1897	5,864	17	11
Sundry creditors on open accounts	142	6	10
Forfeited shares	1	7	6
Net revenue account—balance at credit thereof	1,256	16	7
	£27,235	3	10

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	20,468	18	10
Stores in hand at Dec. 31, 1897—Coal, £4. 13s. 9d.; oils, waste, etc., £47. 12s. 9d.; general, £874. 2s. 10d.	926	9	4
Sundry debtors on account of contracts in course of completion	378	12	2
Preliminary expenses	418	15	2
Sundry debtors for current supplied to Dec. 31, 1897	924	10	0
Others debtors	2,128	5	3
Cash at bankers and in hand	1,989	13	1
	£27,235	3	10

CHATHAM R CHESTER, AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

Directors' report presented to the shareholders at the ordinary general meeting held at Chatham on July 26 1898.

Your directors beg to place before you their tenth annual report, made up to Dec. 1, 1897. Mr. M. H. Hurrell having resigned his position as managing director, we have appointed Messrs. Geipel and Lange, of 68, Victoria-street, Westminster, as consulting engineers. Mr. W. Geipel was 15 years with the Brush Electrical Engineering Company, and acted for several years as their superintending engineer, in which capacity he had charge of their many important electric supply undertakings in London and in the provinces. He has had experience in the erection and working of more than half the electricity supply works in this country. It is anticipated that the unique mechanical and electrical engineering experience of these two gentlemen will result in improving our undertaking. We propose to proceed with the extensions of the mains in the following districts—viz.: Railway-street, Chatham-Maidstone road, Ordnance-terrace, Albany-terrace, and Luton-road; also Castle-hill, St. Margaret's-street, Borstal-road, Watts'-avenue, King Edward-road, Rochester-Maidstone road, and High-street, Strood. To meet the increasing demands orders have been placed for extending the present generating plant with leading makers of this class of machinery, and with a view to increasing the capacity of the present boiler plant your directors have decided to adopt mechanical stokers. One of the boilers has been already so fitted, with the result that, in addition to producing more steam, we are able to use a cheaper class of fuel with a resulting economy. Other improvements are being adopted, all tending to reduce the coal bill, as well as to improve the general reliability of the plant. It is satisfactory to us to know that the improved services we are giving, as the result of the new arrangements in our staff, are already affecting a steady and growing increase in the number of customers, and we have every confidence that the undertaking will ere long be amongst the most prosperous of the electrical supply companies throughout this country.

BALANCE-SHEET.

Dr. Capital and Liabilities.				£	s.	d.
Capital subscribed in 2,027 shares of £5 each	£10,135	0	0			
Capital alloted under contracts, 1,863 shares of £5 each	9 315	0	0			
				19,450	0	0
Creditors for plant, machinery, stores, etc.	1,028	0	2			
London and Provincial Bank	3,000	0	0			
H. Jasper, balance of 5 per cent. loan	2 667	13	6			
H. Jasper, balance of 6 per cent. loan	589	1	11			
Overdraft at bank	1,104	13	8			
				8,389	9	3
				£27,839	9	3

Cr. Property and Assets.				£	s.	d.
Unpaid capital on 27 shares of £2 each	£81	0	0			
Arrears of share calls	2	10	0			
				83	10	0
Plant and machinery	8 410	14	2½			
Building account	2,546	6	11			
Main circuits	4,325	16	3½			
Works in progress	9,315	0	0			
				24,597	17	5
Electrical instruments	399	19	11			
Meters	453	17	10			
Arc lamp plant	177	0	0½			
Office furniture	48	19	10½			
Tools	102	11	1			
				1,182	8	9
Stores, lamps, fittings, etc.	374	14	6½			
Engine-room stores	36	17	6			
Coal	20	12	0			
Stationery	10	0	0			
Unexpired Insurance	13	17	6			
				456	1	6½
Book debts	1,035	18	2½			
Cash in hand	4	4	10½			
Deficit balance revenue account	479	8	5½			
				1,519	11	6½
				£27,839	9	3

REVENUE ACCOUNT.

Expenditure.				£	s.	d.
Salaries	£364	6	10			
Engine-room wages	227	18	11½			
				592	5	9½
Coal, wharfage and cartage included	846	8	3½			
Engine-room stores	81	4	10½			
Repairs	354	9	3			
				1,282	2	5
Rent, rates, and taxes	64	6	0			
Incidental expenses	18	13	5½			
Auditors' fees	15	15	0			
Stamps, stationery, etc.	17	9	0½			
Insurances	27	7	6			
Interest	262	7	3			
				405	18	3
Electrical stores and fittings	145	14	6½			
Wiremen's wages	31	14	2½			
Discounts and allowances	209	11	6			
				387	0	3
Depreciation of stores	240	1	9½			
Depreciation of suspense account	91	2	9½			
				331	4	7
				£2,998	11	3½

Income.				£	s.	d.
Balance from last year				215	16	8½
Gross amount of charges for electric current	£2,064	14	6½			
Meter rents	61	2	4			
Installations and sale of lamps, etc.	177	9	3			
				2,303	6	1½
Deficit balance				479	8	5½
				£2 998	11	3½

WATERLOO AND CITY RAILWAY COMPANY.

The ninth half-yearly meeting was held on the 4th inst. at the London and South-Western Railway Offices, Waterloo Station.

Mr Wyndham S. Portal presided, and in moving the adoption of the report, referred to the unfortunate delay in the opening of the line. The directors were greatly disappointed at not being able to declare any dividend at that meeting, consequent obviously on the absence of any revenue earnings during the past half-year. The interest payable during the construction of the railway was limited to £25,000, and as that amount was reached with the distribution made in January last, there could not now be any further similar payment to the proprietors out of the capital. When the Central London line was complete, the staircases would only be half their present height. He congratulated the shareholders on the almost immediate opening of the line, and hoped to be able to offer a very satisfactory dividend at the next meeting.

The motion was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Melbourne (Victoria).—The Town Council invite tenders for a supply of arc lamp carbons. Particulars may be obtained of, and tenders addressed to, the Town Clerk by Aug. 16.

Wimbledon.—The Urban District Council are prepared to receive tenders for the supply, delivery, and erection of pipework. Tenders by 5 p.m. on Aug. 29.

Buxton.—The Urban District Council invite tenders for various works in connection with their electric light station. Further particulars appear in our advertising columns. Tenders by Sept. 5.

Blackpool.—The Corporation are prepared to sell by private treaty generating plant, vulcanised rubber cable, etc. Further particulars appear in our advertising columns. Tenders by Sept. 13.

Hendon.—The Managers of the Central London Sick Asylum District invite tenders for supplying the necessary plant and for installing the electric light at their new asylum, Hendon, Middlesex. Tenders by Aug. 15.

Kingston-upon-Hull.—The Electric Lighting Committee of the Hull Corporation are prepared to receive tenders for the supply and erection of certain plant in connection with their electric lighting works. Tenders by noon on Aug. 25.

Halifax.—The Tramways Committee invite tenders for excavating and forming about five miles of tramway track within the borough. Plans and specifications may be seen, and forms of tender obtained, on application to Mr. Edward R. S. Escott, C.E., borough engineer, Town Hall, Halifax. Tenders by Aug. 24.

Halifax.—The Tramways Committee invite tenders for the supply of steel rails, points, crossings, fishplates, soleplates, tie-rods, bolts, etc., for about five miles of tramways. Plans and specifications may be seen, and forms of tender obtained, on application to Mr. Edward R. S. Escott, C.E., borough engineer, Town Hall, Halifax. Tenders by Aug. 24.

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Sheffield.—The Tramways Committee invite tenders for the extension of car sheds, consisting of two-span steel roof, car pits, stores, boundary wall, latrines, foreman's house, etc., at Tinsley, Sheffield. Plans and specification may be seen, and quantities obtained, at the office of Mr. Charles F. Wike, C.E., city surveyor, Town Hall, Sheffield, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by Aug. 15.

Glasgow.—The Corporation invite tenders for the supply of 2,000 tons of steel straight-track rails, 200 tons of steel curve rails, and about 120 tons of steel fishplates; or alternatively for 1,000 tons of steel straight-track rails, 100 tons of steel curve rails, and about 60 tons of steel fishplates. Specification, with form of tender and section, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by 10 a.m. on Aug. 22.

London.—Tenders are invited by the Vestry for the erection of a new battery-room, boiler-house, and extension of offices at the electric light station, Coronet-street, Shoreditch. Specifications, etc., can be obtained and the drawings can be seen on and after Aug. 2 at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders, endorsed, by Aug 15.

Pemberton (Lancs.).—Tenders are invited by the Urban District Council for suitable schemes for carrying out the electric lighting in their district. Schemes must be sent to Mr. Paul Partington, clerk, before Aug. 14. They should be accompanied by explanatory details, and must be such as will satisfy the requirements and comply with the regulations of the Board of Trade. Information as to the area and population of the district and other essential particulars may be obtained on application to the Clerk.

Darwen (Lancs.).—The Corporation invite tenders for the erection and construction of the iron and steel buildings in connection with their new refuse destructor at Robin Bank-road, within the borough. Specifications, schedule of quantities, and form of tender may be obtained at the office of the Borough Engineer, where also plans of the site and buildings may be seen during ordinary office hours on payment of £1, which sum will be returned on receipt of a bona fide tender. Tenders by 12 noon on Aug. 25.

London, E.C.—The East Indian Railway Company invite tenders for the supply and delivery of electric overhead travelling cranes and a steam electric power plant, as per specifications to be seen at the offices, Nicholas-lane, London, E.C., on payment of £1. 1s. for each specification. Tenders are to be sent to Mr. A. P. Dunstan, secretary, marked "Tender for Travelling Cranes," or as the case may be, by 1 p.m. on 17th inst. The company reserve to itself the right to divide the order, also to decline any tender without assigning a reason.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1 000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Potteries (Staffs).—The British Electric Traction Company, Limited, invite tenders for the provision of materials and construction of the track and permanent way of about 13 miles of tramways (in sections) in the Potteries district of North Staffordshire. Drawings may be seen, and specifications, stipulations, bills of quantities, forms of tender, and particulars obtained, on payment of a deposit of £3. 3s., which will be refunded on receipt of a bona fide tender and the return of the documents, at the Company's Permanent-Way Engineer's Office, Donnington House, Norfolk-street, Strand, W.C. Tenders before 10 a.m. on Sept. 5.

Rochdale.—The Corporation invite tenders for the following plant: Specification No. 2: (Section A) boilers, fittings, etc.; (B) economisers; (C) condensing plant; (D) feed pumps, tanks, etc.; (E) steam and exhaust pipes; (F) travelling cranes; (Specification No. 3) switchboards; (4) accumulators; (5) cables. Specifications, forms of tender, and conditions of contract may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 12, Delahay-street, Westminster, on payment of £3. 3s. for each specification, which sum will be returned on receipt of a bona fide tender. Tenders (endorsed "Electricity Works") must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by noon on Sept. 6.

Hull.—The Electric Lighting Committee invite tenders for the supply and erection of certain plant in connection with their electric lighting works. Form of tender and specifications for the following are now ready. Contract 1: one high-speed engine, 750 i.h.p., Willans or Belliss type; (2) one high-tension continuous-current dynamo, with Eickemeyer-wound armature, 460 kw.; (3) two Lancashire boilers, 30ft. by 8ft., for 150lb. pressure. Specifications for any one of the above three contracts may be obtained from Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by noon on Aug. 25.

Patras (Greece).—On Sunday, Aug. 16-28, from 9-11 a.m, will be given out in submission, in the Town Hall of Patras, in presence of the Municipal Council, and in public session, the concession of the lighting of Patras and its suburbs. In case the lighting will be executed by gas, the period of the concession will be for 35 years, or in case the lighting will be executed by electric light or another light, the duration of the concession will be left to the discretion of the competitor, according to the conditions of advice No. 2,222 of this year and according to the register of Feb. 7, 1898, modified by the above advice No. 2,222. Offers are to be submitted under sealed cover. A copy of above-named documents, in Greek or French, to be had on application to the President of the Municipality.

Ball's Bridge.—Tenders are invited by the Pembroke Township Commissioners for the erection of buildings and foundations in connection with the township electric lighting works designed by the Board's consulting engineer, Mr. Robert Hammond, M.I.E.E., 64, Victoria-street, London, S.W., and according to plans, specifications, and conditions which may be examined at the Commissioners' Office, Town Hall, Ball's Bridge, county Dublin, during office hours, and bill of quantities with form of tender can be obtained on payment of £1, which will be refunded on receipt of a bona fide tender. The buildings to be completed within seven months from date of acceptance of tender. Approved security will be required. Tenders, enclosed in sealed envelopes and marked "Tender for Buildings," and addressed to the Chairman of the Board, must be delivered at the office of Mr. J. C. Manly, secretary, Town Hall, Ball's Bridge, co. Dublin, by 16th inst.

RESULTS OF TENDERS.

Bournemouth.—The following tenders have been accepted: Contract No. 1, the Brush Electrical Engineering Company, Limited, £1,598; Contract No. 2, Siemens Bros. and Co., Limited, £1,135.

Brighton.—The Town Council have accepted the tender of Callender's Cable and Construction Company, Limited, 90, Cannon-street, London, E.C., at various prices per mile, for the supply of unarmoured and armoured lead-covered cables at the Corporation electricity works during the period of one year from Aug. 31.

Hapton (Lancs.).—The following tenders have been received for lighting the Hapton township with electricity from Sept. 1, 1898, to April 30, 1899:

Simpson Bros., Hapton (accepted)	£118	15	0
Calvert and Co., 4, St. Mary-street, Manchester	400	0	0

South Shields.—The following tenders have been received by the Corporation for the laying of 185 lineal yards of double-line steel girder tramway, electrical bonding, and paving thereto:

Laing, wharton, and Down, London	£2,377	5	0
Thornton and Co., South Shields	1,313	10	0
G. E. Simpson, Newcastle	1,001	6	3
A. Brunton and Son, Edinburgh (accepted)	660	0	0

Bury.—The Town Council have accepted the following tenders, subject to the approval of the Local Government Board being obtained to the proposed loan—viz.: Messrs. Davey Bros., Sheffield, for boilers, etc.; Callender Cable and Construction Company, for mains, etc.; and Messrs. Fowler and Co., Leeds, for plant, etc. The tenders, with the cost of the engineer, clerk of the works, etc., amounted to £19 439. 15s., exclusive of the cost of buildings, which is estimated at £2,500, making a total of £21,939. 15s.

BUSINESS NOTES.

Darlington.—The Town Council have decided to proceed with Prof. Kennedy's scheme of electric lighting at a cost of £25,000.

Change of Address.—Mr. John Parker (Parker and Hassall) has removed from Brougham chambers to 16, Long-bow, Nottingham.

City of London Electric Lighting Company, Limited.—We hear that this Company will shortly be prepared to fit up premises for consumers.

Bristol.—On Tuesday the Town Council adopted a report of the Sanitary Committee which asked for sanction to a loan for electric lighting.

Buxton.—The Electric Lighting Committee have been empowered to make application for an electric lighting loan based on the estimate given by Prof. Kennedy.

Cheltenham.—The salary of Mr. Kilgour, resident electrical engineer, has been increased. Steps have been taken to oppose Mr. Rucker's claim for alleged breach of patent.

Hornsey.—The District Council have resolved to oppose an application by the North London Electricity Company, of Prescot, Lancashire, for power to supply electricity in the district.

Pembroke.—The Lords of the Privy Council on Education have sanctioned electrical engineering as a subject on which instruction is to be given in the Pembroke Technical School, Ringsend.

Great Northern and City Railway Company.—The directors at their meeting on Friday last allotted upwards of two-thirds of the entire share capital, including the whole of the preferred ordinary shares.

St. Helens.—The Council have agreed to erect arc lamps to light with electricity Raven-street, Church-street, Liverpool-road, Westfield-street, Ormskirk-street, Cotham-street, Corporation-street, and Shaw-street.

Paris-Berlin Telephone.—The Belgian Government have proposed to the German Government the establishment of telephonic communication between Paris and Berlin *vid* Brussels. The French Government are said to have already approved of the scheme.

Burnley.—Mr. Wright, the electrical engineer, has reported that the department had had trouble again with the mains in Yorkshire-street, the armour and sheathing of the cable having

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been eaten away by the chemical action of the subsoil, which consisted largely of ashes.

Halifax.—The Gasworks Committee have decided that the charge for the supply of electricity for the public lighting be at the rate of 4d. per unit, less the ordinary discount. The Town Council have authorised the construction of various lines of tramways, at an estimated cost of £31,000.

Personal.—Mr. W. Wyld, A.I.E.E., was, on Wednesday last, the recipient of a handsome marble clock, which was presented to him as a mark of respect by the employés of the Salford Corporation electricity department, of which he is chief assistant engineer, the occasion being his recent marriage.

Haydock.—The St. Helens Electric Lighting and Traction Committee have approved of plans of electrical cars proposed to be used on the tramways by the local tramways company. They have also approved of a time table of service of cars proposed to be run as soon as the electrical traction is in operation.

Messrs. Holden and Brooke.—This firm has sent us a new catalogue of their new well-known Sirus exhaust steam injectors. The catalogue, besides lists of prices, gives very full details of the methods of fixing and regulating the injectors. This list will be sent free on application, and should be on the file of every engineer.

Buralem.—The Town Council have received a notice from the British Electric Traction Company of their intention to apply to the Board of Trade to prolong the time for the completion of the works authorised by the Potteries Extension Tramway Order, 1896, to Feb. 7, and have decided to offer no opposition to the application.

Accident.—A youth named Protheroe met his death in a shocking manner at the Llanelly Steelworks on Saturday last. He came in contact with the electrical charging machine, and was instantaneously killed. The machine, which is an American invention and is in general use in the States, is said to be the only one of the kind in the United Kingdom.

Darwen.—Arrangements have been completed with Mr. Thomas Duxbury to commence the electricity works at Victoria Bank. A deputation has been appointed to meet a deputation from the tramways company, along with a deputation of the Blackburn Corporation, in reference to the proposed purchase of the Blackburn and Over Darwen Tramways Company.

Stourport.—At the last meeting of the Urban Council a good deal of discussion took place with regard to the electric tramway. The company had asked for permission to construct two "turnouts" in the town, and at a former meeting the Council vetoed the suggestion. The rescinding of that resolution was moved, but the Council adhered to their previous resolution.

New Catalogue.—The Electrical Company, of 122, Charing Cross-road, have sent us an advance copy of their No. 2 list of alternate-current machines. This list includes single-phase plant and many lists of dynamos and motors for three-phase systems. Transformers are also included, and the one hundred and one accessories required when erecting machinery.

Parliament.—The provisional orders granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, to the Corporation of West Bromwich, the Aston Manor District Council, the Urban District Council of Smethwick, and the Urban District Council of Oldbury respectively, have been confirmed by the House of Commons Committee on Unopposed Bills.

Stirling.—The Stirling Police Commissioners had before them, on the 8th inst., a minute of the Lighting Committee recommending that the negotiations in connection with the scheme for the electric lighting of the town by water-power should cease. The minute was adopted, and it was remitted back to the committee to carry out their previous instructions in connection with Prof. Kennedy's steam-power scheme.

Falmouth.—At the last meeting of the Urban Sanitary Authority it was stated that nothing had been done by the Lighting Committee with regard to the proposed application by the Electric Light Company for an Act empowering them to supply electric light at Falmouth. The matter had been shelved for three weeks, and as it was urgent it was resolved that the Council at once give notice of their intention to oppose the Bill.

Metropole Theatre.—This theatre is now fully installed with electric light. The effect is exceedingly good and the management truly claim that it is now one of the coolest theatres in London. The contractors were Messrs. Julius Sax and Co., of Coldharbour-lane, Camberwell. Much credit is due to them, inasmuch as they only had 12 days to complete the work, and that the whole installation has been run without a single hitch.

W. T. Glover and Co.—We have received a very well bound copy of the price list of this firm arranged in a form which can be carried without inconvenience in the breast pocket. The details and indexing of the catalogue has been reduced to a fine art, hence a vast amount of time is saved when consulting the little volume. Tables for reference are also freely given, so that the price list is in many respects an electrical pocket-book.

Electrical Company, Limited.—We notice that this company is now circularising the printing trade in the City, *re* electric motive plant, stating that they will supply current from their new direct-current mains in about three months' time. Some of their direct-current motors have been working in some of the largest Continental and other printing establishments for years, the output last year having been 8,500 machines, aggregating 188,000 h.p.

Clerkenwell.—At the last meeting of the Vestry the Electric Lighting Committee reported having appointed Dr. Evan Jones and Mr. J. Crowle-Smith respectively as their chairman and vice-chairman. The Vestry approved of the recommendation of the Electric Lighting Committee to refuse the request of the Metropolitan Electric Supply Company to support their application to Parliament for a provisional order for the lighting of the parish.

Buenos Ayres.—The *Financial News* states that on the 29th ult. a further three and a half miles of the system belonging to La Capital Tramways Company, Limited, in Buenos Ayres, was inaugurated as a tramway operated by electricity. This section has been converted from horse traction, and connects, *vid* San Juan and Comercio, the section of 9¼ miles from Entre Rios to Flores, opened in December last, with Paseo Colon—one of the main streets of the city.

Longton.—At the last meeting of the Town Council the town clerk was authorised to take steps and give the necessary notices of the intention of the Corporation to apply to the Board of Trade for a provisional order under the Electric Lighting Acts to authorise the Corporation to supply electrical energy for public and private purposes within the borough; and it was decided that the application of the Potteries Electric Traction Company, Limited, for a provisional order for a like purpose be opposed.

Bradford.—The minutes of the Tramway, Baths, and Team Labour Committee were adopted by the City Council on the 9th inst, with the exception of the minute fixing the stages and fares for the new Great Horton tramline. The basis of these fares is a charge of 3d. on the up journey and 2d. on the down. Alderman Cowgill explained that he desired to frame a more equitable arrangement of the stages. The Great Horton line, he believed, would be ready for opening in about a fortnight.

Bournemouth.—The Town Council have appointed a committee to take the preliminary steps towards converting the borough into a county borough, the population having risen to over 50,000. Tenders have been accepted for carrying out a scheme for lighting the lower pleasure gardens, pier, and winter gardens by electricity. A special meeting will be held to consider the desirability of applying for a provisional order empowering the Corporation to adopt a scheme for lighting the town generally by electricity.

Tonbridge.—The Town Council have replied to the notice of intention to apply, etc., which they received some time ago, that the Council had obtained an order authorising them to supply electricity within their district, and that they would not therefore consent to the grant of another order. The Electric Lighting Committee, having considered the desirability of instituting a canvass in the town to ascertain the amount of support which would be obtained when steps were taken to install the electric light, do not recommend such a course to be taken at present.

Southport.—At the monthly meeting of the Town Council on Tuesday, Mr. Dimond, the chairman of the Gas Committee, pointed out that there were good reasons why the accounts should not show so well as in previous years. There had been a diminution both in the gas made and the revenue received, and the net profit amounted to only £6,716, a decrease of £2,322, but this was very largely, if not entirely, due to the loss of custom through the popularising of electricity. The gas manager's report was not accepted, and Mr. Dimond thereupon resigned his position as chairman of the committee.

Hyde.—The chairman of the Highways Committee reported to the Town Council at the last meeting of that body that the Main Roads Committee of the Cheshire County Council proposed to make a grant of £900 towards the cost of widening Stockport-road, near the Ring o' Bells corner, and the Electric Traction Company had offered £500 towards the cost. The offer of £500 was regarded as unsatisfactory, and a sub-committee was appointed to confer with the company, who are constructing the tramway, with a view to obtaining an increased grant. The estimated cost of the improvement was £2,710.

Kingstown.—At an adjourned monthly meeting of the Kingstown Commissioners a letter was read from the secretary of the Dublin United Tramways Company, stating that they had again considered the matter of additional interlacing at Stoneview, and if the Commissioners would pass a resolution—necessary under order in council—they would have the work carried out. It was, however, to be clearly understood that no further damages were to be asked for. The town surveyor submitted plans showing the proposed alterations consequent upon the interlacing scheme, and the necessary resolution was adopted.

Lambeth.—At the last meeting of the Vestry, the Clerk said he had received a reply from the Board of Trade to the request of the Vestry to hold an enquiry into the circumstances attending the transference of the electric lighting order from the Vestry to a public company. The secretary of the Board wrote that it did not appear to the Board that they had power to institute such an enquiry as that suggested. He (the clerk), acting on the instructions previously given, had drafted a letter to the Local Government Board asking that authority to undertake the enquiry. The draft was approved by the Vestry without discussion.

Birkdale.—The British Electric Traction Company is likely to be in early possession of the tramways of Southport and Birkdale, the directors of both companies having come to the conclusion that the best thing they can do is to dispose of their shares to that company on the terms offered. A meeting of the Birkdale Company's shareholders will be held shortly to consider the proposals. A deputation has been appointed by the Southport Town Council to wait upon the Birkdale District Council or a committee of the Council with reference to the subject. The matter has been referred to the Highways Committee of the District Council.

Derby.—The report of the Electric Lighting Committee, adopted by the Town Council last week, states that the electrical

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engineer (Mr. J. F. Stewart) had tendered his resignation on his obtaining another appointment, and asked to be relieved from his duties in five weeks time. His appointment was subject to three months' notice. The Council was recommended to pass the resolution placed on the agenda authorising the committee to accept the resignation and release Mr. Stewart as soon as they could conveniently do so, and to draw up conditions, duties, etc., and advertise for and appoint a successor to Mr. Stewart at a salary of £350 per annum, with the right to take two pupils.

Imperial Tramways Company.—The visit of the directors of the Imperial Tramway Company to Middlesbrough on Saturday was taken advantage of to give a supper to the whole of the tramway company's staff on Saturday night, and at the same time make the preliminary arrangements for the formation of a Workmen's Sick and Benevolent Society. Mr. J. Clifton Robinson, managing director, who presided, said, with reference to the benevolent society, the rules would be the same as obtained on the Dublin and other systems. The following officers were elected: president, Mr. J. Clifton Robinson; vice-president, Mr. C. R. Holmes; secretary, Mr. H. Ingall; committee. Messrs. Hayes, Pearson, Balfe, Gardiner, J. H. Pennick, Lines, Nicholson.

Garston.—A special meeting of the Garston Urban District Council was held on the 9th inst. to consider a letter from the Local Government Board intimating that as early as possible one of the inspectors of the Board would hold an enquiry into the application of the Council for sanction to borrow £25,000 for the purpose of providing electricity and a refuse destructor for their district. It was proposed that their legal adviser (Mr. P. F. Garnett) be instructed to conduct the enquiry on behalf of the Council and to engage counsel. The motion was opposed because a company had offered to supply electricity at 5d. per unit, which was very favourable, and in addition they had offered to do the public lighting at 3d. per unit. The motion was carried by seven votes to four.

Birkenhead.—At the last monthly meeting of the Town Council the Chairman of the Gas, Water, and Electrical Committee, referring to the report by the borough electrical engineer with regard to the extension of the electric lighting service to Bidston and Noctorum, stated that the reasons they were desirous of carrying out this work were because the residents there had applied for the light, and had entered into engagements to use the light if brought to them. As shown by Mr. Bates in his report, the electric light could be extended to that district and effect a considerable profit. As it was necessary, however, to give a month's notice of this matter, it was necessary that the resolutions should be withdrawn that day, but they would come before them at the next Council meeting. This was approved.

Lowestoft. — The Town Council have resolved that the destructor and electric light station be erected on the north-west corner of Smith's Marsh. Letters from the Municipal Electricity Supply Company and from Messrs. Crompton and Co. with proposals as to electric lighting are under consideration. Mr. W. C. C. Hawtayne has discussed with a committee the matter of the electric lighting of the borough, and the latter recommended that the electric lighting provisional order be put in operation by the Council itself, and that it be referred to that committee to obtain a scheme for lighting the town by electricity, with all details, estimates, and tenders, and report thereon to the Council, with a view to an application being made to the Local Government Board for their sanction to a loan for carrying out the works. The report was adopted.

Sheffield.—The following contracts are ready for the seal of the City Council: A contract between Ralph Simpson Whitworth and the Corporation for the supply of tramway employés uniform; a contract between George F. Milnes and Co. and the Corporation for the supply of 13 double-deck car bodies in connection with the tramways extensions; a contract between the British Thomson-Houston Company, Limited, and the Corporation for the electric equipments and the Peckham trucks for the 13 cars referred to in the last-mentioned contract; also 12 single-deck car bodies, with Peckham trucks, electrical brake equipments and car wiring, complete for working; and a contract between Askham Bros. and Wilson, Limited, and the Corporation for the supply of the necessary points and crossings in connection with the tramways extension to Valkley from High-street.

Appointments Vacant.—The Electricity Committee of Ashton-under-Lyne invite applications for the appointment of borough electrical engineer. Previous experience of central station working and a knowledge of refuse destructors essential. Salary £250 per annum. Applications, on foolscap paper, stating age and experience, and accompanied by copies of not more than three testimonials, must be sent by 27th inst., addressed to the Chairman Electricity Committee, Town Hall, Ashton-under-Lyne, and endorsed "Borough Electrical Engineer."—A large mill in Yorkshire requires an engineer to take charge of high-speed engine and dynamo, accumulators, etc., and to do installation work; and the Corporation of Derby invite applications for the post of engineer and manager of the Derby electric installation. Particulars of these vacancies will be found in our advertisement columns.

Walsall.—The Board of Trade has notified the Town Council that Walsall has been omitted from the area of supply of the Midland Electric Power and Lighting Provisional Order as requested by the Council, and thus preventing any interference with the rights of the Corporation under their electric lighting order. The following resolution, which had been passed at a conference of the local authorities of the boroughs of Walsall and Wednesbury and the Urban District Councils of Darlaston and Tipton, has been submitted by the General Purposes Committee, and approved, the Council recommending that the necessary steps be taken for carrying the same into effect: "That, in the opinion of this conference, it is desirable that all the local authorities within the district of the South Staffordshire Tramways Company should take steps with a view to purchase the tramway lines within their respective districts, and also to oppose the proposed application to Parliament of the British Electric Traction Company, Limited, for a Bill to confirm a lease of the tramways to that company, and that a copy of this resolution be sent to each local authority." The Council will oppose the proposed application to Parliament of the British Electric Traction Company, Limited, for a Bill to confirm a lease of the tramways of the South Staffordshire Tramways Company.

Trolley Poles.—As we expected, says the *Liverpool Courier*, the Tramways Committee do not intend to permit their æsthetic tastes to be judged by the lofty poles with which they have lined the experimental trolley route between St. George's Church and the Dingle. The poles are but skeletons. They are to be covered with an artistic design, which has already been prepared, and which the committee hope will secure that combination of utility and ornament which has been their aim. So we learn by telegraph from Mr. William Oulton, who is now sojourning at Harrogate. The information will, no doubt, delight the people whose æsthetic tastes are offended by the skeleton poles, and whose fears have been aroused by anticipations of property being depreciated in value by the ugly trolley masts. Now it may be expected the terrified will breathe more freely, and will be less disposed to anathematise the Corporation and all their ways. Of course, Mr. Oulton cannot expect to convert to overhead-wire-ideas persons who are wedded to the faith that perfection lies in the conduit. Still, it is gratifying to realise that the figurative ugly duckling may be expected to develop into something delightful to the eye. After all, what most agitates the public mind is not the design of the poles, but the long interval that may elapse before the local début of the trolley, with 1d. fares all round.

Swansea.—In the Swansea Tramways Act it was stipulated, says the *South Wales Daily News*, that the company was to carry out certain street widenings in return for the concession to monopolise a portion of the streets. Some of these remain to be carried out, and the Corporation sees in the action of the British Electric Traction Company, which has purchased the property of the tramways company with its obligations, in commencing to relay the line and add crossing places to adapt it for electricity, an opportunity for insisting on the conditions being complied with. The Corporation Tramways Committee consequently met Mr. Garcke, the managing director of the traction company, on Friday, and had a long conversation with him on the subject. The conference, however, had so little result that the committee afterwards found it necessary to pass the following resolution: "That no further concession of the streets for the extension of any of the present passing places be permitted until the necessary street widenings are effected in High-street, St. Helen's-road, and Neath-road, which in the opinion of the committee are essential for the safety of the public and the proper working of the tramways." This resolution is regarded as meaning that the work of continuing to adapt the line for electric traction will be practically blocked till an arrangement is come to with regard to the street improvements required.

Blackpool.—The Town Council have passed a resolution to the effect that powers be sought by provisional order in the next session of Parliament for the laying of a double line of tramways from Talbot-square along the carriage drive, the road in front of Carleton-terrace and Queen's-drive to the Gynn. The chairman (Councillor Brodie), and Aldermen Cardwell and Bickerstaffe, and Councillor Ward are to confer with the Cleveleys Property Company on the proposed tramways in Central-drive. The borough surveyor is to submit a section of tramway rails showing a similar construction to the rails of the Hamburg tramways. The Town Clerk has reported that on the 18th ult. an order was made by the magistrates prohibiting the recurrence of a nuisance at the electricity works caused by a chimney there sending forth black smoke in such quantity as to be a nuisance. Messrs. Sutton and Co., solicitors for the Blackpool and Fleetwood Tramroad Company, have written stating that the company prefer to pay for the cost of wood paving and also widening of the street as soon as it is finished, rather than add it to the capital sum on which interest by way of rent is to be payable. The Corporation concur in the cost referred to being dealt with as now proposed by the company. The borough surveyor has been instructed to lay tramways in Queen-square and Queen-street forthwith, with the improvement now indicated as regards the curves, and with the addition of a cross-over in Queen-square.

Limehurst.—The Electricity Committee of the Town Council of Ashton have under consideration the question of providing a means of supplying the townships in the Limehurst District Council's district with electric energy for lighting and other purposes, and have written to the Limehurst District Council to enquire whether (in the event of the Ashton Corporation deciding to promote a Bill in the ensuing session of Parliament authorising them to supply electricity outside the borough) the Limehurst District Council would at the same time apply for the usual provisional order under the Electric Lighting Acts, and on the necessary powers being obtained be willing to enter into an arrangement for the Ashton Corporation to supply electrical energy within the Limehurst Council's district, upon terms to be hereafter agreed upon. An arrangement has been suggested to provide either (1) "That the Corporation should take a lease of the powers, duties, and liabilities under the provisional order which the District Council would obtain, and thereupon the Cor-

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poration would lay down the necessary mains and convey the supply to each consumer in your district"; or, (2) "that the District Council should exercise all the powers conferred upon them by their order, laying down the mains within their own district and distributing the electricity amongst their own consumers, the Corporation selling to the District Council the energy in a wholesale way and delivering same at a convenient point at or near to the boundary of the borough." The various parochial authorities will be invited to consult with the District Council as to the course of action which they should take with regard to the question of electrical lighting.

Hampstead.—At the last meeting of the Vestry the chairman was authorised to affix the seal of the Vestry to the mortgage deed for £39,800 to be borrowed from the London County Council in respect of expenses incurred in buildings, plant, etc., under the Vestry's electric lighting undertaking. The Electric Lighting Committee having considered the letter from Messrs. Hind and Robinson, solicitors for Mr. Martin D. Rucker, as the proprietor of certain letters patent in respect of an invention for improvements in distributing electricity and apparatus therefor, their recommendation that the Vestry do join with other corporations and companies in defending the action commenced against the London Electric Supply Corporation, Limited, and that the vestry clerk be empowered to take all necessary steps in the matter, was adopted. The same committee reported that the number of units of electricity sold by the Vestry for the past Midsummer quarter was 134,231, as against 83,719 for the corresponding quarter. Mr. Hall, chairman of the committee, remarked that another enlargement of the central station would be required if the increase in the consumption of electricity went on at this rate. The General Purposes Committee's recommendation that in future a clause be inserted in all contracts to be entered into by the Vestry that no payment for any extra work shall be claimed by or allowed to the contractor without an order in writing be first had, signed by the architect and countersigned by the Vestry clerk, was adopted; and it was also agreed that the London County Council be informed, in reply to their enquiry, that the Vestry are not aware of any advertising by means of "search" or "flash" lights thrown on the public highways in this parish, but that they are in favour of some by-law being made dealing with the regulation of such advertisements.

Liverpool.—The Lighting Committee of the City Council have granted permission to the Junior Engineers' Association to visit the Paradise-street electrical generating station on the 11th inst. for the purpose of inspecting the works. Extensions of the electric mains to Sefton-drive, Victoria-street, Highfield-street, and Myrtle-street have been sanctioned. At last week's meeting of the Town Council the recommendation of the Tramways Construction (Special) Committee that the Right Hon. Sir Arthur Forwood, Bart., M.P., be appointed a member of the Special Tramways Construction Committee was adopted. On the recommendation of the Generating Stations (Special) Committee, Sir Arthur Forwood was elected a member of that committee. The recommendations of the Tramways Committee as to fares on tramways and omnibuses were presented, and the following amendment was carried by 44 to 21 votes: "That the proceedings of the Tramways Committee, as far as they relate to the report of the Special Committee, dated July 21, be postponed to a special meeting of the Council, which the Lord Mayor is respectfully requested to convene for this purpose on Sept. 14 next." Mr. Oulton, in moving the adoption of the general proceedings of the Tramways Committee, mentioned that a new route had been adopted by the committee between the south end and the north end of the city, and it was proposed to open another route of a similar character shortly. Those were matters which refuted the charges that had been unfairly brought against the Tramways Committee during the proceedings of the Council. The experimental line to the Dingle would be completed in from four to five months, and they might reasonably look to the conducting of the whole tramway and omnibus service of the city by electric or other mechanical energy within the space of two or three years. After some discussion the general proceedings were passed.

Belfast.—The minutes of the meetings of the Sub-Electric and Law Committees with the representatives of the Belfast Street Tramways Company, which were adopted by the Town Council at a meeting held last week, contained a proposed arrangement now under the consideration of the directors under the following heads: (1) The valuation of the company's lines as for 1907, to be now ascertained, so that the amount to be then paid by the Corporation therefor shall be fixed; (2) the lines to be kept in the like good repair by the company in the meantime as they are at present; (3) the company to assign to the Council their right of purchase of the subsidiary lines; (4) the company to work the lines electrically until the termination of the present term; (5) the Council to provide funds to make such extension as may be mutually agreed on, and to electrically equip the lines; (6) the company to pay — per cent. per annum on the funds expended by the Council, and — per cent. for depreciation; (7) the company to take electrical power from the Council at a price to be fixed yearly by an electrical engineer to be agreed on; (8) the company to be indemnified against loss from failure of the Corporation to supply power; (9) the company to assist the Corporation in procuring an Act of Parliament to carry out the arrangement; (10) the fares to be arranged either on the basis of ½d. for approximately one mile stages, or 1d. all the way in one car. If such a basis meet the approval of the Council and the company, the details to be arranged subsequently. It was also stated at the same meeting that although the June quarter was the slackest in the whole year for lighting, the rental showed an increase of about 40 per cent. on the demand of last year, and the applications for the last month alone amounted to 108 h.p., so the Council might soon expect that the Electric Lighting Committee would be coming before them and asking for another grant of money for further machinery.

Dudley.—A special meeting of the Town Council was held last week. As already reported by us, an agreement was come to between the Corporation and the British Electric Traction Company at the hearing of the appeal before the Board of Trade last month. The committee now reported that these terms carried out the views of Council, and obtained for the Corporation all the rights to which they were entitled. First, the line of tramway No. 5, which would run from the present main tramway at Queen's Cross to the borough boundary at Mouse Sweet Brook, would be made as soon as practicable, the promoters laying and electrically equipping the tramway, all the other work being done by the Corporation at the expense of the promoters. The tramway No. 5 was also to be purchased at the end of four years by the Corporation, which would ensure an ownership of the main line in the borough and of the branch line, a matter of great importance, in the opinion of the committee The rights of purchase of such part of the main tramway between Dudley Station and Stourbridge as lies within the area of the borough, and which right was vested in the Corporation, was guaranteed at the end of four years, upon the terms of the Tramways Act, 1870. The committee, however, had every reason to believe that no delay of four years need occur. The supply of electrical energy for traction purposes was secured to the Corporation, which the committee regarded as a most important factor in the profitable working of the electric order obtained by the town in the session of 1897, and the supply to the borough of electricity for lighting purposes. The committee had provided that the Board of Trade should be the ultimate appeal in all cases of difficulty and difference of opinion. The Mayor, in moving the adoption of the report, said he thought that the terms of the agreement were very satisfactory to the Council and also to the British Electric Traction Company. Alderman Claughton seconded the resolution. Mr. A. G. Hooper said that, as the result of the arduous labours of the committee, assisted by the town clerk, the town would ultimately become absolute owners of the tramways within the borough. Mr. Wiltshire said the committee had failed to show that the terms entered into would result in a profit equal to that which Mr. Wilson (the Corporation's consulting engineer) had demonstrated would have been made if the Council had constructed the tramways themselves. The Mayor, replying to some points raised in the discussion, said the general expenses of the recent enquiry would be borne by the Board of Trade. Much of the credit of the successful result of the negotiations was due to the town clerk and Mr. A. G. Hooper. The report was unanimously adopted.

PROVISIONAL PATENTS, 1898.

AUGUST 2.

16679. Improvements in cut-outs for high-voltage electric currents. Henry Mostyn Darrah, 55, Market-street, Manchester.

16706. Improvements in electric supply meters. Ernest Wilson, 64, St. John's-park, Blackheath, London.

16714. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16715. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16716. Improvements in systems of train control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin Wilbur Rice, jun., United States.) (Complete specification.)

16717. Improvements in trolleys. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

16726. An invention for ensuring the safety of operators using rollers driven by hand, steam, electricity, or any other power. William James Stevenson, Regent-street, Newtownards, co. Down.

16734. Improvements in electric locks and combination mechanism therefor. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Henry Guy Carleton, United States.) (Complete specification.)

16754. Improvements in coin-freed apparatus for the automatic delivery of electric current. Otto Bieberstein, 18, Buckingham-street, Strand, London. (Complete specification.)

AUGUST 3.

16771. An improved electric signalling system. Edward Belden Merrill, 67, Elliscombe-road, Old Charlton, Kent.

16775. Improvements in and connected with the manufacture of filaments of carbons for electric lamps. Joseph Baxeres de Alzugaray, Lola Villa, Shortlands, Kent.

16807. Improved methods of controlling and directing electro-deposition of metals and alloys. William David Gooch, 14, New-inn, Strand, London.

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16817. Improvements in automatically operated electric signalling apparatus for railways and the like. Leandre Leduc, 18, Buckingham-street, Strand, London.

16834. Improvements in means for the automatically regulated charging of electrical accumulators. Christian Ulrick Emil Petersen, 77, Chancery-lane, London. (Complete specification.)

AUGUST 4.

16871. Improvements in coupling arrangements for connecting electric wires. Alexander Shiels, 100, Wellington-street, Glasgow.

16872. Improvements in electrical signalling on railway trains. Alexander Shiels, 100, Wellington street, Glasgow.

16875. Improvements in electricity meters. Ernest Schattner, 55, Chancery-lane, London. (Complete specification.)

16876. Improvements in secondary electric batteries or accumulators. Edward James Clark, 73, St. Stephen's-road, Upton Park, London.

16877. Improvements in and relating to desk telephones. Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

16882. Magnetic fastening for safety lamps in mines. Wilhelm Reinhard, 40, Henmarkt, Cologne, Germany. (Complete specification.)

16883. Apparatus for heating and cooking by electricity. Max Hansen, 7, King-street, London.

16888. Improvements in electric bell pushes for communication purposes in railway trains. John Ralph Eccles, 11, Burlington-chambers, New-street, Birmingham.

16902. An improved electric motive-mechanism for clocks, and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London.

16908. A telephonegraph Wladyslaw Nahorsky, 4, South-street, Finsbury, London.

AUGUST 5.

16931. An improved telephonic system. Percy Macaulay Ashworth Matthews, 100, Wellington-street, Glasgow.

16938. A new or improved electric contact making device. Herbert Bingham, 22, Glasshouse-street, Regent-street, London.

16947. Improvements in arc lamps Henry Stanefield Dodd and Robert Ironside Bagnall, jun., Norfolk House, Norfolk-street, Strand, London.

AUGUST 6.

16972. An improvement in jointing boxes for coupling up and insulating electric wires. Thomas McEwan, 8, Elder-street, Edinburgh.

16973. Improvements in or connected with electrical conductors and anodes for electrolytic and similar purposes. The General Electrolytic Parent Company, Limited, Luke Hargreaves, and William Stubbs, 51, Egerton-street, Liverpool.

16981. Improvements in and relating to electric wiring for lamp circuits. David Maxwell, 41, Reform-street, Dundee.

16999. Improvements in or relating to electric accumulators. Ernst Andreas, 6, Lord-street, Liverpool.

17013. Improvements in dynamos. Henry John Walker, 46, Lincoln's-inn-fields, London.

17026. Improvements in or connected with electric meters. Henry Reason and the Mutual Electric Trust Company, Limited, Norfolk House, Norfolk-street, Strand, London.

SPECIFICATIONS PUBLISHED.

1896.

24034. Electric switches. Hall and Craven. (Amended.)

1897.

1521. Electric motors. Holmes. (Amended.)

16919. Means in connection with cycles for generating electricity. Wagner.

17434. Electro-mechanical devices for producing corresponding positions in transmitting and receiving apparatus. Barr and Stroud.

18337. Electrical cut-outs. Hirst.

18644. Electric telegraphy. Lodge and Muirhead.

18865. Safety device for use in connection with carriages propelled by electricity. Brougham and Bersey.

18957. Method designed to facilitate the coupling of wires for conveying an electrical current on railway trains. Powell.

20398. Electric meter for alternating and continuous currents. Blondlot.

20845. Accumulators for secondary batteries and means for transporting the same. Muller.

21157. Magnetic and electric measuring instruments. Russell.

25889. Cell or box suitable for accumulater or other electric batteries. Geary and Robottom.

1898.

10523. Apparatus for regulating electric arc lamps. Hegner.

12323. Electric batteries. Edwards. (Emanuel.)

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended Aug. 7 were £2,077, as compared with £1,781 in same week of 1897, being an increase of £226.

Birmingham Tramways.—The traffic receipts for the week ending Aug. 6 were £4,173. 19s. 8d., as compared with £4 203. 6s. 3d. for same week in 1897, being a decrease of £29. 6s. 7d.

Dover Tramways.—The traffic receipts for the week ending Aug. 6 were £272. 12s. 7d. The total receipts for the year 1898 are £4,311. 12s. 10d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending Aug. 5 were £3,981. 18s. 5d., compared with £3,562. 9s. 6d. for same period of last year, being an increase of £491. 8s. 11d.

South Staffordshire Tramways.—The traffic returns for the week ending Aug. 5 were £881. 13s. 11d., as compared with £889. 7s. 9d. in same week of 1897. The aggregate receipts for the year are £19,272. 6s. 11d., as against £19,572. 18s. 1d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended Aug. 7 were £1,105, compared with £939 for same week of 1897, being an increase of £166. The total receipts for the half-year amount to £5,862, compared with £5,456 for the same period last year, being an increase of £406.

Dublin S.D. Tramways.—The traffic receipts for the week ending Aug. 5 were £1,316. 13s. 11d., as compared with £1,153. 11s. 4d. in the correponding week in the previous year, being an increase of £163. 2s. 7d. The number of passengers carried was 170,373 in 1898 and 153 479 in 1897. The aggregate returns for the half-year are £5 648. 14s. 11d., as compared with £4,594 17s. 3d. last year, being an increase of £1 053. 17s. 8d. The mileage open is 9 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9⅞-10⅛
——	6	5⅞-6⅛
—— Pref. Half-Shares	1	1⅛-1⅛
—— " "	5	4⅛-4⅜
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	5⅞-6⅛
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24½-25
—— Prov. Cert. 90,001-100,000	5	24½-25⅛
—— 6 per cent. Cumulative Pref.	10	16⅞-17⅛
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	2⅞-3⅛
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14⅞-15⅛
—— " " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— " " "	6	8⅛-9⅛
—— 6 per cent. Cum. Pref. " "	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞ 2⅛
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	127-132
—— Preference 5 per cent. Stock	100	142-145
Edison and Swan United Ordinary	5	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	4-4⅛
Electric Construction, Limited	2	2⅜-2⅝
—— 7 per cent. Cumulative Pref.	2	3-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅜ ⅝
Elmore's Wire Company	2	1⅛ 1⅜
W. T. Henley's Telegraph Works, Ordinary	10	21-22
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	113-117
House-to-House Company, Ordinary	5	8⅛-9⅛
—— 7 per cent. Preference	5	9½-10⅛
India Rubber, Gutta Percha, and Telegraph Works	10	21⅛-22⅛
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3⅞-4⅛
Metropolitan Electric Supply, Limited, Ordinary	10	15⅛-16⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	7⅛ 7⅜
—— £4½ shares	4	6-6½
Oriental Telephone and Electric Company	1½	⅞-1
Royal Electrical Company of Montreal	—	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	2	3-3⅛
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	110-108
Waterloo and City Railway, Ordinary	100	128-128
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	2⅛-2½

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NOTES.

Electric Light First Again.—We hear that one of the first local industries to be resumed at Santiago after the surrender of that city to the Americans was the electric lighting undertaking.

Como Electric Exhibition.—The Board of Trade have received through the Secretary of State for Foreign Affairs a copy of the general rules and programme of an exhibition of electric appliances which is to be held at Como next year. This may be inspected on application to the Board of Trade any day between the hours of 11 a.m. and 4 p.m.

Long Electric Railways.—The longest electric railway in the world is, says the *Electrical Review* of New York, that operated between Kenosha and Waukesha Beach, both in Wisconsin. This line is 62 miles long, and arrangements have been made by the Milwaukee Electric Railway and Light Company to run chartered cars from Milwaukee to Waukesha Beach.

Electric Railways in Saxony.—The kingdom of Saxony is likely to get electric railways before long, and the first attempt will most likely be made to establish an electric system between Dresden and Leipsig. Dr. Ulbricht has been made general director of electric traction in Saxony, and president of the commission appointed to select the best system for the line in question.

Telepantograph.—We understand that this is the name of one of the latest forms of picture telegraphs, which has been recently patented by Mr. R. Greville-Williams. It is claimed that by means of this instrument a drawing, letter, photograph, shorthand or other graphic matter can be automatically telegraphed any distance that an ordinary telegram can be sent, through the medium of one wire. A matter of some importance to which attention is directed is the reported fact that the instrument requires no complicated processes. Like all other processes, the question of utility *versus* cost will decide as to its ultimate success.

The Proverbial Brick Wall.—We learn that the Tottenham and Edmonton Gas Company want to embark on an electric light business and to supply electricity for the district covered by their mains. Evidently the company does not care for precedent and likes to run its head against obstructions. It will succeed in spending money on the attempt, but a perusal of the past attempts of other gas companies must convince it that the Board of Trade is in the hands of shrewd men of business, and that their application for powers to supply electricity will be refused. The electric light provisional orders are not granted to be put on a shelf.

Electricity and Gaols.—The introduction of electricity into H.M.'s prisons has not proved an unmixed blessing, as seen by the recent escape of the man Riverton from Swansea. It appears that the prisoner first gained possession of an instrument wherewith to raise the stone in his cell by unscrewing from the wall the electric communicator and breaking off a piece of iron about 1ft. long. He then set to work and raised two slabs near the heating apparatus grating, and got into a flue, through which he forced himself. As the scientific burglar will be an important factor to deal with in the near future, it may not be untimely to suggest a scientific police department to cope with this latest nineteenth-century product.

Vril Launches.—It will be of interest to our readers to hear that the Vril launch built for the Imperial Russian Ministry of Marine has now been shipped to Russia. At the final trial before Captain Grigorovitch, the naval attaché to the Imperial Russian Embassy, on July 13 neither the condition of wind nor sea were favourable, but the launch easily accomplished her contract speed. At half speed, however, instead of 4½ knots for 10 hours, as per contract, she gave a speed of 5½, which would have apparently lasted for 20 hours. Owing to want of time, this exhaustive trial was not made, but the data obtained have put the manufacturers of these launches in a position to be able to guarantee 5½ knots for 15 hours, or a total of about 80 knots without exhausting the storage batteries.

The Liverpool Motorcar Trials.—We are informed that the judges—Sir David Salomons, Bart., Mr. Boverton Redwood, Mr. S. B. Cottrell, Prof. H. S. Hele-Shaw, and Mr. Henry H. West—who were appointed to award the prizes in connection with the trials of motor vehicles for heavy traffic held at Liverpool from May 24 to 27 last, have now arrived at their decision, and have unanimously awarded the first prize of £100 to the Lancashire Steam Motor Company, Leyland (vehicle No. 5); the second prize of £75 to the Liquid Fuel Engineering Company, Limited, East Cowes, I. of W. (vehicle No. 1); and the third prize of £50 to the Steam Carriage and Wagon Company, Limited, Chiswick (vehicle No. 4—four-wheeler). The judges' full report on the trials is still in course of preparation, and will be issued later in the year.

Smoke Nuisance.—The case between the Paddington Vestry and the Metropolitan Electric Supply Company is reported somewhat fully in our legal column, and from this report it will be seen that the company have been given nine months either to find other coal or else alter their furnaces so as to use ordinary coal. As usual, the counsel on behalf of the Vestry showed by his questions an absolute ignorance of his subject. Thus he said it was quite feasible to use gas-engines for driving the alternators, etc. The Welsh coal strike has much to answer for, and the present smoke nuisance in London is not the least of the indirect troubles. Still, we trust that the dispute will end, so that the company may not have to alter their old station. After this warning, however, their new works at Willesden should be arranged to burn any class of coal without creating smoke.

Motorcar Associations.—The amalgamation of the Self-Propelled Traffic Association with the Automobile Club has been effected at a recent extraordinary general meeting of members. The following gentlemen were at the same time added to the club committee: Sir David Salomons, the Hon. C. S. Rolls, Mr. Andrew W. Barr, Mr. Alfred Bird, Prof. Vernon Boys, Mr. R. E. B. Crompton, Mr. Walter Hancock, Mr. Bayntun Hippisley, Mr. J. T. Hopwood, Mr. Alfred L. Jones, Mr. Edmund Macrory, Q.C., Mr. Harry Melville, Mr. E. Shrapnell Smith, Mr. E. R. Shipton, and Mr. John Thornycroft. The Automobile Club, which includes among its founders the Earl of Galloway, the Earl of Shrewsbury and Talbot, the Earl of Carnarvon, Viscount Templetown, Lord Suffield, Sir Bernhard Samuelson, Sir Richard Paget, Sir Douglas Galton, Major-General Sir Arthur Ellis, Mr. Roger Wallace, Q.C., and Mr. Frederick R. Simms, has its clubhouse at Whitehall-court, and has over 360 members, of whom nearly 100 own motor vehicles.

American Science.—As previously announced by us, the fiftieth anniversary of the American Association for the Advancement of Science will be celebrated at Boston next week. The preparations for Section D, which comprises mechanical science and engineering, include the following papers interesting to our readers: "High-Speed Influence Machines," by Charles W. Warner; "Proposed Methods of Determining the Frequency of Alternating Currents," by Carl Kinsley; "On a Dynamometer Car and Its Equip-

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ment," by Prof. L. P. Breckenridge; "An Integrating Dynamometer for Measuring the Work Done in Drawing a Train," by Prof. Thomas Gray; "A Combined Absorption and Transmission Dynamometer for Laboratory Purposes," by Prof. J. J. Flather; "On the Measurement of Train Resistance by Dynamometer," by Prof. F. C. Wagner; "On the Use of Platinum Resistance as a Pyrometer in Boiler Tests," by Prof. F. C. Wagner; "A Comparison of the Efficiency of the Rheostat and the Series-Parallel Controller for Electric Cars," by Prof. Thomas Gray.

Motorcars. — This hot weather emphasises the unpleasant tracks left by motorcars driven by oil-engines. Recently we noticed that one owned by Messrs. W. H. Smith and Co. had scented the whole of the street from St. Clement's Church to St. Mary's. If one vehicle was thus able to make itself unpleasant for that length of street, what would be the effect of a larger number? We are sure that even if one in ten of the vehicles were so propelled, the atmosphere in the underground railway would be nectar when compared with the air in the London streets. Either the oil-cars must consume their own exhausts in some way, or else be banished to the country. Even this latter prospect is not pleasant, as half the enjoyment of a holiday on a cycle would thus be spoiled. Perhaps it was the odorous character of such motor vehicles which induced the Clacton Urban District Council to refuse licenses to motorcars recently. After all, electric cars are the most pleasant to use both for ease in driving and also for ease to the occupants. We trust that the cost of upkeep will also compare more nearly in the future.

Colwyn Bay.—We received an invitation to attend the opening ceremony of the electric lighting of the new promenade on Tuesday last, and also one for a dinner given to celebrate the event. The promenade of this fashionable watering place in North Wales has been equipped with 24 arc lights by Messrs. Biggs and Thomas. The lamps are connected in series, and supplied from a generating station in Ivy-street. After the dinner the company adjourned to the front, when Mrs. Herbert Roberts switched on the lights with a silver key provided for the purpose by the chairman of the District Council. Mr. H. Roberts, M.P., in acknowledging a vote of thanks to his wife, said electric lighting had become an inseparable adjunct of all watering places of leading rank, and Colwyn Bay was not going to be left behind. He felt sure that that ceremony would begin yet another epoch in the successful record of their town's history. The lights which flashed nightly along their promenade would be the source of great enjoyment to thousands of their friends; and, in conclusion, he hoped that the new illumination would prove a symbol of a future bright with success, of a growing spirit amongst them all of still more disinterested service for the public good.

Collisions at Sea.—The dangers of sea fogs are ever being brought to our notice by disastrous accidents involving great damage and loss of life. The recent "Bourgogne" collision has brought to mind the futility of the present arrangements of preventing such sad occurrences. Some reliable indication of the approach of another vessel or of an iceberg is required, and the apparatus must be independent of the climatical condition. Mr. H. Herberts proposes, in our New York namesake, to use the thermopile for such a purpose. He would make the thermopile revolve slowly, and thinks that the radiations from a ship or from an iceberg would give warning of their approach. By a system of relays an electric bell would be made to ring, and the warning, when the thermopile was pivoted in a given direction, would give the direction from which danger was to be expected. It seems to us that the details would be too liable to go wrong, or, rather, to give false alarms. Thus in a heavy sea the rolling or pitching of the vessel would cause the thermopile to face sky and water at different times, and the differences of radiation in the two positions would be much more than any difference caused by a ship a mile away. In fact, we think that Mr. Herberts should have tried his idea in miniature before publishing it.

Gas Profits.—The general experience in places where gas and electricity are in close competition has been in the past somewhat favourable to both. Electrical engineers have established better standards of lighting both for street and private purposes, and where electricity is not introduced more gas is used. Hence, although electric lighting has paid in practically every case, the gas profits have not as a rule decreased. This state of affairs can hardly continue. In the early days the competition was between a dear but healthy and convenient illuminant against an old well-established and cheaper rival. Now electrical undertakings are growing fast, and their costs of production and prices to consumers have come tumbling down to a point at which the inequality in cost between gas and electricity no longer exists. The struggle thus becomes one of the survival of the fittest. A sign as to the way this tends is shown by the results at Southport for last year, where the Gas Committee had to report a decreased profit of £2,322, which they state "was very largely, if not entirely, due to the loss of custom through the popularising of electricity." This result is unpleasant, but having a municipal electricity supply as well, the public at Southport does not suffer by the fact that one illuminant is replacing the other.

The American Electric Gun.—The long solenoid electric gun is, we are told by a bashful "prominent savant," feasible and capable of scientific proof. Such a proof is supposed to be given by him in the *Electrical Review* of New York, but his name is not attached, and the editor unkindly remarks that he has an indiarubber imagination. The writer aims at a muzzle velocity of 6,000ft. per second, and expects to get this from a solenoid gun 100ft. long. The time he calculates between the shot starting to move and its leaving the gun is one-fifteenth of a second, and a current of 95,000 amperes at 3,000 volts is to be started in different segments of the solenoid in that short time. The effects of self-induction are evidently wiped out by the indiarubber imagination, and the author also does not trouble to discuss the theoretical value of such a solenoid as a means of mechanical propulsion. It is so much more simple to assume that the energy of the shell on leaving the gun is the same as that expended in the solenoids. After this the beauty of the gun is apparent, and also the idea that such a gun could work with an open breech so that a continuous stream of shells could be delivered. We are afraid, however, that there is too much indiarubber in the figures, and that ordnance experts will not trouble to check them.

An American War Tax.—An unlooked-for complication has, says the *Western Electrician*, confronted the Internal Revenue Department in its efforts to enforce the provisions of the war measure requiring the placing of stamps on telegraph messages. The representatives of the department have been making examinations of telegraph dispatches that have been received for transmission at offices throughout the country, to see if they have had the necessary stamps attached, and this has called forth protests by many against the exhibition of private messages that have been filed, as they are considered to be sacred from the eyes of all except the ones directly interested, and through whose hands they must pass in transmission. These complaints have reached the commissioner of internal revenue, and as they have been

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of such a nature that they could not be ignored, he has issued a circular to collectors and revenue agents in which they are advised that such examinations in the future are to be restricted to simply ascertaining if the messages have been properly stamped. The telegrams may be shown by a representative of the company in such a manner that the officer making the examination shall be able to see that the messages have been stamped, and it is considered unnecessary for him to have any knowledge of the contents of the telegrams.

The 1900 Paris Exhibition.—Further details of the electrical equipment of this exhibition are now to hand. We refer especially to the arrangements for the generation and distribution of power. Thus the administration have decided that direct-coupled machines only will be allowed for this work, and that no belts or ropes are to be used. Steam will be supplied to the engines at about 142lb. per square inch, subject to a variation of 10 per cent. more or less. Evidently the administration is afraid of high pressures, and also thinks that its steam-pipe arrangements will not be up to much. The dynamos, if direct current, must generate at either 125, 250, or 500 volts. Alternators, whether single-phase or three-phase, must supply at 2,200 volts, and have a periodicity of 50. The machines will be considered as exhibits, and will be judged accordingly for awards. The dynamos and engines will be required from April 15 to Nov. 5. The authorities go so far as to say that no workman running the plants shall work more than seven hours per day. Payment will be made to the providers of the machines in two ways. Firstly, a sum to remunerate them for the first cost of installation of their plants, and, secondly, an hourly remuneration for the cost of running. This latter runs from about 11s. 3d. per horse-power for steam dynamos up to 1,000 h.p., to 5s. per horse-power for machines over 1,500 h.p. The whole of the steam and condensing water will be supplied free, and the supplier of the plant will also receive remuneration per horse-power hour at rates ranging from ·15d. for machines up to 1,000 h.p., to ·051d. for machines over 1,500 h.p. It seems to us that the changes in these rates are too rapid to be fair, and that the figures also are so low as to hardly pay for oil, let alone attendance.

Gold from the Sea.—In a "Note" appearing in our issue of July 22 we quoted a financial paper which had stated that the Electrolytic Marine Salts Company was doing successful work, and that it had obtained about £5,000 worth of gold and silver at the cost of under £1,000. We criticised the statement that the "mother lode" had been struck, and said that we should await the future news of output. Now this news has arrived, and it appears that the lode struck was the old one of the credulity of the untechnical investors in secret processes. It appears that the gold and silver really was extracted, but instead of coming out of sea-water it came from the pockets of the public investors. Conversely, the gold did not go into the investors' pockets, except a 3 per cent. dividend distributed to increase the incoming applications for shares. Now it is rumoured that the Rev. F. P. Jernegan, the inventor, has succeeded in concentrating the funds of the company, and is bringing them across the sea to safer climes. Accordingly, "angry stockholders from all over New England are arriving at North Lubec to investigate the alleged secret process of extracting gold. It is said on the authority of one of the workmen that Jernegan infused gold dust into the mercury accumulators regularly toward the close of each month, resulting in the monthly gold brick. When the accumulators were opened on July 30, as usual at the close of the month, nothing but seaweeds were found, with slight traces of gold on the accumulators." The North Lubec works are now shut down, the thrifty New England investor is all anxiety and tears, and the air is full of wild rumours, but the Rev. F. P. Jernegan will doubtless explain everything satisfactorily to the detectives who are waiting for him at Havre when he lands.

Municipal Trams.—The Wolverhampton papers are full of correspondence on the above subject, about which we published recently a long argument to show the advantages of one company having the control of all the lines in the district. One letter the other way is written by "Royal Daylight." The light introduced by this *nom de plume* is none too pure, and advocates joint action by the municipal authorities, who are each advised to do the best for themselves. This is just where such a proposal fails. Neither unity of management or reasonable inter-urban service can be so obtained on account of the great number of town councillors who would be concerned. The relations between adjacent municipal authorities are not as a rule cordial, and the policy of reports and counter-reports and adjournments would prevail. "Royal Daylight" concludes by saying that: "It is plainly to be seen that the objects of the company are dividends and to set up big schemes, get the towns to make those schemes successful, and then sell them to the authorities at big prices. Let Wolverhampton beware." It almost appears as though it were wicked for a company to either obtain a dividend or to spend their money in establishing an up-to-date service of trams for the public good. The correspondent should remember the old adage, "Time is money," and that a quick service of trams is a big factor in the success of towns' industries.

To Change the Axis of the Earth.—What appears to be the largest electrical installation ever contemplated, and which has for its object not only the revolutionising of the earth, but even the turning of it, has been carefully worked out by Mr. Newton Harrison, E.E., editor of the *Electrical Age*, and was published in a recent number of the *New York World*. In the words of Mr. Harrison, whose imaginative powers seem to be equal, if not superior, to those of Jules Verne: "I would girdle the earth with a giant cable. Through this I would send a current of electricity strong enough to overcome the present magnetic poles of the earth. This would give us a new north pole and a new south pole. The effect of this would be to transform the earth into a huge electromagnet of such tremendous power that it would tend to lean violently toward the sun because the sun's chief constituent is iron. He goes on telling us of the new positions of the continents, and how Spain would have to yield or die of frost. The total cost of establishing the plant he figured out to be £29,000,000,000, and the time required to complete the work 10 years. The cable is to consist of 10 strands, each 12in. in diameter, its length is 25,000 miles, and its weight 264,000,000 tons. The current required would be 1,000,000 amperes, and the pressure 10,000,000 volts. The attractive force of the coil he figured out to be 58,000,000,000lb., and the power required 13,000,000,000 h.p. The figures as to cost may perhaps be accurate, but we doubt the groundwork of the idea. In other words, we do not believe that the magnetic poles determine the axis of revolution of the earth. From what facts there are available about terrestrial magnetism, it appears more likely that the rotation of the earth causes the magnetic effects about the axis.

Lawlessness on Electric Lines.—The *Street Railway Review* explains that the fact that trolley wires are so often stolen in the United States is not a reflection on the police, but a sign of phenomenal development of electric railways. Lines are laid to out-of-the-way places for summer use only, and hence are not easily protected in winter. The above paper

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gives the following detailed account of a fight on a Chicago car: "On the 10.10 p.m. trip, June 22, east bound on Laffin street, the car was approached by three men, and the speed was slackened for them to get aboard. As the third man stepped on the platform he caught the door-pull and, staggering as if falling, closed the door. Conductor E. L. Stickney caught him to prevent his falling, but quickly realised his mistake when the supposed passenger covered him with a revolver and ordered, 'Hands up quick, and make no noise.' The conductor pushed the revolver aside, and seizing the man threw him off the car. The other two robbers came to the assistance of their fallen comrade with revolvers ready for service. The conductor boldly attacked the second one, and forced him off the car while it was going at a high rate of speed. The third man snapped his revolver, but, fortunately for the brave conductor, the cartridge failed to explode, and then the robber dealt him a blow on the head with his revolver, inflicting a slight scalp wound. The motorman, Timothy McAuliffe, and a passenger came to the conductor's assistance in his unequal fight, and threw the third highwayman from the car. The conductor stepped to the lower step of the car, revolver in hand, and was shot at by one of the robbers. He returned the fire four times, two of the bullets striking one of the men, very seriously wounding him. The police captured all three of the bandits, and they are bound over to the grand jury. This successful resistance will likely put a stop to hold-ups on the Chicago General Railway, whose lines run through some outlying districts."

Marine Engineers in Bristol.—The Bristol Channel Centre of Marine Engineers paid a visit last Saturday to Bristol and inspected some of the public works. The party, which numbered about 50, came in a saloon carriage to Lawrence-hill, where they alighted, and were taken in a reserved car to the electrical power station of the Bristol Tramways and Carriage Company. The inspection of the station was made under the guidance of Mr. C. Challenger and Mr. W. Woods, and the members took great interest in the machinery. A visit was next paid to the Bristol electric light station, which the party had the pleasure of being shown over by Mr. Faraday Proctor. The completeness of the arrangements was commented on, and the installation spoken of in the warmest terms of approval. The docks were then inspected from a small steamer, which took the members from the landing-stage of the electric lighting station, and the trip was much enjoyed. At six o'clock the party had dinner at the Royal Hotel. The chair was taken by Prof. A. C. Elliott (president). After dinner Mr. Neville Appelbee, the Cardiff borough electrical engineer, read a paper on electric lighting stations, and sketched what in his opinion was a model station. The Chairman also read a few notes on electric traction, which, he said, had been practically developed within the experience of the youngest of those present. He spoke of the rapid strides made in the extension of electric traction, and pointed out its advantage for running tramcars. He also expressed the opinion that it would supersede steam on the underground railway. Bristol had set a splendid example, and Cardiff was preparing to follow. The present tram system of Cardiff was a disgrace, and there was, in fact, no town of equal importance where the service was more inadequate and unreliable. Votes of thanks were passed to the readers of papers, to the Bristol Docks Committee, the Bristol Electric Lighting Committee, and the Bristol Tramways and Carriage Company.

Electric Tramways.—An important measure, which received the Royal assent in the closing days of the past session, is the London United Tramways Act, promoted by the proprietors of the tramways from Acton to Uxbridge-road Station and from Hammersmith to Kew Bridge and Richmond. This provides for the extension of the present system from Kew Bridge through Brentford and Isleworth to Hounslow, and involves the widening of High-street, Brentford. Another section of the line for which powers have been obtained will connect Hanwell with Brentford, *viâ* Boston-road, and will thus provide a much-needed means of communication between Hanwell and the county town, where the police, county court, and other business of the district is transacted. In the measure as originally drafted it was proposed to connect Hanwell with Acton by a tramway running along the main Uxbridge road through Ealing, but the opposition of the Ealing frontagers succeeded in inducing the House of Commons Committee to declare that portion of the preamble of the company's Bill not proved. The Act as now passed contemplates not only the extension of the system but the substitution on that part of it which is wholly in the county of Middlesex of electric motive power for horse haulage, the opposition of the London County Council to the overhead trolley system, which it is intended to adopt, having prevented the company obtaining powers to apply the system to that portion of the line which is within the county of London. In order to secure the consent of the Chiswick District Council, through whose area the line runs, to the postponement of their powers of purchase, which were exerciseable as to part of the system in 1903, and as to the remainder in 1910, till 1919, when the other local authorities affected will have power to purchase the sections within their areas, the company, as the result of negotiation with the Council, agree to pay £12,000—namely, £350 per annum for five years from the passing of the Act, £500 per annum for the next seven years, and £750 per annum for the remaining nine years.

Electric Work in Auckland, New Zealand.—A great battle to decide as to who shall equip the tramway system of Auckland on the overhead trolley system is being waged. It seems that three parties have made offers to the town authorities for the concession, and that the report of the city solicitors reduces these to two, and recommends the Council to accept, say, Mr. A's offer. In the meanwhile Mr. B has bought up the old tramway, with which there is a six years' lease. By his proposals Mr. A is willing to accept the concession, subject to the present position of matters, his term and payment to commence, however, only when the Council can give him possession of the lines; and he is also willing to pay to the present holders a fair price for their interest in the concession. It is said that the present holders and their predecessors have for years past neglected to observe the terms of the concession, and should the Council think Mr. A's proposal the best, so far as the city is concerned, it will be for them to say whether they will allow themselves to be forced into accepting a less satisfactory proposal simply from the fact that the maker thereof is a purchaser (though not yet approved of by the Council) from the present holders of the concession. The offers include an annual payment and a share of the profits, as well as stating what fares will be charged. We also learn from the *New Zealand Journal of Insurance, Mining, and Finance* that a company, with a capital of £100,000, is to be formed for the electric lighting of Auckland contingent on a Bill being passed by Parliament granting the necessary powers. It is stated that the capital is guaranteed by a strong syndicate, and a Bill similar in every respect to that under which the electric lighting scheme of Wellington exists is to be presented to Parliament during the session. The system of mains proposed is an overhead one, except perhaps in the main business thoroughfares, and under the

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proposed conditions the City Council would be able to acquire the concern at the expiration of 10 years. The initial cost of the work is estimated at £60,000, which would leave £40,000 under the proposed capitalisation available for extension and preliminary working expenses.

The Pacific Cable.—We believe in reiteration if a good cause is to be furthered, and the establishment of an all-British Pacific cable is such a cause, so we give herewith Mr. Roland Belfort's concise statement of reasons for this cable as put in his recent letter to the *Times*: "Both Imperial and Colonial interests demand it. Canada and Australasia are willing to participate with Britain in its cost. It would liberate Colonial cablers from the present crushing cable 'corner.' A cablegram from Vancouver to Melbourne has to tour the world, costs over 6s. per word, and is often subject to disastrous and exasperating delays. By the direct Pacific cable it would cost 2s. per word, and arrive within the hour. Until the alternative cable is laid our Australian colonists will frequently be compelled to depend on the shaky Siberian land lines for telegraphic communication with the mother country. Those lines are controlled by Russia. Naval and military experts assert that our foreign-controlled cables would certainly be cut by our enemies during any crisis. This might imperil the very existence of outlying portions of the Empire. Britain thus needs a strategic cable system free from foreign control. Commerce needs a system free from the deadly grasp of the monopolists. If the Pacific route existed, the cabling public would save nearly £225,000 per annum. In eight years this sum would pay for the new cable. The project is perfectly practicable from the electrical, engineering, and financial standpoints. The control of Pacific cable communication should by right devolve on the British—the pioneers and principal constructors of the world's submarine cable system. To allow another nation to forestall us by executing this great work would constitute a most humiliating abdication of our recognised position as lords of the ocean depths. Finally, by a mutual effort, Britain, Canada, and Australia can establish this communication without the slightest cost to their taxpayers. Under these circumstances Mr. Belfort asks if the Imperial Government would not be quite justified in taking the initiative in this project, which is generally considered to be ripe for execution? Recent official declarations on the part of Australasian premiers prove beyond doubt that such action would meet with a cordial response from the colonies concerned."

Magnetic Densities in Armature Cores.—Our esteemed contemporary, the *American Electrician*, calls attention to the great discrepancies existing in the matter of the density in armature cores. This is said to vary in good practice from 6,000 to 14,000 C.G.S. lines per square centimetre. We are also told that the school of high density is essentially of English extraction, while machines of low armature induction are mostly American designs. The high-density advocates argue that their practice renders a smaller armature permissible and improves commutation, and that the added reluctance that the contracted area inserts in the magnetic circuit is a negligible amount. The low-density engineers hold that the employment of a high induction entails a very careful selection of iron, or the loss by hysteresis will become so great as to overheat the armature, and, further, that the low-density armature is inherently larger, affording a greater radiating surface and rendering a much larger copper loss permissible. In this way the machine may be made to carry large overloads. Moreover, they state that the art of designing windings that will commutate satisfactorily is so far advanced that it is no longer necessary to overpower the armature with a field magnet. Both are right, but the desirable features of the one practice may often be profitably sacrificed to secure the advantages of the other. The strength of the induction, therefore, depends more on the conditions that are to be met in the design. If, for example, slow speed is desired above all else, there is no escape from the high density. If, on the other hand, overload capacity is desired, high density is to be avoided. It is not to be inferred that a machine in which the armature is highly magnetised is of light weight, for as a usual thing little is gained in this direction by such a practice. The diminished area of the air-gap will increase the reluctance and the leakage in sufficient measure to demand a field magnet and exciting coils of added weight. The difficulty, if not the impossibility, of uniformly procuring good iron is certainly a temptation to lower the induction. The consensus of modern opinion seems to be that density is somewhat like speed: it may be increased above a certain limit to gain other advantages, but as a general rule the density cannot be increased over 80,000 lines to the square centimetre without serious sacrifice.

Hard-Drawn Copper Wire.—We see from the last number of the *Journal* that the Franklin Institute Committee on Science and Art have decided to award the Edward Longstreth Medal of Merit to Mr. Thomas B. Doolittle, Bradford, Conn., for his past work in the introduction of hard-drawn copper wire for electric overhead lines. The report advising the award refers to the fact that Mr. Doolittle, in the year 1877, suggested the use of hard-drawn copper wire for telephone and telegraph uses, and in the same year, at the works of the Ansonia Brass and Copper Company, Ansonia, Conn., succeeded, after many experiments, in producing about 500lb. of this material, which was employed on a telephone line connecting these works. This method consists in using drawing plates containing a larger number of holes than the ordinary plates used in copper wire drawing, and increasing the number of passes for a given reduction of area. By this means it is possible to draw copper wire from the beginning to the end of the operation without any annealing, and at the same time to avoid the crystallising of the metal. The wire thus produced is sufficiently flexible to permit of the formation of standard telegraph wire joints without breaking or cracking. The hard-drawn copper wire made by the Doolittle method has its tensile strength doubled and its elongation reduced to about 1 per cent., while its electrical conductivity is not materially impaired. The report dwells upon the great utility of such hard-drawn copper wire for aerial conductors on account of its high conductivity and great tensile strength and reliability in prolonged service, which were amply demonstrated by Mr. Doolittle in his efforts to secure its adoption by the electric line builders; and it was due entirely to his persistent endeavours that hard-drawn copper wire was at length adopted for telegraph and long-distance telephone purposes. Hard-drawn copper wire has now become a staple article of manufacture, not less than 8,000,000lb. having been produced in the United States alone in 1896. It is now frequently employed for all kinds of electric conductors, and especially for long-distance telephone lines, the successful operation of which, the committee of investigation admits, is in large measure due to its introduction. The report concludes that Mr. Doolittle is entitled to recognition: (1) for having been the first to recognise the value of hard-drawn copper wire, and for having by his persistent endeavours, in the face of adverse conditions, succeeded in establishing its use for electric conducting wires; and (2) for his long-continued experiments and labour in overcoming the many difficulties encountered in producing on the commercial scale a hard-drawn copper wire suitable for electric conducting wires.

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THE TELEPHONE ENQUIRY.

The following is the full text of the report of the Select Committee on Telephones. The gentlemen composing the committee were Mr. Bartley, Mr. Griffith-Boscawen, Sir Harry Bullard, Mr. Cawley, Mr. Cohen, Mr. Colville, Mr. Firbank, Mr. Fry, Sir Reginald Hanson, Sir Henry Howorth, Sir James Joicey, Mr. Nicol, Mr. John Redmond, Mr. James Stuart, Mr. Tully, Sir James Woodhouse, and Mr. Hanbury, the chairman. The report, which was presented in the House of Commons last week, reads as follows:

Your committee have carefully considered the evidence given before two select committees of this House in 1892 and 1895, and before the Treasury Commissioner at Glasgow in 1897, in addition to that taken by themselves during 20 sittings.

The reference to your committee is as follows:

"To enquire and report whether the telephone service is, or is calculated to become, of such general benefit as to justify its being undertaken by municipal and other local authorities, regard being had to local finance; and, if so, whether such local authorities should have power to undertake such service in the districts of other local authorities outside the area of their own jurisdiction, but comprised wholly or partially in the same telephone area, and what powers, duties, and obligations ought to be conferred or imposed upon such local authorities."

The principal questions therefore with which your committee have thought it their duty to deal are:

(I.) Is the telephone service now, or is it calculated to become, of general benefit?

(II.) Is the Post Office in any way hindered by legal agreement or by good faith from competing itself or through licensees with the National Telephone Company in exchange areas?

(III.) Ought competition to take place, and should municipal and other local authorities be empowered to undertake a telephone service, and, if so, upon what terms?

I.

In our opinion the telephone service—

(1) Is not at present of general benefit, either in the United Kingdom at large, or even in those limited portions of it where exchanges exist;

(2) Is not likely to become of general benefit, either in the country as a whole, or in existing or future exchange areas, so long as the present practical monopoly in the hands of a private company shall continue; and

(3) As it has already become of much more general benefit in other countries affording less scope for its development than is afforded by the greater density of population and the greater wealth and commercial activity of the United Kingdom, so it is fitted to become in this country, if worked solely or mainly with a view to the public interest, a valuable instrument in further developing the trade and social life of the nation, towards which new means of communication have always hitherto so largely contributed.

Our trunk service, which is in the hands of the Government, and is worked on the toll system, is the most extensive in Europe. The exchange service, which is almost wholly in the hands of the company, and chiefly confined to subscribers, is much behind that of some Continental countries. During nearly 20 years we have tried in turn, first, an unlimited competition, next, restricted competition, and afterwards an unregulated monopoly in private hands. But the exchanges still remain limited, in the United Kingdom chiefly to England, in England to urban districts, in urban districts to the commercial classes, among the commercial classes mainly to merchants and large tradesmen, and among them to those only who find it advantageous to become subscribers.

The present subscription system, with the subscribers' right of unlimited user, means this: that persons who are rich enough to pay a fixed annual sum, and who use the telephone sufficiently often to find such a payment advantageous to themselves, whose correspondents also pay a similar sum, and use the service with similar frequency, can alone, or almost alone, avail themselves of this mode of communication. It is just as if the Post Office should decide to dispatch telegrams only from persons paying an annual subscription, and to allow such persons on payment of their subscription to dispatch without further charge any number of telegrams, requiring at the same time that telegrams should be addressed only to persons connected with the Post Office telegraphs by private wires.

Within the London area, containing a population of over six million persons, there are only 237 call offices open to non-subscribers for the transmission of messages. In Stockholm there are 700 for a population of only a quarter of a million.

Even where call offices exist, a non-subscriber can, as a rule, only send messages. The message must, unless a previous arrangement has been made between the parties, be dispatched to a subscriber, except where the sender and the recipient of the message are both in the same postal district or town. In that case the message is written down at the post office to which it is transmitted, and is delivered for a small charge by express messenger service. This limited privilege appears, however, to be little known to the public, and has certainly been insufficiently advertised.

The Treasury minute of 1892 appears to your committee to contemplate a much greater extension of this system of express delivery of telephone messages, a system which, worked in connection with an adequate supply of call offices, would throw the telephone service open to the public at large.

Clause 7 of the Treasury minute of 1892 is as follows: "The companies will connect their exchanges with the offices of the Post Office, in order that their subscribers may telephone messages (*a*) for transmission over the public telegraphs; (*b*) for transmission through the post as letters; (*c*) for delivery as express letters; (*d*) that they may call for the service of express messengers; and may (*e*) request to be placed in telephonic communication with other towns by means of the trunk wires of the State."

The delivery of telephone messages as express letters was one of the advantages put forward by the Postmaster-General, Sir James Fergusson, in his speech of March 22, 1892, as a result of the contemplated purchase of the trunk wires by the Government. "The concessions which might be made to the telephone companies are mainly these: that messages might be transmitted by telephone and communicated to the public telegraph wires, so that there might be free communication between the two systems; that messages might be sent from any telephone subscriber to be delivered to his correspondent by the Post Office; that they might be sent by post as letters, or by express messenger service; that no charge should be made by the Post Office for the work of taking down the telephonic messages and dispatching them by telegraph or by post," etc.

The present restriction of this more popular system does not appear to be called for by a regard to the maintenance of the telegraph revenue. Mr. Preece, engineer-in-chief to the Post Office, in his evidence before us clearly stated that in London the growth of the telephone service has been simultaneous with, and, indeed, has probably produced, an increase also of telegraph messages.

In any case such a restriction prejudicially affects the revenue of the trunk wires of the Government, and confines the receipt of trunk messages to subscribers to the National Telephone Company, except in a few places where the Post Office has itself an exchange.

One obvious tendency of the present system is thus to limit the use of the telephone service as a whole, and especially of the trunk lines of the Government, to the company's subscribers to the exclusion of, and the cost of, the general taxpayer. Another result is to increase the rates to subscribers themselves, and those rates are, in fact, higher in this country than the rates paid in similar places abroad. A third result is the fact that fewer telephones are used.

Mr. Gaine, the general manager of the National Telephone Company, admitted to your committee that the system of limiting the service almost wholly to subscribers and giving to each subscriber an unlimited user—a system which is universal in this country and is adopted to a large

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extent abroad—had been based from the first on a wrong principle. The right system appears to us to be the one advocated strongly by Mr. Preece, and which Mr. Gavey, also an electrical engineer to the Post Office, has shown to be so successful in popularising and developing the service in Switzerland. Messages can be sent by non-subscribers from call offices and delivered to non-subscribers by express messengers; but, in addition to this, just as some persons in this country hire private telegraph wires to connect them with the general telegraph service, and thus avoid the necessity of delivering messages at or receiving them from a telegraph office, so persons who wish to save the journey to a call office to dispatch a telephone message or to receive it direct instead of by a written message can secure a private telephone in their house or office on payment of an annual sum of (after two years) £1. 12s. For all messages actually sent subscribers and the public alike pay the same fixed toll, smaller if the message is a local one, larger if it travels over the trunk wire; the price for all distances over trunk wires being in Switzerland the same. Each message sent by a subscriber is numbered and an account against him is kept. It follows under this system that every telephone can be used by the general public instead of being confined to the actual subscriber, with the result that in many towns every shop or place of business which has a telephone becomes in practice a public call office.

Such a system, Mr. Preece is convinced, would be equally successful in this country, and go very far to extend the telephone service to almost every class. It would, of course, be opposed by the subscribers on the existing system, who, at present, almost monopolise the service, and pay a small price for the large number of messages they can send. The National Telephone Company, Mr. Gaine stated, had already realised the force of this opposition, but it is clearly not one to which a municipality or the Post Office starting operations in any area for the first time would be exposed.

In addition to the general objections to the existing system there are other reasons connected with the practical monopoly of the National Telephone Company which lead us to believe that, under present conditions, the service is not likely to become cheaper or more generally developed.

(1) Mr. Forbes, chairman of the National Telephone Company, stated to the committee of 1895, that at the date when the rival companies had been absorbed by the National Telephone Company, "the total amount of money spent in the actual construction of the thing was £1,813,000; the amalgamation value and purchase value (those are the figures I read to you) was £3,105,000. The difference (what some people are pleased to call the water value) was £1,292,000."

About £300,000 was paid for patents, which expired in 1891.

It is difficult, of course, to ascertain exactly the difference between the actual cost of constructing the system and that cost plus the amount spent in buying out competing companies, or purchasing useless plant, and licenses and patents which have now come to an end. Nor is it clear how much has recently been spent from capital on replacing the single wires by the metallic-circuit system in most of the larger provincial towns. It is evident, however, that the service has cost the company much more than it would now cost to replace it by a system at least equally good. This increased cost must naturally involve either a decreased dividend to the shareholders, or increased rates to the subscribers. The dividend has hitherto averaged about 5 per cent.

(2) The license of the company expires on Dec. 31, 1911, and the committee of 1892 recommended that it should not be renewed. The Post Office is under no obligation to buy even the plant of the company at that date, and the Post Office alone could find a use for such plant should all licenses alike be terminated in that year. It is hardly probable that any government will give the prescribed notice to purchase not only the plant, but the goodwill by arbitration in 1904—a step which was not taken under somewhat more promising conditions in 1897. But the company, unlike all similar monopolies, has power to charge what rates it chooses; and in view of the comparatively small amount already placed to reserve, and the short period for which its license will run, it is evident that in order to recoup its great expenditure, the present high rates of the company may soon be still further raised. They affect, no doubt, a comparatively rich section of the community, who probably receive full value for their subscription to the practical exclusion of the non-subscribing public. But any further raising of the rates, besides stopping the growth of new subscriptions, would inevitably produce complaints from all sides of the increased dearness of a service which becomes daily more vital to the trading interests of the country, and a public demand might in consequence arise for the Government to undertake the service itself. Unless the Government had already an alternative plant available, supplied wholly by the Post Office or partly by municipal licensees, the purchase of the company's undertaking at an inflated price might thus be imposed upon the Government. The inducements to the company to produce such a result are obvious; and your committee cannot too strongly recommend that no delay should occur in taking adequate precautions to prevent it. Mr. Preece informed your committee that it would probably take five years to provide such an alternative plant for the whole country.

(3) Under the peculiar conditions (or freedom from conditions) of its license, the company has an obvious reason for limiting the number even of its subscribers. As subscribers upon an exchange increase, the cost of the service increases so much that a point is at last reached at which an increased number of subscribers fail to repay the additional cost. The company, unlike the Post Office, from whom it receives its license, has power to refuse service, and thus to pick and choose its subscribers and thereby to limit their number, and in doing this it is materially assisted by the grant of extensive areas, which afford it a wide choice of the most remunerative subscribers, and at the same time go far to protect it against competition.

As the number of subscribers on an exchange is thus restricted the number of exchanges within an area must in consequence be increased. The cost of thus sending a message through two or three exchanges and over the junction wires has, of course, to be paid for by somebody, and it is paid for in the disguised form of a larger annual subscription. Under a scheme of smaller areas than those which have, in fact, been allotted to the company, the wires which connect such exchanges would in most instances have been Government trunk wires, directly producing a revenue to the Post Office.

(4) Mr. Forbes stated to your committee that owing to the necessity for the company to recoup its expenditure before 1911, it would probably not extend its operations into new districts after 1904, and in reply to the question, "Do you mean to say that after 1904 you will refuse all new subscribers?" said "I think it is highly probable." It is possible that even an earlier date might have been named. What is thus true of rural districts is probably true also of many urban districts not yet supplied with exchanges, and is possibly applicable even to extensions of the service in the areas already thus supplied. Mr. Gaine indeed added in his evidence that in no fewer than 106 areas already assigned to them the company has no exchange, and, though an active canvass had been undertaken, in some not one subscriber. It is not evident why such areas were assigned to the company before any public demand existed, and it is difficult to reconcile the fact stated by Mr. Gaine with the evidence of Mr. Lamb, second secretary to the Post Office, to the effect that areas were created only as the public required them, and that so far as he knew no area had been created which did not contain an exchange.

(5) Another serious difficulty is the question of way leaves. Underground wayleaves are stated by the company to be a necessity of an efficient service in urban districts. Between post offices and exchanges, and from exchange to exchange, underground wires are laid by the Post Office and rented to the company, and as regards wires between two exchanges, in the case of towns of a population exceeding 30,000, the Post Office is bound by its agreement to provide and lay them down if a price can be agreed on with the company. Even to these, however, objections are raised by many municipalities, who complain

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that it is an abuse of the special powers of the Post Office to assist a private company to disturb the public streets. So far as regards those wires which connect exchanges with a post office, such a proceeding is fully justified by considerations of the public interest. As regards those between two exchanges the justification is less obvious, although no doubt such an arrangement is in accordance with the terms of the agreement. The legal right, however, of the Post office to enter into such an agreement is disputed by some of the large municipalities. The Post Office has not exercised the statutory powers which it claims to lay underground communication for the company between the exchanges and subscribers of the company. All municipalities can refuse their consent to such wires being laid by the company itself, and many have, in fact, done so. Yet it is just these wires which are declared by the company to be a necessity for any effective service. The service hitherto given has been conducted chiefly by overhead wires, and for these the company has been generally able to get wayleaves, though at times in order to obtain these it has had to resort to the peculiar power it possesses of refusing service, except where onerous conditions are agreed to. This power does not appear to your committee to have been always used in a satisfactory manner, and the conditions attached to the agreement have in many cases misled subscribers. Parliament has repeatedly refused to extend the wayleave powers of the company, and it does not appear likely to grant them now.

More serious than the difficulty of obtaining new wayleaves in the future is the precarious tenure of those which already exist, overhead and underground alike. Mr. Gaine gave evidence to show that out of 143,000 miles of the company's wires, 120,000, or about five-sixths, are liable to be removed at short notice of six or twelve months.

Even the underground wayleaves between exchange and subscribers granted by local authorities, and which exist mainly in certain large provincial towns, where special agreements have been come to with the company, are liable to be terminated in some cases after twelve and in others after six months' notice. The Post Office has for some time past granted the use of underground wires between its local offices and the exchanges, or between two exchanges in various large towns, but no binding arrangements have yet been made, and Mr. Lamb stated that even the draft agreement had not yet been submitted to the company.

In the opinion of your committee the service given by the company, though not generally inefficient, is inadequate. For the class of subscribers who have a right of unlimited user, and whom almost alone the company serves, the rates cannot be considered unduly high, though higher than are paid by similar subscribers in many Continental countries, but to the large majority of the public who only require a limited user the rates are prohibitive.

We think that a service already so essential to commercial men, and so well calculated under other conditions to benefit directly or indirectly all classes of the community ought no longer to be treated as the practical monopoly of a private company, a course for which no legal or moral necessity appears to exist, and especially ought not to be worked on a system and under conditions which confine its benefits to a limited class in selected areas, permit preferential rates to be charged, and allow a private licensee of a public monopoly to refuse the use of a business necessity to one tradesman and grant it to his competitor under similar circumstances, impose no limitation of charges, and leave the public at large dependent on a service which is in its turn wholly dependent upon innumerable wayleaves held upon very precarious tenure, and nearly all liable to be terminated after six or twelve months' notice.

II.

We had next to consider whether municipal and other local authorities should have power to undertake a telephone service, regard being had to local finance. Your committee, however, felt bound, before dealing with this question, to fully satisfy themselves that the Post Office is not prevented either by legal agreement or by good faith from limiting or ending the monopoly of the company.

On the right of the Post Office to compete in any area, either itself, or by means of licensees, the written agreement between the Post Office and the company are distinct and unmistakable. But in the evidence given before us, Mr. Forbes endeavoured to insist on verbal understandings which he alleged to exist, restricting the evident meaning of the written contracts.

This is in contradiction with the evidence given by him in 1895.

In 1892 Mr. Lamb gave the following evidence before the Select Committee on the Telegraphs Bill:

"(Q.) 114. Is there any understanding that the Post Office will not compete with the companies in these areas?—(A.) No; under the existing license it is expressly reserved that the Postmaster-General can either give a license or may himself carry on the business; and that is to be a distinct part of the new understanding. (Q.) 115. The minute says, 'the department holding itself ready to comply with the reasonable demands of any town or district?' Supposing it were maintained that there were already reasonable facilities given by the company, would it still be open to the Post Office to compete?—(A.) Yes, that would be distinctly reserved."

In 1895 Mr. Lamb gave further evidence before the Select Committee on Telephones. In answer to Sir Charles Cameron, with reference to Clause 18 of the proposed agreement, he said, (Q.) 259, "There is no doubt the Post Office could, without any breach of honour or contract, grant additional licenses."

"(Q.) 260. Or faith?—(A.) Or faith; there is no doubt about that."

Before the same committee Mr. Forbes himself was examined as follows as to this evidence: (Q) 4,643. "Mr. Lamb, whom we examined, or who was a witness on behalf of the Post Office, said (I think I can almost quote his own words) that the Post Office was certainly not in law, on the strictest interpretation of the agreement, in any way debarred from granting competing licenses, and that it was under no obligation, even in honour, not to grant competing licenses?—(A.) I believe they are absolutely free. (Q.) 4,644. You agree with him that there is not even an honourable engagement on the part of the Post Office not to grant competing licenses?—(A.) The Post Office are absolutely free. I will go a little further, and say that in all the negotiations (which were prolonged) there never was the slightest suggestion, directly or indirectly, of any such cession on the part of the Post Office of a promise or pledge to lock up their own discretion."

Before your present committee Mr. Forbes took up a different position.

(Q). 5,687. "But they [the Post Office] reserved it [their discretion], according to you, under a verbal pledge not to exercise the power which they so deliberately reserved?—(A.) Well, they reserved their discretion; but they reserved their discretion in a positive promise that that discretion should only be exercised in each case under certain circumstances; they have got their discretion now; if they choose to begin to-morrow in any town they can begin; if they choose to license anybody they can; but if they did license, or if they did begin, they would be breaking the pledges made to me by Mr. Goschen, by the Postmaster-General, and by others as to the circumstances under which that exercise of discretion should be put into operation."

This evidence, however, he subsequently modified as follows: (Q.) 6,469. "But did Mr. Goschen in any way in this private negotiation lock up his discretion?—(A.) Not in the slightest. (Q.) 6,470. Then what did he do?—(A.) He simply said the conditions of the Treasury minute will be applied with discretion, and that sort of thing. I put to him what interpretation am I to attach to this? Well, you are to co-operate, you are to do what you can to carry out the desire of the Government, which is to get possession of the trunk wires to greatly improve the trunk service of the country, and to develop its telephone system both in local areas and from one area to another as rapidly and as efficiently as possible; you are to co-operate in that; we are both in the same boat, so to speak, in desiring to do this; you can help us, we can help you; words almost of that kind. (Q.) 6,482. Did ever he give any promise whatever that he would exercise this discretion in any particular manner?—(A.) Not beyond that, that we should be treated

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with all proper consideration. I believe that was the very last word he said to me at the end of the discussion—you will be treated with proper consideration; and that we really had to make this property a success. (Q.) 6,483. It is on those words you rely to be protected against competition?—(A.) I do. (Q.) 6,484. And those only?—(A.) And those only."

Mr. Goschen, who was Chancellor of the Exchequer in 1892 when the heads of agreement were arranged and initialled, gave this evidence before us: (Q.) 7,228. "I should like to put the same question to you as I put to Mr. Forbes. Would the granting by the Post Office of a license to a municipality now be in your opinion an evasion of the spirit of the agreement entered into with the National Telephone Company?—(A.) I cannot think that it would; I think there are words which distinctly contemplate it in the very speech to which attention is called."

Sir J. Fergusson, who was Postmaster-General, and initialled the heads of agreement in 1892, gave the following evidence on the subject of competition: (Q.) 2,244. "You are quite convinced that there was no sort of undertaking come to of any sort?—(A.) I am quite convinced; on the contrary, when you come to talk of an 'undertaking,' I gave the strongest refusal to entertain it at all, because I said that neither the Government nor the House of Commons would listen to any undertaking of the kind."

Mr. Arnold Morley, who was Postmaster-General from 1892-1895, stated that he had never heard of any such understanding as that alleged by Mr. Forbes.

The two remarkable letters dated respectively Feb. 9 and March 13, 1893, which your committee saw for the first time at their last meeting for taking evidence, placed beyond doubt the entire absence of any limitation, whether by verbal understanding or otherwise, upon the unrestricted right of the Post Office to allow the fullest competition.

The plea of verbal understandings being thus disposed of, we may now cite the actual documents.

Clause 19 of the Treasury minute of May 23, 1892, states that—

"As to fresh licenses, no further license for the whole country will be granted; and even for a license to establish an exchange in a particular town no application will be entertained unless a formal resolution in its favour has been passed by the corporation, or other municipal authority, and evidence given that there is sufficient capital subscribed to carry out the undertaking. In this way competition will not be excluded, but a check will be imposed on the formation of companies whose sole object it is to force the existing licensees to buy them up.

"But although this is the policy which commends itself to her Majesty's Government, it must be distinctly understood that, should licenses hereafter be granted on other principles, no company, now or hereafter to be licensed, will have any ground to complain of breach of contract, or want of good faith, on the part of the Postmaster-General.'

The heads of arrangement between the Postmaster-General and the National Telephone Company, Limited, dated Aug. 11, 1892, contain the following Clause 2 (3):

"The license to be for the residue, still unexpired, of the term of years specified in the present license held by the National Company, and to contain all the provisions contained in such license (including the provisions for determining such license and purchasing the business of the company) so far as such provisions are not inconsistent with these heads of arrangement."

The license of the National Telephone Company, Limited, date Nov. 29, 1884, stated in Clause 19:

"Nothing in these presents contained shall prejudice or affect the right of the Postmaster-General from time to time to establish, extend, maintain, and work any system or systems of telegraphic* communication (whether of a like nature to the aforesaid business of the company or otherwise) in such manner as he shall in his discretion think fit, neither shall anything herein contained prejudice or affect the right of the Postmaster-General from time to time to enter into agreements for, or to grant licenses relative to the working and user of telegraphs (whether of a like nature to the aforesaid business of the company or otherwise) or the transmission of telegrams in any part of the United Kingdom with or to any company, person, or persons whomsoever, upon such terms as he shall in his discretion think fit."

The draft agreement of Aug. 7, 1894, and the agreement of March 25, 1896, between the Postmaster-General and the National Telephone Company, Limited, contains the following clause:

"Nothing in these presents contained shall prejudice or affect the right of the Postmaster-General from time to time to establish, extend, maintain, and work any system or systems of telegraphic communication (whether of a like nature to the aforesaid business of the company or otherwise) in such manner as he shall in his discretion think fit, neither shall anything herein contained prejudice or affect the right of the Postmaster-General from time to time to enter into agreements for or to grant licenses relative to the working and user of telegraphs (whether of a like nature to those worked and used by the company or otherwise), or the transmission of telegrams in any part of the United Kingdom with, or to any company, person, or persons whomsoever upon such terms, and whether with or without authority to exercise the powers in Section 5 of the Telegraph Act, 1892, referred to, as he shall in his discretion think fit."

III.

The right to compete being thus made clear, we had next to consider whether competition was expedient, and if so, whether local authorities should be empowered to undertake a telephone service.

Competition appears to be both expedient and necessary, in order, firstly, to extend and popularise the service, and next to avoid a danger which is by no means remote, if no alternative system is in operation, that a purchase of the company's undertaking at an inflated price may be forced upon the Government of the day.

Competition by a local authority must differ in many ways from competition by a private company, and requires special provision to meet the special conditions of the case.

In areas where the company have already an exchange, municipal competition, if permitted, should be conducted, as far as possible, on equal terms. It would be plainly unfair to concede to the new licensee a position of general advantage over that possessed by the older competitor.

The peculiar advantages, however, already possessed by the company themselves constitute the principal difficulty in the way of formulating such an equality of treatment. The duration of its license, the power to give preferential rates (a power which, when exercised by the predecessor of the company, is alleged to have driven the Post Office from the field at Plymouth), the absence of a maximum rate, the power to refuse service and the consequent power to require concessions of overhead wayleaves, its numerous exchanges, and the power to make other areas pay for reduced rates in areas where competition exists—these are advantages which together outbalance the special advantage which would be possessed by a local authority as licensee, the right to give to itself and refuse to its rival permission to lay wires under its own public streets.

A local authority must also submit to conditions to which the company is not subjected.

Among these conditions are the following:

(1) The system (unlike that of the company) must be one of double wires, and be erected in accordance with the regulations of the Post Office. The Post Office should insist upon uniformity of system, so far as the differing conditions of different localities may permit.

(2) A maximum rate should be imposed, and no opportunity be afforded to local authorities to carry on the service with a view to lighten the burden of local taxation.

(3) It must give a service to all alike on equal terms.

A royalty should be paid to the Post Office, which should be 10 per cent. on the gross receipts, and be the same in all respects as that paid by the company.

Although there appears no reason in equity why a new licensee should not be conceded a term equal to that

* It has been decided by the courts that "telegraph" includes "telephone."

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originally conceded to the company, there may be reasons of public convenience why all licenses alike should lapse to the Post Office at the same date.

Where two systems compete in the same area, the first in the field has a further advantage. But your committee believe that, the areas being so large, in every area large sources of supply remain untapped. Under a more popular scheme of service this supply may be very considerable. The company is itself in vigorous competition in several areas with its licensor the Post Office, which in almost every case was the first to occupy the ground. While the profits of the company in such areas are probably large it is satisfactory to learn that in spite of the hampering restraints till lately imposed by the Treasury and of the necessity a public body is under to give no preferences, the local profits of the department have not been inconsiderable.

A difficulty arises in holding the balance equally between the local authority and the company from the fact that while it seems generally admitted to be desirable in the public interest that all licenses should terminate in 1911, it is not possible to secure this, and at the same time leave to the local authorities adequate time to recoup themselves for their outlay.

The opinion has been strongly urged that as between the company and the local authorities the most equitable course would be that the Post Office in licensing a local authority should undertake to buy its plant at a fair valuation in 1911, if the license were terminated at that date, but that owing to the length of time which the company has had for recouping its outlay it is not necessary to apply the same condition to it.

It has also been urged that it would be unfair to the company that the Post Office should agree to purchase the property of the local authority, and remain in the future, as it is now, under no obligation to purchase that of the company in the same area.

It would be unjust to the taxpayer that the Post Office should undertake to purchase in 1911 two sets of plant and buildings, which might be to a great extent superfluous.

While, however, a portion of the plant and buildings of the two competitors may be superfluous or obsolete in 1911, much will probably be found useful and as good as the Post Office could purchase elsewhere.

On the whole, your committee think it would be fair as between its competing licensees that the Post Office should agree to take off their hands in 1911, at the then value, without any compensation for goodwill or future profits, so much of the plant and buildings as it might consider suitable for the actual requirements of its own local service. Should the total quantity so considered to be suitable exceed the amount necessary for such requirements, due regard should be had, in purchasing the quantity actually required, to the fact that the local authority had been allowed a shorter period of license than the company in which to recoup its expenditure.

At the same time your committee are strongly of opinion that the Post Office should remain, as it is now, under no obligation to purchase any plant or buildings in any area where a local authority and the company are not in *bonâ fide* competition, or are not working together under the sanction of the Post Office.

In case, however, instead of competing, the corporation and the company should combine their operations, the greater part of both the plant and the buildings would in all probability be so suitable and so conveniently placed as to justify the Post Office in agreeing to take over the whole upon clear conditions to be named beforehand.

Just as, in the event of competition, the company and the local authority would be placed, as we consider, on fairly equal terms, if the proposals we have made are carried out, so if the two systems are amalgamated, or a working agreement for connecting their respective subscribers everywhere be arrived at between them, there should be equality as regards preferences, the right to refuse service and underground wayleaves. The company should surrender the two former rights, which no public body could exercise, and the municipality should allow the company to have equal underground wayleave facilities with itself for connecting its exchanges and subscribers. In order to avoid difficulties as to disturbance of the streets, these wayleave facilities should be afforded to both by the Postmaster-General under his statutory powers in the same way as underground facilities are at present afforded by him to the company between post offices and exchanges, and between two exchanges. The Post Office should in no case undertake to buy useless or antiquated plant or unnecessary buildings, but subject to that condition it might properly agree, at the time when such working agreement is concluded, to purchase at its then value, in 1911, the plant and buildings of the whole undertaking.

Having thus provided for equality of treatment so far as is possible, in the event of either competition or agreement, your committee would leave the two parties to take which course they prefer, believing that much must depend on the size of the area and the other special circumstances of different localities.

The peculiar conditions of the agreement with the company prevent the Government from laying trunk wires to connect the subscribers of different systems within one area. This renders it almost necessary that the whole of the company's telephone area should be worked by any local authority which is desirous of giving a service to its own ratepayers. The frequent cases in which a corporation has obtained powers to supply gas, water, tramways, and electric light outside its own municipal boundary afford adequate precedent for a similar telephone service, especially as the telephone service within an area must necessarily be a connected whole.

Your committee would recommend that if licenses are to be granted to local authorities the precedent of the Electric Lighting Act of 1882 should be followed, and provisional orders containing borrowing powers should be made by the Post Office for the installation of a telephone service as they are now made by the Board of Trade where wayleaves and other powers are required for electric lighting purposes.

From the point of view of local finance, your committee are of opinion that a telephone service would be as successful as has been the supply of gas, water, tramways, and electric light by local authorities. Much, of course, depends in this case as in those upon the cost of constructing the service, and in all cases the local authority is perhaps the best judge of what is likely to be successful or not. It seems clear to your committee that a local authority should be able to construct a system at a price below that which from various causes the company have spent upon theirs, and this opinion is confirmed by the fact that the probable cost of such a service in the hands of the Glasgow Corporation is based not upon estimates alone but on tenders actually received

So far, therefore, as the legal or equitable rights of the company or the financial or other interests of the locality are concerned, your committee see no reason why licenses should not be granted to local authorities.

Although, as stated in evidence by Mr. Gaine, 95 per cent. of the telephonic messages are local, yet a local telephone service must differ in some important respects from a local service for supplying gas, water, or electric light. It is not, like them, purely local and isolated, but it forms part of a national system, the general efficiency of which largely depends upon its uniformity and the equal facilities afforded for communication everywhere. The council of the Association of Municipal Corporations by a small majority, and a conference of representatives of London local authorities unanimously, preferred the competition of the Post Office to that of local authorities. At the meeting of the council of the Association of Municipal Corporations there were no representatives of Scotch municipalities, the two largest of which have applied for licenses.

A more general competition than the local authorities appear likely to undertake is a necessity because

(1) Individual traders and others have a right to object to the service of a public necessity becoming a private monopoly where the monopolist has the power to distinguish between competitors in the same trade and the same district, a result which is not possible when the service is in public hands.

(2) A service so important to the trade of the country

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should not depend on the present precarious wayleave rights of the company, and the necessary general wayleave powers over the whole country can only be entrusted to a public department.

(3) The taxpayers have a right to be protected against purchasing as a monopoly a system which was never intended to become such, and as to which the most complete rights of competition were reserved; and more especially against being placed in a position in which they may be forced to purchase such a monopoly at a price still further inflated by the necessity of immediate purchase.

On reviewing the whole of the evidence, your committee is strongly of opinion that general, immediate, and effective competition by either the Post Office or the local authority is necessary, and consider that a really efficient Post Office service affords the best means for securing such competition. We further consider that when in an existing area in which there is an exchange, the local authority demands a competing service, the Post Office ought either to start an efficient telephone system itself, or grant a license to the local authority to do so.

With regard to areas in which there is no exchange, and districts which are not areas, we think some provision should be made beyond what is now offered by the National Telephone Company for giving a service when there is a reasonable local demand. In such cases the Post Office should either start a service of its own or should grant licenses to the local authorities to do so, subject to proper regulations.

Your committee in thus recommending a Post Office service assume that it will constitute a real and active competition, and that concessions to the company not required by the agreement will cease. Such a competition should, in their opinion, be carried on by a distinct and separate branch of the department, and in future be conducted under strictly businesslike conditions, and by a staff specially qualified for such a duty.

Aug. 9, 1898.

SPARKLESS REVERSAL IN DYNAMOS.*

BY H. N. ALLEN, B.SC.

(Concluded from page 207.)

Variation of Flux through the Pole-Pieces in a Running Machine.

A coil may be wound round the armature, separated from it so that the armature is free to turn, or the coil may be wound on the pole-piece. Any alternating variation of magnetic flux when the machine is running will induce an E.M.F. in this coil which can be measured by the alternating-current voltmeter. This experiment was tried with the Immisch motor and with a Goolden drum-armature dynamo. The variation of flux was found in some cases to be considerable, but by properly adjusting the brushes it was found possible to reduce it to a very small quantity, the sparking becoming very small at the same time. This might well prove a valuable method for estimating the intensity of sparking in a given machine.

Measurement of the Reversing Field.

In the theory of commutation, as developed by Swinburne in his paper on "The Theory of Armature Reaction in Dynamos and Motors" (*Journal* of the Institution of Electrical Engineers, vol. xix., p. 90, 1890), a most important factor is the magnitude of the reversing field in which the armature coil moves during the period of commutation. It was decided to dry to measure this field in a running dynamo. A Manchester machine, by Mather and Platt, was made use of. It had a ring armature, and was designed to give 100 volts and 35 amperes at 1,600 R.P.M. The field magnets were compound wound. In order to be able to run above the sparking limit without using an excessive current, the speed was reduced to 1,180 R.P.M, thus diminishing the terminal voltage, the current in the shunt coil, and, as a result, the flux through the armature. The result was that a current only a little larger than the normal working current made sparkless commutation impossible. The brushes were placed in such a position that a coil during commutation moved from a place just outside the pole-tip to one well under it, and it was found possible so to adjust the current that sparking almost ceased. Any change in the current, whether it were an increase or a decrease, increased the sparking, and with the proper value the sparks were very minute indeed. A coil of four turns of very thin wire was wound like a ring coil on the armature between two of the sections. One end of this was soldered to the armature spider, and was thus connected to the body of the machine, the other to an L-shaped brass contact piece, which was insulated from the shaft by an ebonite ring, to which it was fastened. A radial brush of steel watch-spring touched the projecting part of this contact piece once in each revolution. The position of the brush could be varied by means of a suitable rocker, on which an arbitrary scale was cut, so that its position could be recorded for every observation.

A wire led from the brush to one of the quadrant pairs of an electrometer, the other pair being connected to the instrument case and to the dynamo frame. The current given by the dynamo throughout the experiment was 37 amperes, which gave minimum sparking.

Results of this Experiment.

The results are shown in the form of a diagram, in Curve I., Fig. 4. Ordinates represent the volts induced in

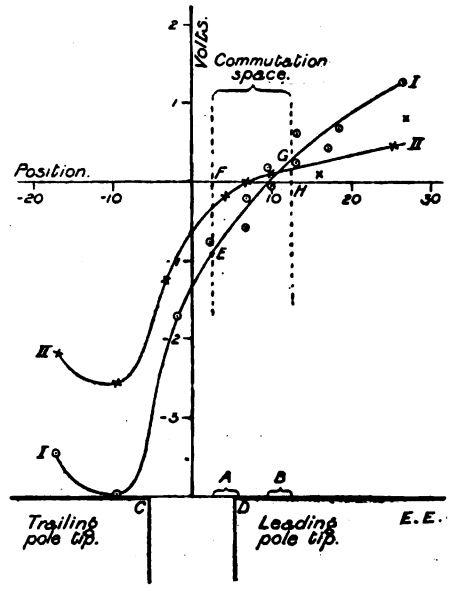

Fig. 4.

the test coil, being taken as positive when coinciding in direction with the current which flows in the armature coil after reversal. Abscissæ represent the positions of the test coil with respect to the poles, in terms of the scale cut on the rocker of the test brush. A shows the position of the coil when commutation commences, B when commutation ends; the pole-tips are indicated by C and D. The diagram shows that the field in which the coil moves during commutation varies from a value which produces about one volt in the moving test coil, in the negative direction—that is, in the direction of the initial current in the armature coil (indicated by E F in the diagram)—to a value which produces about three-tenths of a volt in the positive direction in the coil (indicated by G H). If the armature had been drum-wound, such observations would have indicated that the average value of the reversing field during the whole period of reversal was negative, but small. Since, however, there is a leakage field inside the ring, and the test coil cuts this also, what is proved is that the field entering the armature on the outside, and that leaving it on the inside, at the place where commutation occurs, are nearly equal. It may be noted that at the speed at which the dynamo was run 0·4 volt would be induced in the test coil if the outside wires cut a field of about 500 tubes per square centimetre. According to the ordinary theory the induction density should have at least this value throughout the whole commutation space.

* From the *Journal* of the Institution of Electrical Engineers.

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Second Experimental Determination.

Curve II., Fig. 4, shows the result of another set of observations, in which the speed was 880 R.P.M. The non-sparking current, with the brushes in the same position, was 26 amperes. The points observed are marked by crosses, while those belonging to Curve I. are surrounded by circles. The two curves are very similar, the amplitude of II. being less than that of I., on account of the lower speed.

Measurement of Field without Armature Reaction.

In order to make sure that the electrometer was working properly, an experiment was made without current in the external circuit. The volts in the test coil were found to be nearly the same under the two pole-tips. From the numbers obtained the induction density under the poles was calculated, and found to be 1,990. From the observed volts on the dynamo terminals, the known number of armature conductors, the dimensions of the pole-faces, and the speed of the machine, the value B = 1,930 was obtained.

Theory of the Reversing Field.

Consider the case of a drum armature, so wound that two neighbouring bars belong to the two coils which undergo commutation at the same time on opposite sides of the commutator. For the sake of simplicity, imagine these pairs of coils to be combined into single coils, each of one turn, and conveying the full dynamo current. Let the brushes be just wide enough to cover one commutator segment and overlap the insulation, so as to touch the next one. Then, if at the beginning of commutation the conductor E is at A in Fig. 5, and is conveying the full

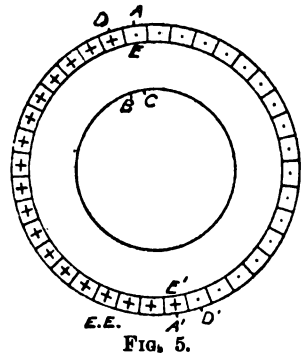

Fig. 5.

current upward, it will be at D at the end of commutation, and will convey the full current downward. The conductor just behind it will have moved up to A, and will still convey its current upward. Both cross and back turns are now exactly what they were at the commencement of commutation; and C. C. Hawkins, M.A., A.I.E.E., in a paper on "Armature Reaction and the Theory of Commutation" shows that they remain constant throughout the whole period of commutation. The resistance of an armature coil in a modern dynamo is so small that only a very small E.M.F. is required to send the current through it. This E.M.F. will be supplied by cutting a very weak field; and, if the current dies away to zero and rises again to its maximum value according to a straight-line law, a negative E.M.F. and a negative field will be required for this purpose during the first half of the commutation. For the present the resistance may be neglected, and the effect of moving a coil of infinite conductivity in a magnetic field considered. A current is induced in such a coil which keeps the flux through it constant. It follows that, as the armature coil moves from A to D, the flux through it remains nearly constant, the current being exactly reversed when it reaches D, in the case of sparkless commutation. In other words, the flux at any instant through the coil at A is equal to that through the coil at D. For the latter coil has just come from A, the flux through it is the same as when it was at A, and it is clear that whatever coil may be at A the flux through it will be the same. Now, in order that the flux through the coil at A may be equal to that through the coil at D, it is necessary that the resultant magnetic field between A and D, and between A' and D', should be zero. As a matter of fact, a small negative field will be required near A, and a small positive field near D, to keep the current running in the coil against the resistance of the copper; but 40 or 50 tubes per square centimetre will probably be sufficient for this, if the brush makes good contact.

As it has been stated that a very much larger reversing field than this is required, it will be well to examine the matter more closely, and find out what the difference is due to. Consider first the field due to the armature alone. Both the cross turns and the back turns tend to produce a field, the direction of which is into the core at A D, and out from it at A' D'. Let B' be the resulting induction density in the air outside the core, and a be the area traced out by the axis of the bar in moving from A to D. Then $B' \times a$ is the flux into A D, and $B' \times a$ is the flux out of A' D'. It follows from this that the change of flux through the coil E in passing from A to D is $B' \times 2a$. Now the current in the other armature coils is unchanged by the motion of the coil E from A to D, and no part of the change of flux through E is due to them; also, the true inductance of coil E is hardly changed by change of position, so that B' (A D + A' D') is the change of flux in coil E due to the change in the current from the value − C to + C. Thus $2 L C = B' \times 2a$. Now, in order that the current may be reversed in the manner indicated, the flux due to the field magnets in through A' D' and out through A D must, the resistance of the coil being neglected, exactly neutralise the flux due to the armature. If B is the field intensity produced by the field magnet, $B \times 2a + B' \times 2a = 0$. Thus $B = -B'$.

If, however, the fact that the change of flux through the armature coil, due to the change of current, and the back field through A D and A' D', due to the current in the entire armature, are simply different ways of looking at the same thing is lost sight of, an erroneous result will be obtained: the value of B will be taken twice as high as it should be. If, however, L_a, the apparent inductance, is used instead of L, the true inductance, and if L_a is one-fourth of L, the component of the reversing field due to the field magnet will only have to be increased 25 per cent. beyond its true value. So that, if the field due to the armature is 4,000 tubes per square centimetre, that due to the field magnets will be taken as 5,000, so as to leave a resultant field of 1,000, which is wrongly supposed to be necessary to neutralise the change of flux through the coil, due to the change in current. In a previous section of this paper the ratio of L to L_a was found to be about 4·5 by calculation, or 2·8 by observation.

It is clear that the result of an error such as that just mentioned would be to cause an underestimate of the possible output of a machine as limited by sparking. For, if the field due to the field magnets is 5,000, it would appear necessary to keep the current so low that the back field due to the armature should be not greater than 4,000, whereas in reality it might rise almost to 5,000 without making sparkless commutation impossible.

Energy Lost in a Spark.

Though a knowledge of the apparent inductance proves to be of no value in determining the magnitude of the reversing field, it is needed to calculate the energy lost when sparking takes place. If C_1 is the initial value of the current in the coil at the instant when the tip of the brush breaks contact with the commutator sector, and C_2 its final value when the spark has died away, the current through the spark at any instant will be $C_2 - C$, where C is the current in the coil. The potential difference between the ends of the coil is $L_a \frac{dC}{dt}$, and the energy lost in the spark in the time dt is $(C_2 - C) L_a dC$. The total energy lost in the spark is

$$\int_{C_1}^{C_2} (C_2 - C)\ L_a\ d\ C = C_2\ L\quad (C_2 - C_1) - \tfrac{1}{2}\ L_a\ (C_2^2 - C_1^2);$$

and this is equal to $\frac{1}{2} L_a (C_2 - C_1)^2$, or half the apparent inductance times the square of the change of current. This result, however, is only obtained when the resistance of the armature coil is neglected. If this is taken into account, the energy lost in the spark will be found to be greater; one assumption as to the way in which the

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resistance of the spark varies making the energy lost $L_a (C_2 - C_1)^2$.

Suppose a dynamo is so designed that it will just run sparklessly at full load, the forward lead being so large that the coil undergoing commutation is right under the pole-tip. If the current is switched off without altering the excitation, or the lead of the brushes, the machine will spark, and the energy of each spark will be proportional to

$$\frac{L_a B^2 l^2 d^2}{L^2 S}, \text{ or to } \frac{L_a}{L} \frac{l d q}{S^2 \phi}, \text{ or to } \frac{L_a}{L} \frac{B V r n q}{\phi^2};$$

with a multipolar dynamo the last expression becomes proportional to

$$\frac{L_a}{L} \frac{B V r n q}{\phi^2 p}.$$

l = length of armature;
d = diameter of armature;
S = number of commutator segments;
q = effective length of magnetic circuit;
ϕ = polar angle;
r = revolutions per second;
n = number of complete turns to a coil;
L_a and L are the apparent and real inductances of one turn;
p = number of poles;
V = volts per commutator part.

The question of the sparking of a machine when loaded, if the brushes are kept in the neutral plane, is of more practical importance, but is more difficult to treat theoretically.

Constancy of Flux in Short-Circuited Coil.

That the flux through a short-circuited armature coil in a dynamo that is not sparking remains nearly constant appears as follows:

Let a closed coil, the resistance of which is R and the inductance L, be moved in a magnetic field. At time 0 let the flux through it due to the outside field be F_1 and the current be C_1, so that the total flux through it is $F_1 + L C_1$. At time T let the flux due to the outside field be F_2 and the current be C_2, and at some intermediate time, t, let the flux be F and the current C. Then the total flux through the coil at time t is $F + L C$.

The E.M.F. acting at this instant to overcome resistance is $-\left(\frac{d F}{d t} + L \frac{d C}{d t}\right)$, and this is equal to R C. Assume that the coil is moved in the field in such a way that the current is a linear function of the time, or

$$C = C_1 + \frac{C_2 - C_1}{T} t.$$

$$\text{Then } d F + L \frac{C_2 - C_1}{T} d t = - R C_1 d t - \frac{R (C_2 - C_1)}{T} t d t.$$

$$\therefore F_1 - F_2 = + \int_0^T \left\{ L \frac{C_2 - C_1}{T} + R C_1 + \frac{R (C_2 - C_1)}{T} t \right\} d t.$$

$$= L (C_2 - C_1) + R C_1 T + \tfrac{1}{2} R (C_2 - C_1) T.$$

Suppose $C_1 = 0$ and $F_2 = 0$, then

$$F_1 = L C_2 + \tfrac{1}{2} R C_2 T.$$

The initial total flux through the coil is F_1, the final is $L C_2$; the difference between them is $\frac{1}{2} R C_2 T$. This difference will be very small if R is small, or if T is small. In the case of a coil of a dynamo armature during reversal, both these quantities are small, so that the flux through the coil must remain practically constant during the whole period of reversal. It will be noticed that $R C_2$ is the E.M.F. required to keep the current C_2 running in the coil, so that the difference between the initial and final flux is half the change of flux that would be required to keep the current C_2 flowing in the coil for the time T.

Summary.

The results obtained may be recapitulated as follows:

1. The apparent inductance of an armature coil in the median plane is nearly the same, whether determined by the secohmmeter or by the alternating-current method.

2. Under ordinary working conditions the shunt winding of a dynamo or motor, being short-circuited by the armature, acts like the short-circuited secondary of a transformer with considerable magnetic leakage.

3. The result is that the apparent inductance, under these conditions, is about the same as that of the coil on the core when removed from the field, which can be determined approximately by calculation.

4. If the theory is correct which makes the apparent inductance of an armature coil equal to $\frac{L L' - M^2}{L}$, and if it is possible to reduce the magnetic leakage, the apparent inductance can be reduced by this means, thus diminishing the energy lost in sparking when the brushes are not exactly adjusted.

5. The apparent inductance when the coil is at right angles to the median plane does not differ very much from the true inductance, as determined by measuring the flux with a continuous current.

6. In finding the apparent inductance of a ring armature, the external field is regarded as being the same as in the case of a drum. The field in the interior of the core has also to be taken into account.

7. The magnitude of the reversing field is shown by experiment, and by theory, to be very small.

8. The variation in flux through the armature when sparking occurs can be observed by means of a fixed coil wound outside the armature or upon the pole-piece, and connected to an alternating-current voltmeter. It is shown that this variation is small in a machine which is running with little sparking.

THE CONSTRUCTION OF A 150,000-VOLT TRANSFORMER.*

BY ELLERY B. PAINE AND HARRY E. GOUGH.

As a subject for post-graduate thesis work at the Worcester Polytechnic Institute during the past year the writers have designed and constructed a 150,000-volt transformer, and as some radical changes from the usual method of transformer construction are necessary when dealing with such high potentials, a short description of this piece of apparatus may be of interest.

The source of supply of current for the transformer is the 30-kw. Westinghouse smooth-core alternator situated in the power laboratory. This machine has a frequency of 133 cycles, and its virtual voltage is 1,000. Since it would not be convenient to arrange the necessary switches and circuit breakers in a 1,000-volt circuit, it was decided to reduce the pressure by means of small transformers, and in this way the supply for the high-potential transformer could be either 50 or 100 volts as desired, with the alternator excited so as to give 1,000 volts on the line. As there were 10 transformers available for this purpose, and the capacity of each was 2 kw., the output of the high-potential transformer was limited to 20 kw. From this it is seen that the problem was to design a 20-kw. transformer for a frequency of 133 periods per second to give 150,000 volts at the terminals of the secondary with 100 volts supplied to the primary. In working out the design the end kept in view was to produce a transformer which would give the highest insulation for the lowest first cost of materials, and an efficiency sufficiently high to maintain good regulating qualities.

The core type of transformer was selected for this case because that form seemed to offer better means for insulation than did the shell type, and would at the same time be easier to build. With a virtual voltage of 150,000 at the terminals of the secondary the maximum voltage to which the insulation will be subjected is 150,000 by 1·4, or over 200,000 volts, since the E.M.F. wave of the alternator is very nearly sinusoidal. With this voltage a spark will jump across an air space of about 15in., whence it is evident that the transformer must be surrounded by some better insulating dielectric than air. To determine what was the best oil to use for this transformer a series of comparative tests was made with different commercial oils. In making these tests an induction coil giving an E.M.F. of

* Written for the *Journal* of the Worcester Polytechnic Institute.

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approximately 15,000 volts was used. From the results obtained in this way, together with the results obtained by other experimenters, it was decided that kerosene oil would be used, and it was estimated that 3in. of this oil would withstand a potential of 200,000 virtual volts. To find out if the oil would be apt to take fire if it were used and sparks should pass through it, heavy arcs were formed in a sample of kerosene, and in no case was the oil observed to take fire.

From preliminary calculations carried through with different values of magnetic density in the core and different core areas, it was decided that a maximum core density of 8,128 gausses per square centimetre should be used. The core is rectangular in form, and the windings surround the two vertical legs. It is built up of soft-iron strips 0·025in. thick, and the over-all dimensions are 18½in. by 39in. The two upright parts are composed of strips of different widths, so that the form of cross-section is approximately a circle a little over 4in. in diameter. The actual area of cross-section of iron in the core limbs is 78·7 square centimetres, so that the total flux passing through the windings is 640,000 webers. The yoke pieces are built up of strips 4in. wide, and the area of cross-sections at this point is 92·9 square centimetres. At the joints some of the laminations overlap, and the remainder are butted together. The laminations are held in place by means of two pairs of wooden pieces placed on either side of the yokes and drawn up by bolts.

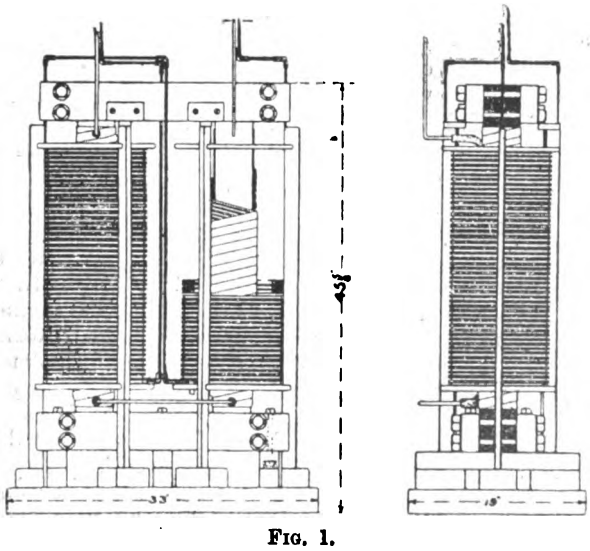

FIG. 1.

This construction is shown in the accompanying drawing (Fig. 1). The limbs of the core are covered with four thicknesses of heavy duck, and over this is wound one even layer of braided cotton rope about $\frac{3}{16}$in. in diameter. This is covered with two more thicknesses of duck, and over this is wound the primary conductor. This winding consists of six No. 4 B. & S. double cotton-covered wires connected in parallel. There are 13 turns around each limb, making 26 turns in the primary coil. The primary wire is covered with two thicknesses of duck. The secondary coil consists of 39,200 turns of No. 30 B. & S. double cotton-covered wire. In order to increase the insulation of the coil it is divided into 100 sections, 50 of which are placed on each limb. Thus the number of turns in each section is 392, and the potential between any two consecutive sections is 1,500 volts. These sections are wound upon wooden rings, as shown in the cut. These rings are turned from well-seasoned soft pine, and are 10¾in. in outside diameter. The wire is placed in a groove ¼in. wide and 1in. deep. The inside diameter is 8¼in., which allows 1½in. of clear oil space between the ring and the primary wire. This forces the spark to traverse 3in. of oil should it break down through the primary winding or the core. The wooden rings are supported by wooden frames, as may be seen in the cuts. Both these frames and the core are fastened firmly to a plank 2⅝in. thick, which serves as a base, and the whole is placed in a galvanised iron tank filled with oil. In two opposite sides of this tank are placed two glass windows, and through these one is able to observe the condition of things within the tank.

The tank contains 110 gallons of kerosene oil, and the top is covered by plates of glass. All connections to the two windings are made through the top of the tank. The primary wires are not insulated, but the secondary terminals are enclosed in glass tubes with glass elbows at the bends. After the terminals of the secondary leave the oil they are kept at least 14in. apart, besides being enclosed in glass tubes.

Before the secondary coils were connected permanently in series, experiments were made with the sections joined in parallel to determine the no-load current, the core loss at various voltages, the ratio of transformation, the efficiency, the resistances, and the regulation curve.

The following table shows a comparison of the calculated and observed values:

	Calculated.	Observed.
No-Load Current.		
Primary voltage, 50	19·2 amp.	18·8 amp.
,, ,, 100	33·2 ,,	34·3 ,,
Core Loss.		
Primary voltage, 50	815· watts	875· watts
,, ,, 100	2,821· ,,	— ,,
Ratio of transformation	1,508.	1,504·
Drop at full load	2·1%	2·2%
Primary resistance, 18° C.	0·0023*	0·003 ohm
Secondary ,, 18° C.	10,029·	9,860 ,,
Efficiency.		
10 kw., 75,000 volts	89·7%	89·3%

The fields of work in which a transformer of this character may be used are many. One of the most important and practical of these is the study of insulating materials with regard to their properties for preventing disruptive discharges. Another subject which has, as yet, received comparatively little attention is the production of ozone. Perhaps the most interesting experiments are those showing various sorts of discharges in air. What is known as a brush discharge may be produced by connecting the secondary terminals to wires enclosed in glass tubes, placed parallel to each other 8in. or 10in. apart. When the voltage is raised to about 80,000 volts, the space between the tubes will be filled with a violet-coloured flame, and at the same time brilliant sparks will be seen darting in crooked paths between the tubes. Another interesting display may be obtained by placing the two terminals on opposite sides of a glass plate, when, if the distance is not too great, the sparks will pass around the edge of the plate causing brilliant flashes and a peculiar crackling sound. In both of these discharges a large quantity of ozonised air is produced, and the glass soon becomes very warm.

The most interesting form of discharge is produced by forcing the current to jump from one terminal to the other through a clear air space, thus establishing an arc. These discharges are studied best by the aid of a camera, since it can record many of the effects produced which are of such short duration as to be scarcely noticed by observing the discharge with the eye. Reproductions of a few photographs of this variety of discharge are shown in the original article. All of these arcs were of very short duration, since as soon as the arc was once formed the current taken by the transformer was so great that the circuit breaker in the primary circuit was thrown out. The longest of these arcs was 14in. and the voltage for this discharge was about 190,000 volts maximum.

THE TRANSFER AT GARNESDON.

BY J. H. C. B.

It may not be quite so precisely laid down in Solomon's very justly celebrated Book of Proverbs; it is not even mentioned in Will Shakspere's adages, or in Tupper's distressingly virtuous blank verse; but the fact remains, solemn and indisputable, that the element of luck has often more to do with the success of electricity supply than skill, tact, and an algebraic scale of consumers' charges combined.

A vivid example of this is to be found in the history of the transfer of the business of the Garnesdon and District Electricity Supply Company, Limited, to the Local Board of Garnesdon at a 45 per cent. premium for goodwill, etc.

* No allowance was made in the calculations for the resistance of six soldered joints in the primary winding.

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The preparation for this little deal had been on the carpet for some time, and had at length arrived at a state of dead-lock on account of a bare majority on the Local Board against the purchase. A sweeping majority one way or another might have settled the question, but there were very particular reasons why the electricity company's best efforts should be put forth to complete the transfer at the earliest possible date, and they would not take a bare majority negative for answer. For instance, extensions were urgently needed, and, while little or nothing had been set aside for depreciation (in a praiseworthy attempt to provide fat paper-dividends), the plant was in need of considerable overhauling and repair. Also, the mains were such that it was unsafe for jointers to sneeze when working in junction boxes, and the vibratory effect of heavy traffic down certain streets could be traced on the switchboard ammeters.

However, the fat dividends and the report upon the undertaking by a hedge consulting engineer (whose chief recommendation was a relationship to the chairman of the Local Board) seemed so satisfactory to that portion of the Local Board whose motto was municipalisation, that they moved heaven and earth to bring about their desire.

It is true that a fresh coat of paint and a lavish use of oil was bestowed upon the plant when inspected, and that the test of the network from the station was performed with the fuses carefully removed from the nearest joint-box. These circumstances, allied with the affability of Holloway, the manager, and a marvellous lunch at The King's Head, may help to account for a report which was to the virtues of the undertaking more than kind, and to its faults a little blind.

The capital expended upon plant, etc., had been at the rate of about £100 per kilowatt, and while the expenditure of £14,500 that this implied did not frighten the worthy burgesses who supported the transfer, yet it was likely that the cost of extensions and renewals added to this would tend to at least decrease the "goodwill" percentage by very weight of figures. In fact, the psychical moment had arrived for the transfer.

The chief obstacle in the way of the municipalisers was Mr. Jabez Smugge, a man of influence in the town, an elder of his chapel, and ringleader in most of the Local Board's doings that tended to the repressing of undue frivolity. He was called in all irreverence "the twopenny crusader," and he deserved a crazy-patchwork window and halo combined equally as well as many of the olden-time ladies and gentlemen who sought similar publicity, and who were usually utilised as fuel *before* crossing the Styx.

Mr. Smugge's reason for opposing the transfer may be quantitatively analysed as: 75 per cent. gas share holding, 15 per cent. fear of raised rates, and 10 per cent. pure cussedness. His avowed and stated reasons were two: the infancy of electricity, and the utter unsuitability of electrical men to become associated with a public body on account of their loose language and intemperate habits.

The final meeting of the Local Board to deal with the transfer question was announced for the first week in April, and opinion as to the issue was so evenly divided that a toss up would have been fair to both sides. In the meantime Mr. Smugge had gone to London to attend the March inter-denominational meetings, and to gather more conclusive information as to the unsuitability of municipal control of electricity supply.

Holloway had also journeyed unto Babylon that he might attend an Institution meeting. It was not altogether the value of the papers that caused him to look forward to these meetings with a sense of pleasure, so much as the sight of familiar faces, his appreciation of the playful allegories, asides, and personalities that are wont to be ruthlessly boiled down or omitted from the *Proceedings* altogether, and the reunion of kindred souls that occurs in the tearoom afterwards.

As it happened it was a "professors' night," the paper dealing with lab. experiments, and consisting chiefly of equations and descriptions of complicated apparatus invented by the author for the purposes of measuring infinitesimal improbabilities and stupefying the practical man. So that very few fellow-engineers were present, and the discussion was a mere descriptive recital of similar previous experiments, or apparatus that the speakers had evolved from imagination and the slide-rule. Occasionally a professor would jump up in the middle of a speech to controvert or to enquire, but that discourtesy being the special privilege of professors, the chair had to gulp it down. The tearoom was barren of interest, the voracious student alone appreciating the unwonted accessibility of urns and cake. So Holloway decided to stay on, and spend the next evening at the monthly Electro-Harmonic, that he might see and take counsel with men of understanding.

The St. James's banqueting-hall was packed that night. At the presidential table (close to the refreshment bar) there was the usual circle of professional big-wigs; heads of rival firms who drank each other's healths with no thought of commercial enmity; champions of rival "systems" whose mutual recriminations in hall and technical paper were now hidden by the cloud of intermingled tobacco smoke. And shoulder to shoulder, and face to face, around the tables that filled the room, lounged men in pairs, or in cliques, representing the larger electrical firms. All had their pipes or weeds in full blast, and liqueur glasses, coffee cups, and tumblers plentifully adorned the scarlet table covers.

Holloway was quickly pounced upon by an old crony, and was dragged among and introduced to a table-ful of jovial spirits. His favourite medicine was put before him, and a choice of cigars from various cases offered. There is always a strong feeling of *camaraderie* among electrical men, the more particularly when one from a country works falls into a hive of contractors.

The evening's entertainment consisted of the usual tenor and baritone songs of love and of war, but there was also a small string band of excellent quality, a reciter whose drollness drove the audience into hysterical mirth, and the violin solos of the joint editor, whose rendering of Schumann's "Träumerei" held his listeners' attention till one could almost hear hearts beating, and the waiters for once ceased ministering to the flesh, 'tranced by the pathetic melody.

In the intervals arose the sound of vigorous converse. There is often more to be learnt from a table-ful of reminiscence at an Electro-Harmonic than there is in a C.E. hall-ful of facts. Afterwards Holloway saw his friend into a 'bus at the Circus, and then stood near the door of "Jimmy's" Restaurant to watch the nightly procession that passes to and fro along a length of pavement of which "Jimmy's" is about the centre.

Presently, a couple of people brushed past him out of the restaurant, got into a hansom and were driven rapidly away. One of the pair was an unmistakable womanimal, a magnificent species of the kind, so that Holloway's attention was riveted upon her until a parting glimpse at her companion's back, as he climbed into the vehicle, awoke curiosity as to where he had previously met the owner of the back. Half an hour afterwards, at his hotel, he remembered where. It was at a meeting of the Garnesdon Local Board to which he had been summoned to furnish information as to his company. His seat had been behind the official chair of Mr. Smugge, and that member's back view was identical in character with the back view of the middle-aged Lothario who emerged from "Jimmy's" that evening.

* * * * * *

There are various ways of appreciating the backsliding of an acquaintance. The *via angelica* is to pity and to attempt reformation; the way of a man is to treat it as a joke; woman's way is to scatter the news broadcast; and the devil person makes the best use it can of the lapse, in the sacred interests of self. And since every man, in the course of a single day, is capable of playing on all the notes of the moral keyboard, from the childish innocence of the treble clef to the sonorous bass of unmentionable villany, it is hardly to be wondered at that Holloway should have abused himself for not making sure of the identity of the Lothario with Mr. Smugge. Because, when the future of an electricity supply company practically depends upon the casting vote and influence of one person, it is just as well for the supply company to be able to put its hand upon the controlling mechanism of that individual's actions, whether it be the valve-wheel of friendship or the switch lever of fear.

There is no doubt that if Holloway had been sure he had seen and could have proved that Mr. Smugge was the man in question, that gentleman would have had the choice of a public exposure or a change in his attitude on the transfer question. As it was, it did not seem as if anything could be done without a more definite knowledge.

There was just a half-chance, however, that the *rencontre* had suggested to Holloway, based upon the assumption that conscience doth make cowards of us all; and, acting upon this impulse, he addressed a letter to Mr. Smugge at Garnesdon, containing four words and a note of exclamation: "All is discovered. Fly!" Then he returned to Garnesdon, and prayed for the success of the ten-to-one chance with a faith and fervour worthy of a better cause.

* * * * * *

It is not publicly known even yet in Garnesdon why Mr. Smugge disappeared shortly after his visit to the March inter-denominational meetings in the year that the electricity supply company's business was taken over by the Garnesdon Local Board. There is certainly one person who thinks he has an idea, but he is by no means sure of the details. He does not share in the belief as to foul play as an explanation, and his own private theory regarding the identity of the companion of the beautiful unmistakable who emerged from the notorious "Jimmy's" restaurant has received a bad shock upon seeing at least half a dozen similar incriminatory backs in various places, not one of whom belonged to the errant Mr. Smugge. However, it is tolerably certain that the present happy state of affairs in Garnesdon electrical circles is mainly due to the exercise of that virtue which is called luck—and a hair-trigger conscience.

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with its attendant disadvantages. It also utilises more completely the available space, and tends to bring about a better distribution of the heating of core and conductors. Therefore, in cases where the voltage and corresponding necessary insulation permits, the conductors are sometimes spread out to a greater or less extent from the elementary groups necessary in cases where very high potentials are used. Windings in which such a sub-division is adopted are called a multi-coil winding, having two or more coils per pole-piece per phase, as distinguished from the form in

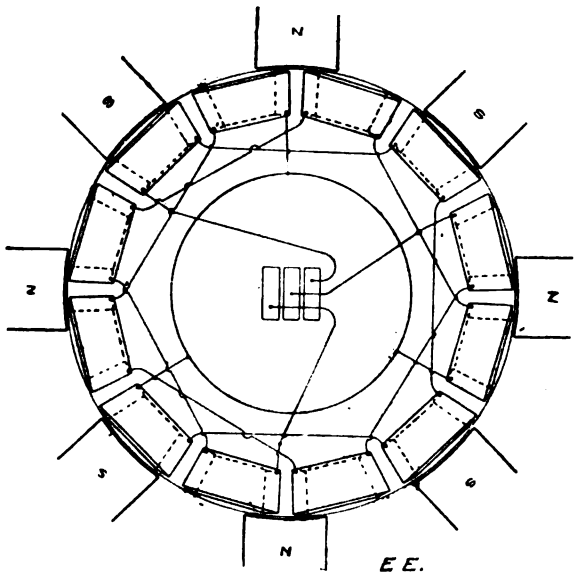

FIG. 1.—Three-Phase Non-Overlapping Unicoil Winding.

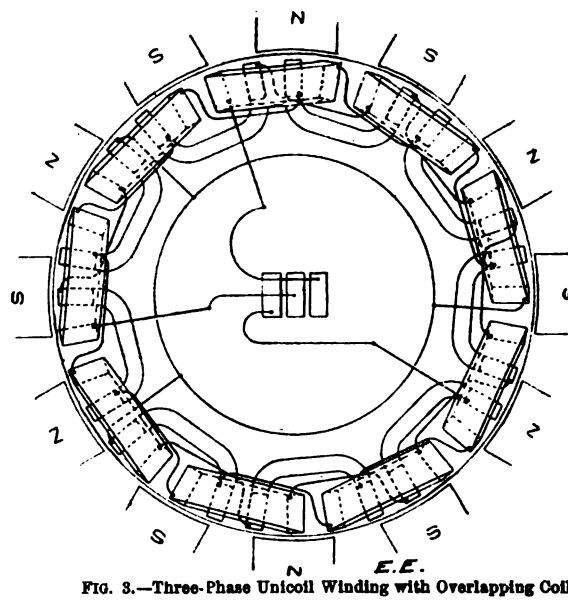

FIG. 3.—Three-Phase Unicoil Winding with Overlapping Coils.

which the conductors are assembled in one group per pole-piece per phase, which latter are called uni-coil windings, or windings having one coil per pole-piece per phase. It will be seen later that in most multiphase windings multi-coil construction involves only very little sacrifice of E.M.F. for a given total length of armature conductor, and in good designs is generally adopted to as great an extent as proper space allowance for insulation will permit.

Often in alternating-current installations step-up and step-down transformers, or both, are used, and in such cases the other extreme is approached, and the apparatus

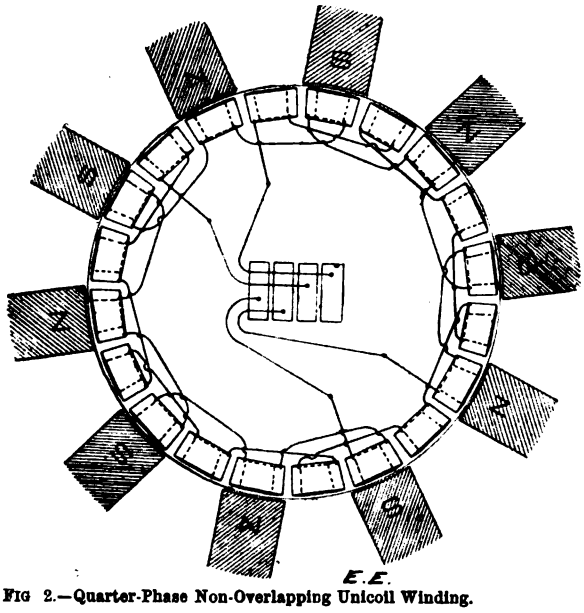

FIG 2.—Quarter-Phase Non-Overlapping Unicoil Winding.

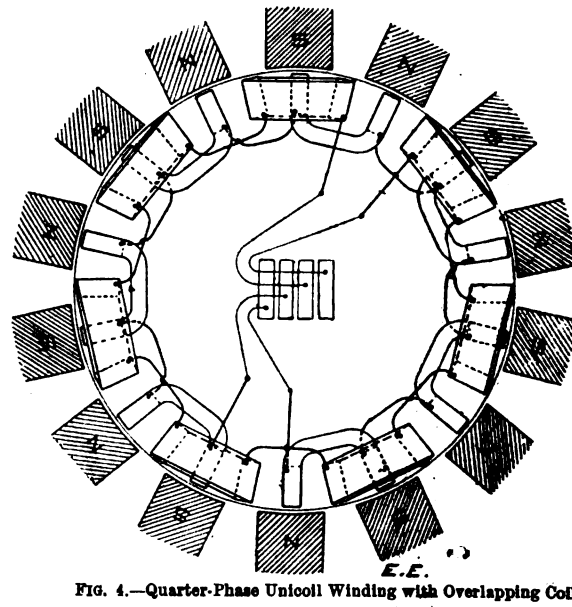

FIG. 4.—Quarter-Phase Unicoil Winding with Overlapping Coils.

is built for very low voltages. This permits the use of very small space for insulation, and conductors of very large cross-section, often arranged in only one conductor per group, are used. Here the multi-coil construction is less difficult, although still attended to some extent with the disadvantage of obtaining less than the maximum possible voltage per unit length of armature conductor. Examples of winding adapted respectively to both the above extremes will be given. With a given number of conductors arranged in a multi-coil winding, less terminal voltage will be obtained at no load than would have been the case if they had been arranged in a uni-coil winding, and the discrepancy will be greater in proportion to the number of coils into which the conductors per pole are subdivided, assuming that the spacing of the conductors is uniform over the entire surface. Thus, if the terminal voltage at no load be taken as 1 for a uni-coil construction, it will, for the same total number of conductors, be ·7 for two-coil, ·67 for three-coil, ·65 for four-coil, etc. But, when the machine is loaded, the current in the armature causes reactions which play an important part in determining the voltage at the generator terminals, and this may only be maintained constant as the load comes on by increasing the field excitation, often by a very considerable amount (this is overcome by the Stanley Company by having the armature winding so arranged that more turns may be switched into circuit at full load than at no load, thus maintaining the voltage constant). Now with a given number of armature conductors carrying a given current, these reactions will be greatest when the armature conductors are concentrated in one group per pole-piece—that is, when the uni-coil construction is adopted, and they decrease to a considerable degree as the conductors are subdivided into small groups over the entire surface—that is, they decrease when the multi-coil construction is used. Multi-coil design also results in a much more equitable distribution of the conductors, and, in the case of iron-clad construction, permits of coils of small depth and width, which require less insulation for the same amount of wire. The form of the potential wave of the machine is also determined to some extent by the style of winding adopted, being more peaked as

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the conductors are concentrated; as in the case of a winding having one coil per pole-piece per phase the potential curve is very sharp or peaked, and becomes more flat and rounded as the winding is spread out, until with a uniformly distributed winding a sine wave is produced. Usually, if the winding is arranged in three or more coils, or groups of conductors per pole-piece per phase, the curve of E.M.F. is sufficiently close to a sine wave to fulfil most requirements. Thus it will be seen that the type of winding to be adopted may, in a general way, be determined by the form of wave shape desired, and possibly make a type of winding necessary that, for other considerations, would not be used. A class of apparatus, such as rotary converters, is now being found of much value in various ways. They are in a general way used for feeding continuous-current circuits from alternating (single or multiphase) circuits, and sometimes for feeding alternating circuits of one class from those of another, thus, for instance, transforming from single-phase to three-phase or quarter-phase, etc.

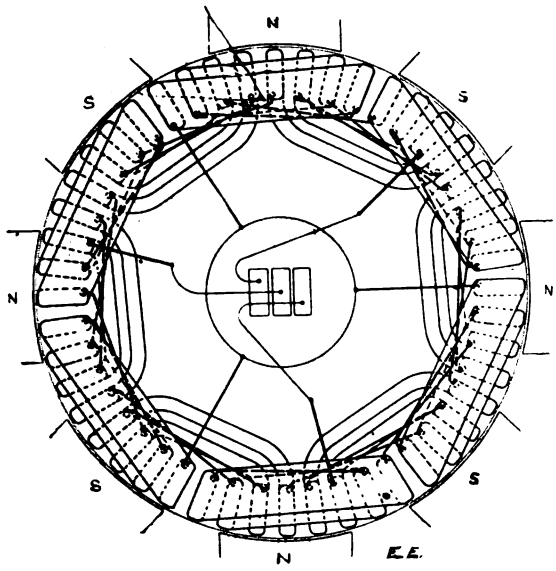

FIG. 5.—Three-Phase Multicoil Winding with Two Coils per Pole per Phase.

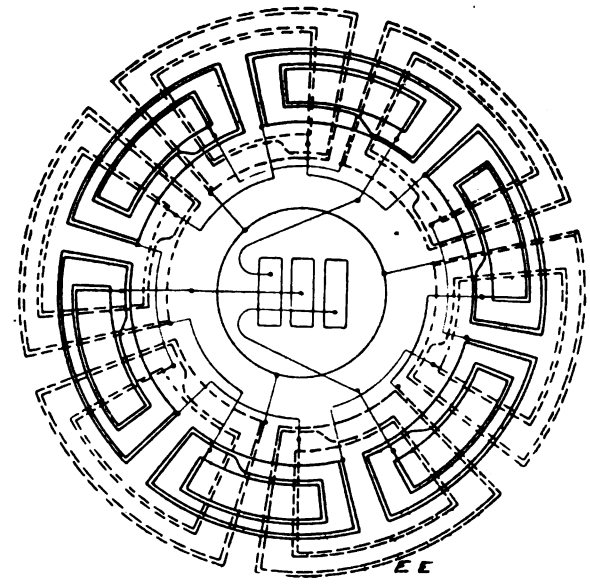

FIG. 7.—Three-Phase Multicoil Winding, having Two Slots per Pole per Phase.

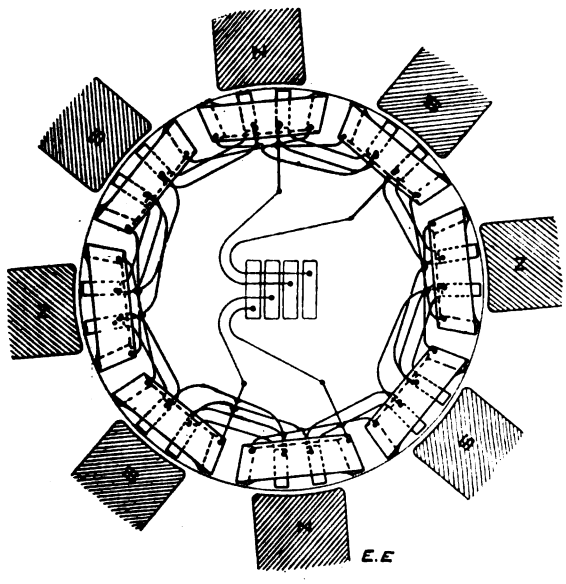

FIG. 6.—Quarter-Phase Multicoil Winding with Two Coils per Pole per Phase.

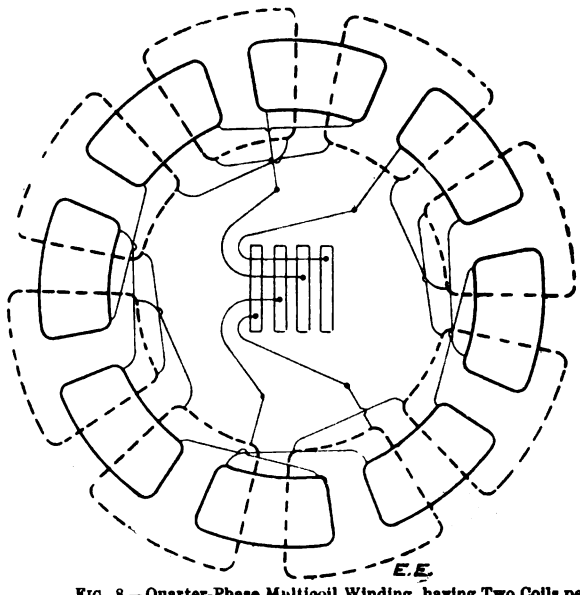

FIG. 8.—Quarter-Phase Multicoil Winding, having Two Coils per Pole per Phase

Uni-Coil Winding.—The first winding we will consider is the non-overlapping uni-coil winding, having only one group of conductors per pole-piece per phase. The end connections for both a three-phase and quarter-phase armature are shown in Figs. 1 and 2 respectively, as will be seen from an examination of the diagrams. This is necessarily a fractional pitch winding—that is, the pitch, or spread, of the coils is less than the distance between the centres of pole faces—so that the coil can never embrace the total flux coming from one pole-piece, especially in the case of the three-phase winding, and will not in the quarter-phase winding unless the pole arc is very small. This fact renders the winding objectionable from an electrical point of view, but mechanically it is excellent, as there are no crossings. This winding might be well adapted to motors, especially in the case of three-phase, on account of its weakly defined dead points. The manner of connecting the coils can be readily traced. A uni-coil winding having overlapping coils is shown in Figs. 3 and 4, where there are the same number of coils per pole-piece per phase as in the previous diagrams, but half the coils are straight and half bent, the straight coils overlapping the bent ones. In the quarter-phase winding the two circuits are brought out independently to four collector rings, which is the usual practice, although the two phases could be interlinked and only three rings used, one of them being common to both phases. The three-phase winding is shown Y connected—that is, one end of each of the three phases is connected together, the other three going to collector rings. The coil connections can be readily traced from the diagrams. This is perhaps the best polyphase winding for a uni-tooth construction having one coil per pole-piece per phase.

Multi-Coil Winding.—Figs. 5 and 6 show an overlapping winding similar to the preceding, but having two coils per pole-piece per phase. The quarter-phase winding (Fig. 6) is similar to the preceding three-phase winding, which shows an armature having the same number of coils but connected three-phase. From this it seems that the three-phase winding shown in Fig. 3 could be used for a

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quarter-phase winding in a field having two-thirds the number of poles by changing the coil connections. Similarly the three-phase winding shown in Fig. 5 could be used as a quarter-phase winding in a field having six poles by changing the pole connections so that all the straight coils are connected for one phase and all the bent coils for the other phase. It may be noticed from these and from the preceding diagrams that the three-phase winding has twice as many coils in the group—*i.e.*, the straight coils overlap twice as many bent coils in the three-phase winding as they do in the corresponding quarter-phase winding, which might make it appear as though there were more coils per pole-piece per phase in the case of the three-phase winding than there were in the corresponding quarter-phase winding. This is due to the fact that the straight coils have to span over the coils in the remaining phases, so that in the quarter-phase winding there is only one remaining phase to be crossed, while in the three-phase winding there are two, thus making twice the number of coils. This also makes possible the using of the same armature as a three-phase or quarter-phase by changing the number of poles.

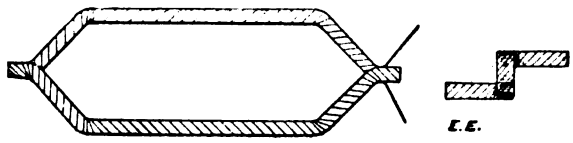

FIG. 9.—Formed Coil for Drum-Wound Armature.

As the end connections from coil to coil, as shown in the diagrams, become somewhat complex and indistinct when there is more than one coil or group of conductors per pole-piece per phase, the winding diagrams corresponding to Figs. 5 and 6 are shown in Figs. 7 and 8, where the connections can be more readily followed, the bent coils being shown in full and the straight coils by dotted lines. This winding and the uni-coil winding are the best adapted to high voltages. The insulation of the coils being of a necessity very thick, it is advantageous to make the winding in as few coils as possible. For this reason the

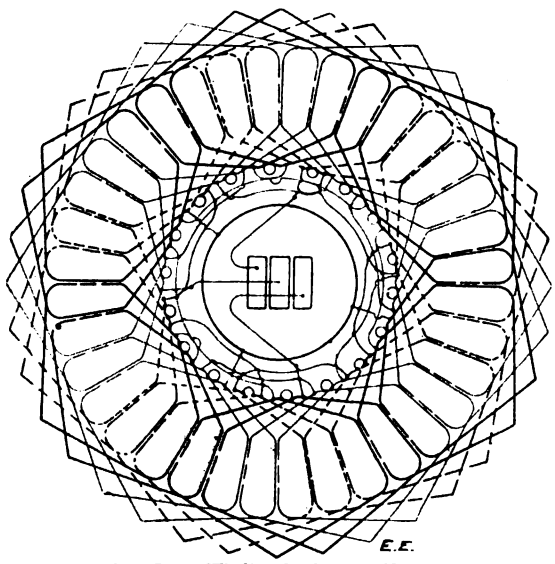

FIG. 10.—Three-Phase Drum Winding, having Two Slots per Pole per Phase.

uni-coil winding would have the advantage, but when better regulation and less armature reaction are desired, or for long-distance transmission work, the winding is best arranged in two coils per pole-piece per phase, as shown in Figs. 5 and 6. If a still further distribution of winding is desired, it can be carried out on the same plan as that shown in Figs. 5 and 6, but in the case of the quarter-phase winding, if the number of slots per pole-piece per phase is an odd number it will make an uneven distribution and arrangement of the coils, making the winding unsymmetrical; hence it is usual to adopt another style of winding when there are more than two slots per pole-piece per phase.

In the case of the three-phase winding the same style of winding can be used as shown in Fig. 5 by putting three or more coils together, and the winding will still remain symmetrical, but if more than three coils are used in a group the end connections become very long, thus making the copper losses high. It also requires a large number of different sized coils, which is a disadvantage, as it makes necessary a multiplicity of winding forms. Hence where there are more than two coils per pole-piece per phase in the case of the quarter-phase and the coils for the three-phase a drum winding is usually used. In a drum winding all the coils are alike, and, as the coils must cross each other on the ends of the armature, it is necessary to make them interlock in some manner. This can be done in a number of ways, but is perhaps best accomplished by making one half or side of a coil in one plane and raising the other side to another plane, as shown in Fig. 9. In this manner it is possible to make all the coils symmetrical. From this it will be seen that all one side of a coil will occupy the bottom and the other side, or half, the top of a slot; therefore, in order that all the slots may be entirely filled, two coils are put in each slot. The coils are laid in the slots one after another around the armature until the winding is completed, the connecting being done after all the coils are in place. To facilitate connecting, the leads are brought out of the coil at one end close together, as shown in Fig. 9. The connections for a six-pole three-phase winding of this description are shown in Fig. 10. For simplicity, a winding is shown having only two coils per pole-piece per phase, the coils being drawn in heavy lines, one side of a coil being in the bottom of the slot under one pole (shown by a dotted line in the diagram) and the other side in the top of another slot in the corresponding position under an adjacent pole. A winding of this type can be made for any number of coils per pole-piece per phase, the connections being similar, but having a greater number of elements per group.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE II.

(Continued from page 213.)

The mixing machine (Fig. 25) was introduced by my friend, Mr. Paul Pfleiderer, about 20 years ago, under the name

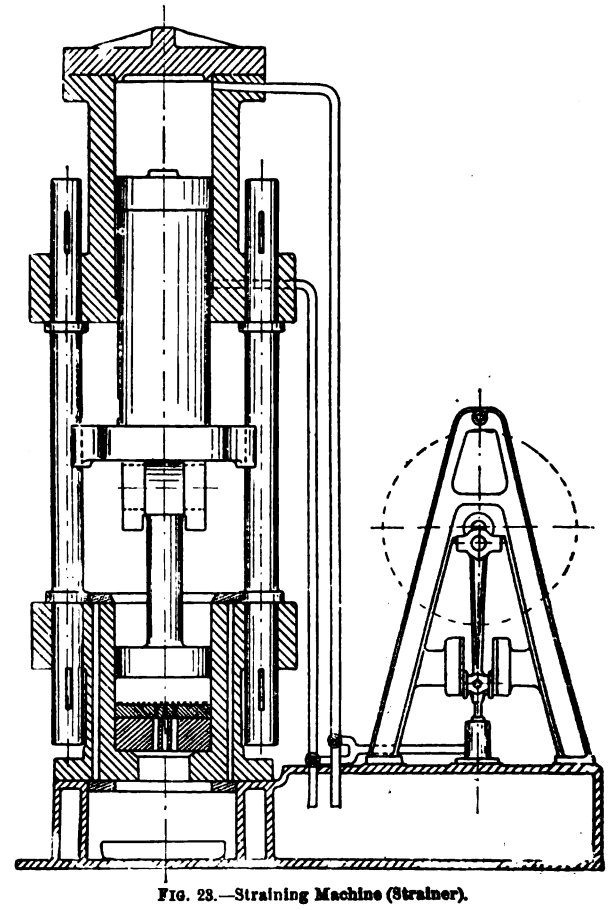

FIG. 23.—Straining Machine (Strainer).

"Universal kneading and mixing machine." It is largely used in the chemical industry, the indiarubber and lineoleum manu-

* Cantor Lectures delivered before the Society of Arts.

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facture, etc., and it consists of two iron rollers, provided with peculiarly-shaped blades, which work against one another, as shown by the arrows. The machine is used for intimately mixing the various sorts of guttapercha, in order to obtain a material of any requisite properties. It can also be used for blending guttapercha with pigments or other ingredients for special purposes. I need hardly say that the rollers can be heated by means of steam, but heat is also developed by the kneading process itself, and one has to be careful not to overheat the material and thereby injure it.

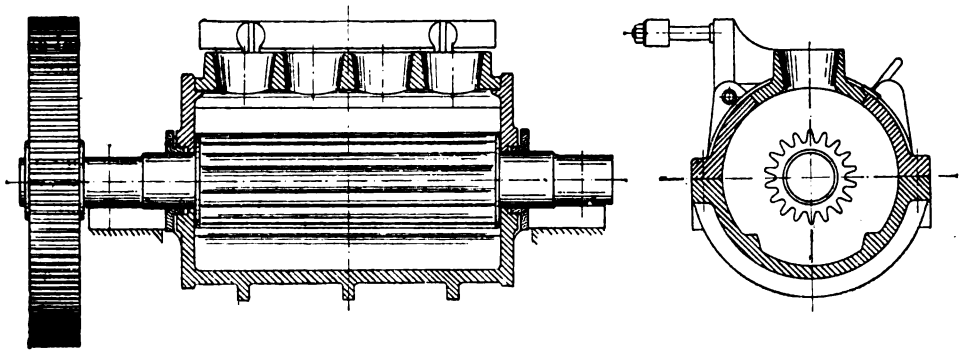

FIG. 24.—Kneading Machine (Masticator).

After mastication the guttapercha is rolled out into a sheet of suitable thickness, usually between $\frac{1}{8}$in. and $\frac{1}{4}$in., and it is then cut up into lengths of 5ft. or 6ft. for stacking in the cellar until required for use.

The rolling-mill is shown in Fig. 26. The soft guttapercha from the kneading machine is laid on a table in front of a pair of parallel rollers. It is then pushed up against the rollers and squeezed through in the form of a sheet, which is taken up by an endless band, on which it travels some distance to and fro until it is sufficiently cool and hard to be cut into the shorter lengths for storing.

We have determined the percentage of water and dirt in various kinds of guttapercha at different stages of the mechanical cleaning process, and the average result obtained with several materials, is shown in diagram Fig. 27.

Let us first consider the water. The material, as it comes from the chopper, contains 21·5 per cent.; this is reduced to 14·4 per cent. during the softening and preliminary preparation for the washer; but, curiously enough, the water actually diminishes in the washer to about 13 per cent., and then remains constant until it reaches the rolling-mill, when it loses another 2 per cent. by evaporation. This seemingly paradoxical result is to be ascribed to two causes—viz., the consolidation of the material in the washer by pressure, and the removal of the dirt, which on account of its porous nature encloses a large amount of water.

As regards the dirt, we observe that the chopped material encloses 12·8 per cent. Some of it—viz., about 3 per cent.—is removed during the preparation for the washer, but most of it disappears during the first washing operation. The straining, on the other hand, hardly affects the percentage of dirt, and this operation is carried out more for safety's sake to prevent any larger pieces of dirt, especially of a fibrous kind, being left in the cleaned material. The second washing process following the straining is again effective, as it removes nearly another $\frac{1}{2}$ per cent. The remaining 1·8 per cent. of impurities would be admissible for most practical applications, but for special purposes it may have to be still further reduced.

The result of an experiment on straining is given in Table VI. The object of this experiment was to determine the amount and character of the impurities retained by the gauze diaphragm of the strainer from a definite quantity of washed guttapercha. The diaphragm consisted of three superimposed discs of wire gauze, the upper one being of iron wire, and having 68 meshes to the linear inch; the middle and lower discs were of brass wire, and had 100 meshes to the inch. Twelve charges of $\frac{1}{2}$cwt. each were forced successively through the strainer, after which the diaphragm was removed and the adhering guttapercha dissolved by carbon disulphide. The discs were then taken apart, the dirt carefully scraped from each, separated into "fibrous," "granular," and "magnetic," and weighed. Part of the magnetic substances was probably present in the raw guttapercha, but some of it no doubt got into the material by abrasion from the iron machinery with which it had come into contact during the preceding cleaning process. The figures show that in each case the coarse 68-mesh strainer on the top contained by far the largest amount of impurities, and that a little dirt which passed the intermediate 100-mesh gauze

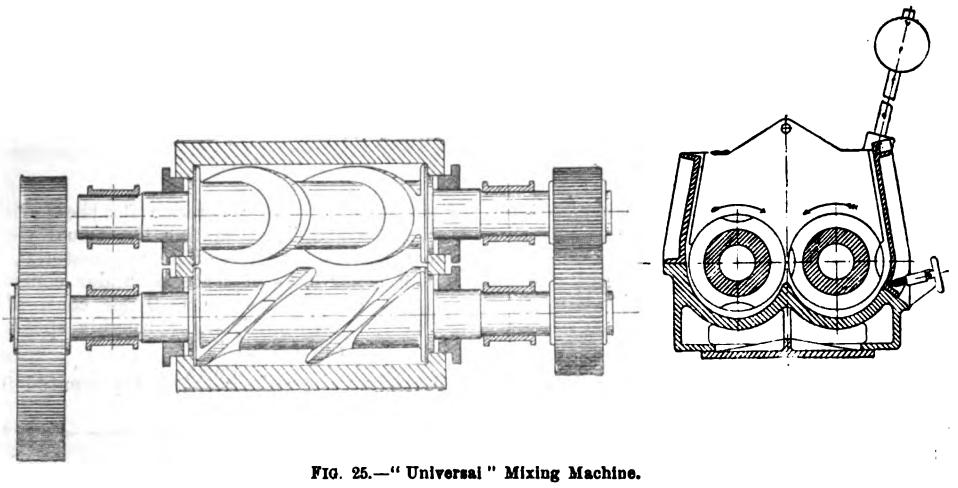

FIG. 25.—"Universal" Mixing Machine.

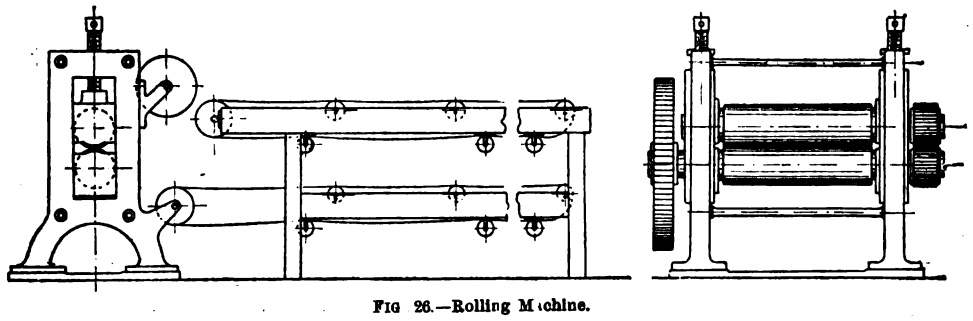

FIG 26.—Rolling Machine.

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TABLE VI.—Straining Experiment.
(6cwt. passed through triple strainer.)

Description of impurities.	Weight of impurities found on strainers.			
	Top strainer (68 mesh).	Intermediate strainer (100 mesh).	Bottom strainer (100-mesh).	All three strainers.
	g.	g.	g.	g.
Fibrous	0·722	0·425	0·062	1·209
Granular	0·433	0·221	0·051	0·705
Magnetic	0·170	0·081	0·014	0·265
Total	1·325	0·727	0·127	2·179

	g.
Impurities retained on strainers	2·170
,, removed in guttapercha..	0·430
Total.....	2·609

Guttapercha retained on strainers, 160 g.

sponding percentages of guttapercha proper, calculated from the analyses of small samples of the same raw materials which were eventually cleaned in the works, the column marked (A) showing the results of the laboratory, and that marked (B) those of the works. The thinner black line to the left of (A) shows the percentage of guttapercha proper for each particular brand obtained from the analyses of a much greater number of individual lots, and is taken from diagram Fig. 14 of the first lecture. A comparison of the length of the black column (A) with that of the thin line by its side shows therefore to what extent the lots, for which both analytical and practical data had been available, really represent the particular "brand" of guttapercha.

According to the diagram the percentage of guttapercha actually obtained in the works is in every instance lower than that determined by analysis—*i.e.*, column (B) is invariably a little shorter than column (A). The reason of this discrepancy is not far to seek. When the small sample of raw guttapercha is taken for analysis, it is almost impossible to prevent loss of moisture and dirt; moreover, the larger enclosures, such as stones, pieces of bark, etc., are not represented, and, therefore,

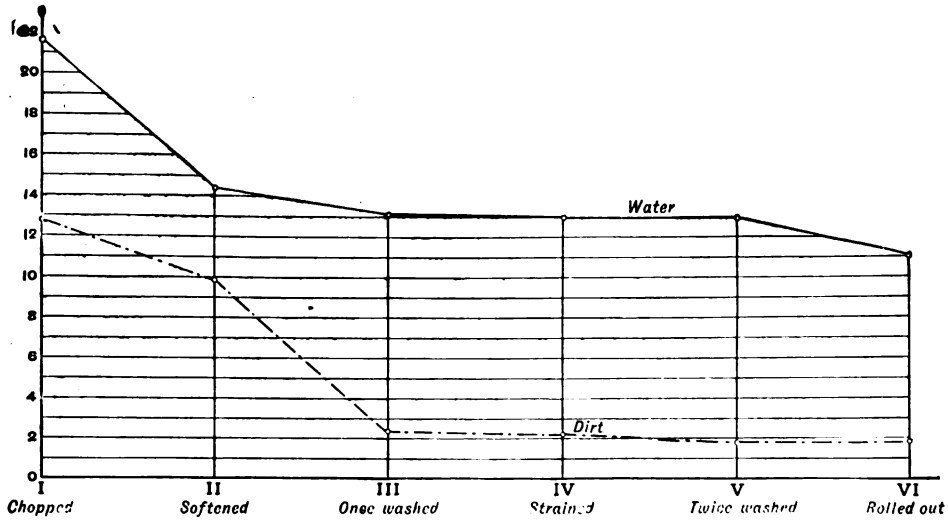

FIG. 27.—Percentage of Water and Dirt during Mechanical Cleaning.

was removed by the next gauze disc of equal fineness. Altogether 2·179 grm. of dirt were found on the three gauze discs, the fibrous constituent thereof amounting to over one-half. To this has to be added the dirt found in the guttapercha extracted with the solvent—viz., 0·43 grm.—making a total of 2·609 grm. The quantity of guttapercha from which this dirt had been abstracted by straining being 6cwt., it is easily seen that the percentage of dirt cannot have been perceptibly affected.

evade analysis. An allowance for these omissions has, therefore, to be made in estimating the actual yield of clean guttapercha from the analysis of its raw material, which depends on the particular class of material under consideration; but may be taken on the average as 9 per cent. of the guttapercha proper found by analysis, or, roughly speaking, 6 per cent. of the original raw material.

As before, the ratio, $\frac{\text{gutta}}{\text{resin}}$, is represented in the diagram by

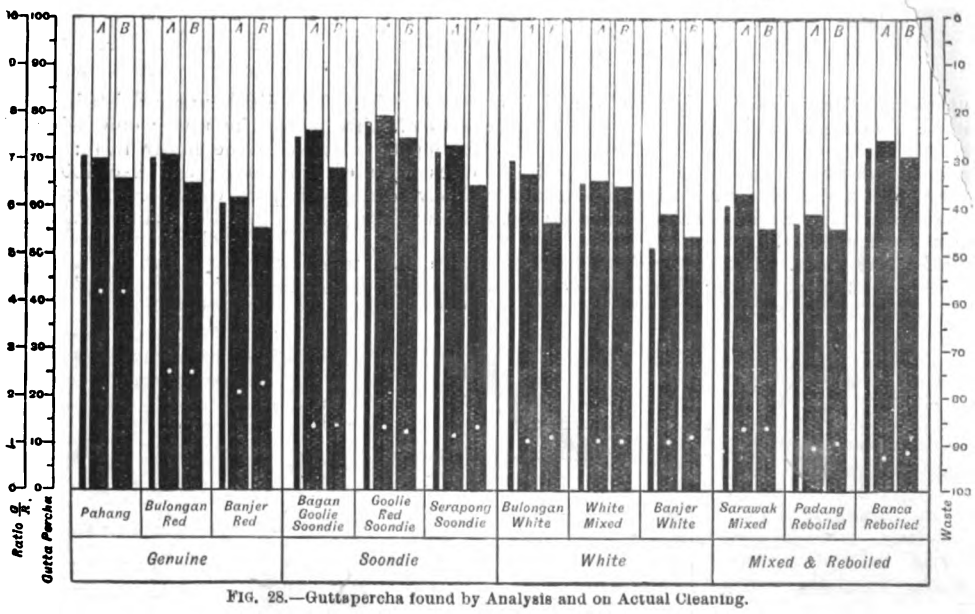

FIG. 28.—Guttapercha found by Analysis and on Actual Cleaning.

LOSS DURING MECHANICAL CLEANING.

The loss or "waste" which raw guttapercha sustains during cleaning and drying is sometimes a very heavy one, and occasionally reaches fully 50 per cent.

Diagram Fig. 28 represents the percentage yield of guttapercha obtained on cleaning a number of raw materials of each of the 12 different "brands," mentioned in my first lecture. For direct comparison I also give in the diagram the corre-

the height of the white dot in the corresponding black column, and it is interesting to observe that this ratio is on the whole more favourable in the case of cleaned guttapercla than in that of raw materials. One reason is that when the resin is extracted from the raw material during analysis a little resinous matter is also abstracted from the wood and bark, whereas this is not the case with cleaned guttapercha. Another reason is that raw guttapercha is more porous, and, consequently, more pervious

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to the solvents than the denser clean material. The resin is therefore more completely removed from the former than from the latter. The slightly higher position of the dot indicating the ratio $\frac{g}{r}$ in column (B) as compared with that in column (A) is clearly indicated in the diagram. The exact figures are given in an appendix.

Diagram Fig. 29 represents the average percentage loss obtained on cleaning large quantities of raw guttapercha of various kinds for each of the last 20 years. The results are significant, showing that this loss gradually increased from 22·5 per cent. in 1877 to 32·2 per cent. in 1880, 35·6 per cent. in 1885 and 44·6 per cent. in 1890; the mean loss during the entire period being about 33⅓ per cent. This diagram also gives the average percentage of dirt found in the same lots of raw

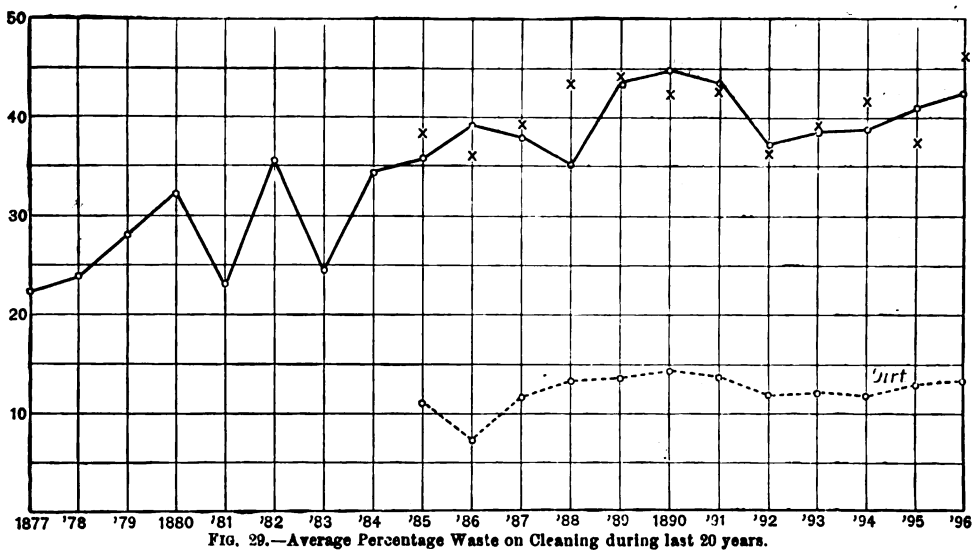

FIG. 29.—Average Percentage Waste on Cleaning during last 20 years.

guttapercha by analysis for each year from 1885 to 1896, and the total waste thus obtained and corrected as explained before (shown on the diagram by crosses). The actual figures are published in an appendix. To a certain extent the percentage of waste goes hand in hand with the quantity of raw guttapercha exported from Singapore, as a comparison of the respective curves shows, but, roughly speaking, one may say that at the present time it is almost twice as great as it was 20 years ago.

You may have noticed the comparatively fine dirt, chiefly wood and bark, contained in most of the raw materials which I showed you on the last occasion and to-night, but frequently larger pieces of various foreign substances are fraudently hidden in the blocks. One may, I think, term this big lump of quartz a rather "coarse impurity," as it weighs over 3lb. Notice also these large quartz crystals and those pieces of metal. I have here quite a collection of such "rarities," which have been found embedded in blocks of raw guttapercha. These include three iron axes, such as the natives use for felling trees, and with which we have become acquainted in the previous lecture under the name of "billiongs," and pieces of wood, one of them showing the marks of the serrated chopper knives with which it came into collision. If stones or metals are enclosed in the blocks, the knives of the chopper will be seriously injured, and if they should get into one of the washing machines the damage may be considerable, unless frictional driving is resorted to, which is very advisable. Here, for instance, is a small iron stamp, such as is used for marking block tin, which was found only a few months ago, when it was already too late—that is, after it had got into one of the washers and damaged it to the extent of over £60.

Last year, shortly after the discovery of the X-rays by Prof. Röntgen, I also experimented with these rays, and it occurred to me to test the transparency of guttapercha to them. I found it exceedingly transparent, and this induced me to have a number of blocks of raw guttapercha examined with the cryptoscope to see whether they enclosed any stones or other heavy materials. Out of 450 pieces of "White Bulongan," a material which appeared particularly likely to give some results, we found seven containing stones. We also examined 300 pieces of "Mixed Sarawak," but failed to defect any; however, in another lot of the same kind of material we found one piece containing a stone, and I have photographed it by means of the X-rays, and will now show you the result on the screen. This stone nobody has seen since it was first put into the block of guttapercha; we shall now cut the block open and expose the stone—here it is, and you observe it corresponds exactly with the X-ray photogram.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

90. Can the unipolar or homo-polar direct-current dynamo be made to give a high voltage, say 200 volts. If not, why not?—Z. Q.

91. Describe the single-wire system of ship-lighting and its advantages or disadvantages. Which pole of the dynamo should be connected to the ship?—W.

ANSWERS.

Question No. 84.—What is the cause of "hunting" in electric lighting engines, and how may it be remedied?

Best Answer to No. 84 (*awarded* 10*s.*).—There are several causes which produce hunting in electric light engines, the majority being due to some defect in the governing arrangements, and it is there that we must look first. Electric light engines are governed almost without exception on one of two systems—either the governor acts on a throttle valve, altering the amount of steam supplied to the engine, or the governor acts on an eccentric, which alters the cut-off in the high-pressure cylinder. With engines using the first of these systems, such as the Willans, Belliss, etc., the throttle valve is a very good fit in its casing, and has only a very small movement, and a common cause of "hunting" in these engines is, therefore, the throttle valve sticking, thus admitting steam to the engine in jerks at the wrong times, and causing it to "pump" the lights. To remedy this, the throttle valve should be taken out at regular intervals—say, every two months—cleaned, oiled, and put back, but if this is no use the valve is probably a trifle out of line with the spindle, and it should therefore receive the attention of the makers. As the throttle valves of this type of engine have such a small travel it follows that the governors have only a small range, and no slackness or play should be allowed in any part of them, as this is a common cause of hunting. All pins in the governors should be of large diameter and made of hard steel—in fact, all wearing parts should be made of hardened steel, and good workmanship is essential.

Another thing which may cause hunting where several of these engines are driving alternators in parallel is that one engine may be getting less or more steam than the others, and therefore all the governors and throttle valves

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should be set so that each engine has the same speed when running light with the stop-valve wide open, and this setting should be tested periodically.

With engines using the second system of governing, such as most types of open high-speed vertical engines, a common cause of hunting is slackness in the governor parts, and the same remarks as to hardened pins and bearings will apply as to the Willans type of governor. Another cause of hunting is that governors of this type are sometimes not sensitive enough. The weights are too heavy and springs too stiff, so that inertia comes into play and retards the action of the governor, causing the valve to hang fire both at high and low speeds; but, at the same time, governors for electric light engines may be *too* sensitive, especially when several engines are driving alternators which are in parallel. In this case too sensitive governors may cause hunting. There should be a certain amount of give and take, a variation of 3 per cent. being better than a variation of 2 per cent., as the alternators act partly as governors.

Another case of hunting common to all types of reciprocating engines is bad valve setting. The engine gets more steam on one side of the piston than the other, causing the up-stroke to be quicker than the down, or *vice versâ*, or one cylinder gets more than its proper share of steam, and consequently does most of the work, causing an uneven turning moment in the crankshaft. To guard against bad valve setting the engines should be indicated at regular intervals, as even if the valves have been set right in the first instance, they often work loose on the spindles, and a slight slackness would probably only be discovered by the indicator, although it might make a good deal of difference in the working of the engine.

Yet another cause of hunting is sometimes to be traced to an unbalanced crankshaft or an improperly balanced shaft, but the principal causes of hunting in electric light engines are: (1) slackness or play in governor parts; (2) bad valve setting, or valves coming adrift; (3) dirt; and the remedies or preventatives to be employed are:

1. All governors and valves should be well made and no slackness allowed in any part; they should be carefully examined at regular intervals and kept clean and well oiled.
2. Each engine should be indicated periodically, the horse-power worked out, and the cards compared with former ones in order to detect any alteration in the valve setting, looseness of valves, etc.
3. All engines which are to run together should have their governors adjusted to make them run at the same speed when running light with the stop-valve full open.

If these precautions are taken, very little trouble will be caused by engines "hunting."—R. S.

Answer to No. 84 (*awarded* 5*s.*).—An electric lighting engine is frequently subjected to rapidly-varying loads. As the speed must be kept constant, the admission of steam must be varied instantly to answer the call made on the engine. Hence a very good governor is necessary. If the governing gear does not answer rapidly enough, or answers rapidly but incorrectly, the amount of steam admitted will be out of proportion to the work required, and the engine may either race or slacken speed. Each variation in speed produces a new condition of the governors, and so the probability is that the engine will alternately race and fall behind, or "hunt." In the first case, when the governor does not answer rapidly enough, the governor may be altogether unsuited for the work it has to perform. As, however, the engine should have been tested at the works under varying conditions of load, this is not a likely thing to happen. A usual works test is to suddenly throw the full load off and on. A good governing performance would be a 3 per cent. variation of speed.

The most likely cause of bad governing is friction in the governor parts. Dust and dirt may have got into bearings on whose perfect freedom of action the working of the governor depends. The remedy is to flood with paraffin, clean, and afterwards to keep the governor covered in as far as possible. The crankshaft disc governor is less liable to trouble from this cause, as both the movement and control parts are so heavy that a small amount of dust does not hurt. A case in point may be quoted. An engine, enclosed all but the governing gear, standing close by two boilers in such a position that all coal dust or ashes flying past would lodge on the governor, has been running for three years on a varying load without need of overhauling, the only attention necessary being the regular oiling and wiping. There may be too much friction in the parts connecting the governor with the steam control—*e.g.*, in the case of governing by throttle valve, the gland on the valve rod may be packed too tightly for the rod to move freely. A frequent cause of friction in governors (especially cheap ones) is bad workmanship. Get the governor adrift and overhaul the parts; then decide whether to try and make it run, or get rid of it and buy a good one. If possessed of patience, it is soothing to remember that in course of time small irregularities in rubbing parts are worn down. If there are any intermediate bearings between crankshaft and governors they should be carefully watched, as if they run hot they will upset the action of the governor. "Slack" in governor gear is quite as detrimental to good governing as friction. For example, in variable expansion governor gears in which an eccentric on crankshaft is used, the governing will be very variable if the strap is allowed to wear too slack. Some governors are driven by belts; if these get slack a sudden variation of load would make them slip, and throw the governors wrong for a moment.

The second main cause of hunting—the governors acting rapidly but incorrectly—may be due to incorrect setting of the valves or valve motion. In governing by throttle valve, for instance, if the valve is set too high it will cut off steam too sharply, and the engine will drop in speed. Then as the governor balls drop, steam is suddenly readmitted, and the speed of the engine flies up again. In setting a throttle valve, the object is to so set it that when the governors are at their fullest extent the throttle should remain just sufficiently open to run the engine without any load on it at its proper speed. A weak control on the governor itself will cause hunting through too rapid action. Suppose, for instance, the governor has a spring control which is too weak for the engine's normal speed. Let the load suddenly drop. The speed of the engine increases, and the governor balls fly outwards. The spring is carried with them beyond its proper length, and then pulls back. The governor thus fluctuates, and the engine hunts.—J. A. SEAGER.

Answer to No. 84 (*awarded* 5*s.*).—Governors of steam-engines do not always act as they should, and admit steam in exact accordance with the speed. Apart altogether from questions of friction or movement of heavy valve or expansion gears, many forms of governor, especially what may be described as the relay kind, alter the steam admission with some delay. The friction of the various parts, and their tendency to remain in one position until the disturbing force comes up to a certain value, and to then move suddenly and overshoot the mark, increases this action. The result of this time lag in the action of governors is that in many cases engines, especially on light loads, get into a state of vibration known as "hunting." When the load of an engine varies, for instance, by decreasing, if the steam supply remains the same, the extra energy goes to increasing the speed of the flywheel. Whether the speed of the engine follows the steam supply quickly or not thus depends on the flywheel. It also depends on the load. If 1,000 h.p. is working at full load, and 900 h.p. is suddenly thrown off, and the governor does not act instantly, 900 h.p. is devoted to increasing the velocity of the flywheel, and unless the wheel has an enormous amount of inertia, or is turning very quickly, this power will increase its speed, say 2 per cent., in a very short time. On the other hand, if the engine is only doing 100 h.p., and this load is suddenly reduced to 10, there is only 90 to increase the speed of the flywheel, and to increase it 2 per cent. will take 10 times as long as in the former case. Putting the matter the other way, the engine obeys variations of steam supply more slowly at light loads, or, in other words, it obeys its governor more tardily at light loads. In practice many engines which run steadily at full load hunt terribly when worked light. The governor is sometimes treated without reference to the flywheel or engine load. A simple Watt

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governor and most governors on small engines have no appreciable time lag except sticking slightly, due to friction or the absurd practice of putting a comparatively small governor to work direct on a heavy expansion gear or a stiff stuffing box. There is not much tendency to hunt with these governors. If a governor is made isochronous, usually it is not powerful enough if it has to move through a long range with a small percentage of speed variation. It is likely to stick until the speed is varied a good deal, and then to move to its fullest extent, the result being that the engine would be governed by having full steam and none at all alternately. The method of overcoming friction or weight of the valve gear is to use some relay. The governor then does not act directly on the valve gear, but puts some mechanism into gear which works the throttle valve. Such an arrangement can be made very accurate, as a very small movement of the governor, opposed by a very slight force, can be made to work the most obstinate valve gear. But we have at once danger from hunting, as there is considerable time lag in the governor. Suppose the load is suddenly decreased, the engine speeds up, and the governor begins to increase the expansion, but effects this slowly, and by the time the valves are right for the reduced load, the engine is much above speed. The governor, therefore, goes on reducing the steam until the engine has far too little. It therefore slows down again. But the governor continues reducing the steam until the engine is slowed down to its normal speed. By that time the engine has far too little steam, so it goes on falling in speed. The governor then begins to turn on steam again, but it does it so slowly that the engine has fallen far below speed before the normal steam supply is given, and the governor goes on turning up steam till the engine arrives at its normal speed, when it has far too much steam, and is again rapidly increasing in speed. This cycle of operations is repeated over and over again. It depends on the lag of the governor, the fly wheel, and the load whether the hunting is temporary, so that the variations of speed are less and less every time, or permanent, in which case the engine alternates between no steam and, perhaps, full supply. An engine which hunts permanently at very light loads, often works perfectly over half load. Where throttle governors are used, hunting will often occur if the packing is tight in the spindle gland. To prevent this, the gland should be repacked very often, and the spindle kept well greased with tallow.

Expansion governors such as the McLaren type have a tendency to hunt, due to the slackness of the controlling springs. If the slackness cannot be taken up by the adjusting gear, a turn or two must be cut off the springs and the governor readjusted.—A. BROUGHTON.

Question No. 85.—**In power distribution what are the relative advantages and disadvantages of a direct-current system and a multiphase-current system as far as speed regulation only is concerned?**

Best Answer to No. 85 (*awarded* 10*s.*).—In comparing the advantages and disadvantages of continuous and multiphase current distributions respecting the regulations of speed, the available means of the two systems will have to be considered somewhat in detail. Considering the fundamental principles of the continuous-current supply first, what is generally desired to get in practice is a constant speed of motor, whatever may be the mechanical power taken out of it at any moment. The construction of the motor to comply with these requirements depends, of course, on the conditions of supply. Out of a large variety of cases, only two, from a practical point, need consideration: (1) the supply at constant pressure, such as can be obtained from a central station; (2) a supply of constant current at variable pressures from a generator erected specially for the purpose, the regulation of the current and pressure being automatic.

The latter case is that more particularly met with in long-distance transmission of power, the former case (1) referring to the distribution of power over short distances from a central station.

Considering case 1 first, we have these supply conditions: pressure at the terminals of the motor constant, and current variable according to the power required. If the motor is series-wound, the larger the current the stronger will be the field; and if the speed is to remain constant, the back E.M.F. must increase in the same ratio as the field strength. But the back E.M.F. must be smaller than the impressed E.M.F. by just the amount required to overcome the resistance of the circuit through the motor, and this difference is proportional to the current. To satisfy the supply conditions, the counter E.M.F. of the motor should slightly decrease with the load and with it the current increase; then the speed will keep constant. But this is the opposite to what the motor wants. If when the machine is running at a certain speed, giving out a certain amount of mechanical power, the load is increased, then the speed of the motor will slightly decrease also the back E.M.F., and the current will increase; this will strengthen the field and raise the back E.M.F. again, checking the current, and producing a further drop in speed. These reactions will go on until a new condition of working is reached at a larger current and lower speed. When the load is taken off, the above reactions take place again, but in the opposite sense. The above reaction happens only, of course, if the machine is worked on the rising portion of the E.M.F. curve, which is the part that is naturally selected for economical working. If we over-excite the field magnets by employing a great deal more wire than is necessary, then the machine may be worked on the drooping part of the E.M.F. characteristic. Then we can obtain approximately constant speed between certain limits. But as the machine will still be liable to race as soon as the load is taken off completely, it will thus be seen what difficulties there are in the case of series-wound motors.

Now looking at the actions of the shunt-wound motor, it will be seen that the field excitation does not depend upon the current in the armature, as in the series motor, but is the result of the terminal pressure; so that whatever current is required by the armature for giving power is supplied by the source of current without in any way affecting the field excitation. If the terminal pressure varies, the excitation will also vary. But a variation in the working current will not influence the field strength, only in a slight degree, due to the reactions of the armature, which produce a magnetic effect in opposition to the field excitation, which produces a drooping in the magnetisation curve. This curve in shunt motors with wrought-iron cores is almost a straight line in the first portion, and in this region the magnetisation is nearly directly proportional to the E.M.F. at the motor terminals; and to work the motor at this part of its characteristic, all we have to do is to supply it with current at a pressure lower than that for which it is designed. If, therefore, we work the motor below its power, the armature reactions will be considerably small, and may be negligible, and under these conditions the back E.M.F. will be almost equal to the E.M.F. impressed, and therefore the speed has a definite value which is independent of the supply E.M.F., and brings about a remarkable result—that is, if a shunt motor is worked under load and at a lower pressure than it was designed for, the pressure can be varied within certain limits without affecting the speed or power given out. However, as the motor must be large in proportion to its work, the practical use of this remarkable property is limited. But, again, suppose we work a machine throughout the whole range of the output for which it was designed. First, as to speed, let us assume that the motor is working at a certain speed, giving out a definite amount of mechanical power. Suppose we wish to increase the speed; to do this we have to weaken the field, and to decrease the speed we must strengthen the field, or, which is the same thing, the back E.M.F. must be proportional to the strength of the field, and when the motor is running light this back E.M.F. is nearly equal to the E.M.F. impressed.

Now let a load be thrown on causing considerable increase of current; the back E.M.F. need not be so large as before, since part of the impressed E.M.F. has been already absorbed by the resistance of the armature, and the back E.M.F. need only balance the remainder, so that the supply conditions of constant pressure require the back E.M.F. to become lower as the power demanded from the motor increases. At the same time the working conditions of constant speed can only be attained by a lowering

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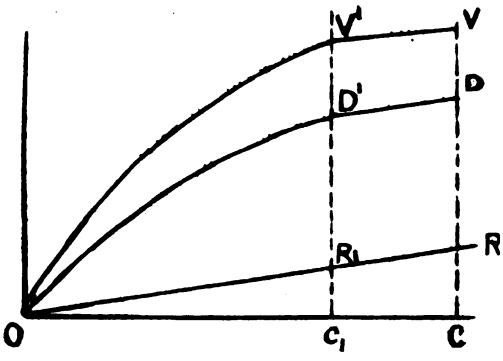
of the back E.M.F. as the current increases, and it is therefore obvious that in the lowering of the back E.M.F., as determined by either conditions, we must have constant speed at variable power—that is, a self-regulating motor. But if the motor is designed so as to get the same speed when running quite light and when fully loaded, the speed will be slightly less at half load; but this difference can only be very small.

Thus it will be seen that a shunt motor is an excellent machine for keeping the speed constant when worked on a constant-pressure circuit, the only drawback in its employment being that a resistance must be inserted into the armature circuit at starting. But this is done automatically by placing the resistance permanently in the circuit and causing it to be short-circuited by means of a centrifugal regulator fixed to the armature shaft, and so arranged that when the speed has attained a certain value the balls of this arrangement fly out and cause a switch to be closed. Such an automatic device is also of value in case the motor should be overloaded, for when this happens the speed will drop, and the resistance will automatically be reinserted, keeping the current within certain limits. In the case where a motor is supplied with current, not from a general system of mains, but from a special generator serving no other purpose, regulations of speed and power can be effected equally well by a series, compound, or shunt machine. As regards compound motors, after what has been said respecting constant pressure, it will be seen that these motors with the main coils demagnetising are equivalent to shunt motors with large armature reactions, for shunt-wound motors with very small armature reactions, such as a multipolar machine, may be made self-regulating by the addition of demagnetising coils on the field magnets.

In the case of the series motor, the generator and motor are series wound, and by suitably designing the machine we can bring about the condition that the motor will run at constant speed under varying loads if the speed of the generator is kept constant. Let the two curves in the figure



represent the E.M.F. characteristics of the two machines, the upper curve referring to the generator and the lower to the motor. These curves give the useful E.M.F. after deducting armature reactions, and refer, of course, to constant speed in each case. The current flowing through the circuit is that which we obtain by dividing the difference between the ordinates of the two curves by the total resistance. The resistance is, of course, a constant, and the curve representing the current and difference of E.M.F. is, therefore, a straight line, O R, in the diagram. The vertical length, C R, gives the voltage loss, with a current, O C, due to the resistance, and this must be equal to the voltage difference, V D, between the curves. This determines, therefore, the speed of the motor for that particular current. Suppose the lower curve is the E.M.F. characteristic for that particular speed. Now let us throw some of the load off, then the current will assume a smaller value, say O G_1 The voltage loss is now C_1 R_1, and the voltage difference V_1 D_1. If the E.M.F. characteristics fit these new working conditions, then V_1 D_1 must be equal to C_1 R_1, and the speed will remain the same as before. We thus find that if we so design the machines that the differences between their E.M.F. characteristics at any working point is equal to the volt loss by resistance, we obtain a perfect self-regulation system of power transmission. The difficulty met with in this system is that we cannot always get the two characteristics to fit each other exactly over the whole range of output. Another difficulty arises from there being generally a slight difference between the ascending and descending characteristics, but the most serious obstacle to quick and perfect regulation is the self-induction of the field magnets. A sudden change of load cannot be followed by a sudden change in power supplied to the motor, as time is required for the magnets to settle down into their new working conditions, and during this time, which may be some seconds, there is a surging of power to and fro which creates fluctuations of speed. To mitigate this evil, Herr Dobrowolsky devised a plan by which a kind of an electrical damper is applied to the generator in the shape of a non-inductive high resistance, placed across the terminals of the magnet coils as a shunt, and left there permanently; and abnormal E.M.F.'s, which might otherwise disturb the working of the motor, or endanger the insulation of either machine, spends itself in heating this resistance, and the disturbance quickly subsides.

In multiphase transmission of power, owing to the low efficiency of the two-wire revolving-field motor and to its small power, its employment is necessarily restricted to cases where these defects are of little consequence, but for the distribution of power over long distances it is not suitable. For such a purpose we must have a three-wire. But the revolving-field motor has, however, the defect that it is not self-regulating. Its speed may be anything between zero and that speed which will give synchronism between the two machines. Accordingly, as the mechanical load varies from maximum to nothing, this defect is overcome by combining with the armature in the motor a real magnet which will force the armature to keep step with the current, and thus ensure constant speed at varying loads. The motor will thus start with great power by virtue of the current induced in the armature windings by the revolving field, and will soon reach the synchronising speed, and will keep there by virtue of the interaction between the revolving field and the revolving magnet. It behaves just like an ordinary alternator run as a motor, with this difference, however, that the alternator, if overloaded to 50 or 90 per cent., will be thrown out of phase and come to rest, whereas the combination above will always be ready to recover itself on the load being removed.

Now, in the three-phase distribution by alternating currents, we have no commutators, not even rubbing currents; we can greatly extend the distance of transmission, thus overcoming the difficulties met with in continuous-current distribution—that is, in the way of commutation of large currents at high pressure; and another difficulty met with in continuous-current supply is the insulation of the machines. This is entirely removed by working through transformers, the insulation of which offers no difficulty whatever respecting speed regulation. Both kind of motors require some automatic arrangement, and as far as speed is concerned they may be considered equal. But it will be seen by the advantages and disadvantages set forth in both systems that for short distances the series motor and generator is the most reliable, for long distances from distributing mains the multiphase system.—J. C. B.

[The last part of this answer discloses a somewhat incomplete knowledge of three-phase motors, and "J. C. B.'s" conclusions must not be taken without question.—Ed. *E. E.*]

SOUTH KENSINGTON SCIENCE EXHIBITIONS.

We have received from the Department of Science and Art the following list of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (science), 1898: Royal Exhibitions.—George S. Taylor, 18, engine-fitter's apprentice, Devonport; Leslie H. Hounsfield, 20, engineer apprentice, London; William McG. Wallace, 23, fitter and turner, Crewe; William W. Firth, 23, engineering student, Oldham; Henry J. Round, 16, student, Cheltenham; Sidney A. Main, 16, engineering student, Brighton; James Davidson, 25, millwright, Newcastle-on-Tyne. National Scholarships for Mechanics (Group A).—Aidan N. Hender-

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son, 23, student, Edinburgh; John E. Jagger, 21, draughtsman, Manchester; William Alexander, 22, engineering student, Glasgow; Victor G. Alexander, 21, fitter's apprentice, Portsmouth; Ernest A. Forward, 20, engineer apprentice, London; George E. Parker, 16, student, Denholme, Bradford; Percy W. Kelsey, 20, student, Brighton; *Frank H. Phillips, 23, engineer, Crewe; *Joel J. Lee, 19, fitter's apprentice, Portsmouth. Free Studentships for Mechanics (Group A).—George Walker, 17, student, Bradford; Marshall H. Straw, 24, patternmaker, Sneinton, Nottingham. National Scholarships for Physics and Chemistry (Group B).—George M. Norman, 18, science student, Brighton; William S. Tucker, 21, science teacher, Kidderminster; John Satterly, 18, student, Ashburton; Robert J. Bartlett, 19, laboratory assistant, London; Joe Stephenson, 18, student, Linthwaite, Huddersfield; Lewis L. Fermor, 17, scholar, London; Robert Gillespie, jun., 18, laboratory assistant, Glasgow; *Frederick C. Clarke, 21, science teacher, Plymouth; *Thomas Stenhouse, 18, teacher, Rochdale. Free Studentships for Physics and Chemistry (Group B).—Arthur E. Garland, 18, student, London; Stanley C. Dunn, 18, London; †Harold V. Capsey, 18, student, Wellington, Salop; †Isidore Tom, 18, student, London. National Scholarships for Biology (Group C).—Stanhope E. Baynes-Smith, 27, student, Sheffield; Stafford E. Chandler, 18, London; Arthur Pickles, 17, clerk, Burnley; William E. Clarke, 19, student, London. In Group D (geology) there were no competitors.

LEGAL INTELLIGENCE.

PADDINGTON VESTRY v. METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

The Smoke Nuisance.

Mr. Curtis Bennett was engaged at Marylebone on Saturday in hearing a summons taken out by the Paddington Vestry against the Metropolitan Electric Supply Company, Limited, of St. Peter's Wharf, Amberley-road, Paddington, for permitting black smoke to issue from their works in such quantities as to be a nuisance.

Mr. H. C. Byron supported the summons, and Mr. Spencer Bower appeared on behalf of the company.

It was stated that a similar summons in respect of the same works had already been heard by Mr. Lane, Q.C., and dismissed. The defence then raised was that the company, being compelled by statute to generate electricity and being unable, by reason of the Welsh coal strike, to obtain smokeless coal, were obliged to commit the nuisance.

Mr. Byron submitted that the dense black smoke emitted from the chimney had considerably increased, and was fast becoming intolerable. In other districts, he pointed out, generating stations of exactly the same kind were being worked without producing any nuisance, and this went to show that a great deal, if not the whole, of the nuisance in the present instance was caused either by defective working or carelessness on the part of the company. The defence previously raised, he contended, was no answer to the case. True, the company were compelled to generate electricity, but the Act did not specify the kind of coal to be used, and if the company chose, for the sake of economy, or for other reasons, to rely upon a particular kind of coal, and failed so to construct their furnaces as to consume the smoke necessarily created by the use of other coal, they must take the consequences.

The **Magistrate** enquired why the energy could not be produced by gas-engines.

Mr Byron: Exactly; there is no reason whatever.

Mr. Bower: It is absolutely impossible.

Evidence having been given in support of the summons, **Mr. Bower** contended that where the Legislature had given power to do a certain thing, and it had been done with all reasonable and proper care, no blame could follow.

Mr. Frank Bailey, managing director of the company, admitted in cross-examination that the furnaces were adapted for the use of Welsh coal and not soft coal. A great deal of the smoke was caused by sudden pressure, which could be avoided if a larger number of boilers were employed. Had the company intended to use soft coal a chimney would have been put to each boiler, and had that been done, he admitted, it would have kept the company well out of any proceedings like the present. He agreed that careful stoking made a considerable difference to the amount of smoke produced. To reconstruct the works would involve an enormous and prohibitive expenditure.

Mr. Curtis Bennett remarked that where an Act of Parliament sanctioned the doing of any particular thing, and anybody suffered in consequence, the answer was that the Act provided for it, and they must abide thereby. The gentlemen belonging to this company had been sufficiently keen to see that electricity had a great future before it, and had accordingly obtained from the Board of Trade an exclusive right to provide the people of Paddington with that commodity. It was clear that the company had not adopted the best means for preventing the nuisance. He must therefore hold them responsible, and should make an order that the nuisance be abated within nine months, that being the time, he understood, it would take to construct the necessary chimneys. He allowed the Vestry 20 guineas costs.—*Daily Telegraph.*

* Extra scholarships transferred from Group D.

† Extra free studentships transferred from Groups C and D.

COMPANIES' MEETINGS AND REPORTS.

BELFAST TRAMWAYS COMPANY.

The fifty-second half-yearly general meeting of the Belfast Street Tramways Company was held in the offices, Sandy-row, on the 16th inst.

The **Chairman** (Mr. George Richardson) said that with regard to electric traction up to the present they had not been able to come to terms with the Corporation. The Company had made the Corporation a very liberal offer, and the Corporation had made a counter proposal, which he did not think was one that they as directors could possibly advise the shareholders to accept. If the Corporation wished to purchase on fair mercantile terms they were quite willing to entertain a proposal in the interest of the shareholders. The directors had recommended that the Corporation should buy out the shareholders at £20 per share, but they were not going to make the same proposals to the Corporation now. They wanted more money than they had offered to take at the first. The proposals submitted were as follows: The Corporation to give their consent to overhead electric traction and to the doubling of the lines, and to extend the Company's lease for 14 years from 1907 to 1921. The Company to agree to charge a penny fare for any distance whatever on the system as extended. It was explained that this would mean carrying people as far as 6¾ miles for a penny. To pay the Corporation a rent of £5,000 a year. To abide by all structural requirements of the Corporation's deputations on electric traction. To construct and work electrically the following extensions: along Stranmillis-road and Malone-road to Fenaghy-lane; along Lisburn-road, towards Balmoral: along Duncairn-gardens; along Grosvenor-road and Springfield-road; to extend Shankill-road line to the Ballygomartin-road; along Cliftonville-road to Oldpark; along Shore-road to Whitehouse; from Bridge End along Newtownards-road to Ballyhackamore, Knock, and Dundonald; and from Mountpottinger-road along Castlereagh-road. The Corporation were not prepared to treat on the extension of time. The proposals of the Corporation were, briefly, to pay a certain price, to be agreed upon, for the system at the end of the present lease, in 1907; to supply the electric current in the meantime to compensate the Company for any loss arising from an insufficient supply or want of current; the tramways company to construct and work by electric traction such extensions as required by the Corporation; the Corporation to charge the tramways company for supply of current at a sum to be fixed by an independent engineer; and if an agreement was to be arrived at with regard to a Bill to be promoted in Parliament for powers to carry out the proposed changes, the cost of such a Bill was to be borne equally by the Corporation and the Company. He did not think that there was any present prospect of an arrangement being agreed to between the Corporation and the Company.

The reports having been adopted, the **Chairman** proposed the usual dividend, which was accepted.

A vote of thanks was passed to the chairman, the secretary, Mr. Nance (the manager), and directors for their endeavours during the past half-year in the interests of the Company.

SOUTHPORT TRAMWAYS COMPANY, LIMITED.

The fifty-third general half yearly meeting was held in the Albany Galleries, Lord-street, Southport, on Monday, Mr. R. Whittaker, J.P., presiding.

The **Chairman**, in proposing the adoption of the report and balance-sheet and the declaration of a dividend at the rate of 3 per cent. per annum, said the directors were absolutely unanimous in their decision to sell their shares to the British Electric Traction Company for £8 each, and they were strongly of opinion that the shareholders would find it to their advantage to do the same. It was a condition of the sale that the directors retired that day.

Mr. Sheppard seconded the motion.

Mr. Platt (the secretary) said nearly three-fourths of the shareholders had already expressed their readiness to sell. If they did not sell they would have to take the chance of getting what they could some time in the future. Ninety-three shareholders, holding 2,529 shares, had signified their approval, and five shareholders, holding 50 shares, did not want to sell. From the remainder they had not yet heard.

The motion having been carried, a vote of thanks to the chairman closed the meeting.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

The report of the directors presented to the shareholders at the ordinary general meeting held at Bristol on the 10th inst., states that the gross receipts for the half-year amount to £67,246. 16s. 10d., and the working and general expenses and renewals are £49,460. 11s. 6d., leaving a net balance of £17,786. 5s. 4d., which it is proposed to appropriate as follows: interest on 4 per cent. mortgage debenture stock, etc., £2,189. 5s. 4d.; dividend at the

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rate of 6 per cent. per annum (free of income tax) for the half-year ending June 30, £11,000; balance carried to reserve and renewal funds—viz., leased premises redemption, £250; contingencies, £2,520. 3s. 5d.; electrical renewals, £1,000; permanent-way renewals, £826. 12s. 7d.—together, £4,596. 16s. The receipts from the tramways department show an increase of £6,906, and the returns of the carriage department an increase of £732. The total number of passengers (excluding postal riders) carried during the six months on the Company's cars and omnibuses was 10,680,379. After protracted negotiations with the Corporation of Bristol, during which the Council waived the conditions requiring the Company to take their supply of electricity from the Corporation lighting works and as to any payment to the Corporation, an agreement was arrived at, and the Company's two Bills were unopposed in Parliament. It is gratifying to the directors to announce that the Act authorising important electrical extensions of the Company's system, and also the Act empowering the Company to adapt their present horse lines to be worked by electricity on the overhead trolley system, received the Royal assent on July 25. The directors are now actively engaged in the preparations for executing the whole of the works, and have already ordered a large portion of the material required for the construction of the lines. A portion of the large site known as the Counterslip Warehouses, with waterside frontages, has also been purchased for the purpose of erecting thereon the Company's central power station. It is anticipated that the whole of the Company's system will be worked by electricity within two years from the present date. The Board of Trade have intimated that they will in due course confirm the order made by the Light Railway Commissioners authorising the St. George and Hanham Light Railway, and immediately the order is issued the construction of the line will be undertaken. A call of £2. 10s. per share on the £5 paid shares will be made payable on Oct. 1, the balance being probably called up in January next.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The following is the report of the directors (with revenue account) of this Company for the half-year ending June 30, 1898:

In presenting the half-yearly statement of capital and revenue accounts to June 30, 1898, the directors have to report that the gross revenue receipts amount to £37,511. 17s. 5d., and the working expenses to £23,376 5s. 9d. The number of passengers carried during the last two years is as follows:

	Half-year ending Dec. 31, 1896.	Half-year ending June 30, 1897.	Half-year ending Dec. 31, 1897.	Half-year ending June 30, 1898.
First-class	476,817	608,278	621,392	637,547
Second-class	2,473 828	2,618,844	2,790,768	2,686 651
Workmen (special return tickets)	968,489	1,042,138	1,055,330	1,148,743
Total	3,919,134	4,269,260	4,467,490	4,472,941

Revenue Account.

Receipts from passenger traffic amount to	£36,819	18	5
Miscellaneous receipts	691	19	0
	37,511	17	5
Less working expenses	23,376	5	9
	14,135	11	8
Deduct interest on mortgage debentures	3,400	0	0
	10,735	11	8
Add balance brought forward Dec. 31, 1897	2,878	1	11
Leaving available for dividend	£13,613	13	7

Out of this balance your directors recommend the declaration of dividends at the following rates, less income tax, payable on and after Aug. 12 next: 5 per cent. per annum on preference shares, £3,000; 3 per cent. per annum on ordinary shares, £6,750; leaving a balance of £3,863. 13s. 7d. to be carried forward to next half-year.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Maintenance of way, works, and stations	4,160	3	6
Locomotive power	5,937	7	10
Repairs and renewals of carriages	697	5	6
Traffic expenses	8,442	5	4
General charges	2,069	9	8
Law charges	76	10	11
Compensation	33	8	0
Rents, rates, and taxes	1,886	2	3
Government duty	73	12	9
	23,376	5	9
Balance carried to net revenue account	13,844	3	10
	£37,220	9	7

Receipts.	£	s.	d.
Passenger traffic	36,819	18	5
Parcels, etc.	41	18	0
Rents	337	6	2
Transfer fees	21	7	0
	£37,220	9	7

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wimbledon.—The Urban District Council are prepared to receive tenders for the supply, delivery, and erection of pipework. Tenders by 5 p.m. on Aug. 29.

King's Lynn.—The Corporation invite tenders for various works in connection with the electric lighting of the borough. Further particulars appear in our advertising columns. Tenders by Sept. 7.

Bury St. Edmunds.—The Corporation invite tenders for the erection of buildings for their electric lighting station. Further particulars appear in our advertising columns. Tenders by Sept. 10.

Buxton.—The Urban District Council invite tenders for various works in connection with their electric light station. Further particulars appear in our advertising columns. Tenders by Sept. 5.

Liege.—Tenders are invited for the renewal of tramway rails, points, etc. Specifications, etc., can be obtained from, and tenders addressed to, the Secretary, Tramways Est-Ouest de Liège, rue de Hesbaye (Belgium), by Aug. 25.

Madrid.—Tenders are invited by the Postal Department for 22,000 zinc cylinders for batteries. The deposit required is 5 per cent. Specifications, etc., are to be obtained from, and tenders addressed to, the above Department by Aug. 22, at 11 a.m.

Ashton-under-Lyne.—The Committee of the Central Conservative Club, Ashton-under-Lyne, invite specifications and tenders for the installation of the electric light in the club buildings. Tenders to be delivered to Mr. John Moss, secretary, by Aug. 27.

Brussels.—Tenders are invited for the supply of electricity for the lines Liège Vottem and Liège-Beileur. The deposit required is £1,000. Conditions, etc. (10d.) are to be obtained from Société Nationale des chemins de fer Vicinaux, rue de la Science 26, Brussels. Tenders by Sept. 7, at 11 a.m.

Halifax.—The Tramways Committee invite tenders for excavating and forming about five miles of tramway track within the borough. Plans and specifications may be seen, and forms of tender obtained, on application to Mr. Edward R. S. Escott, C.E., borough engineer, Town Hall, Halifax. Tenders by Aug. 24.

Halifax.—The Tramways Committee invite tenders for the supply of steel rails, points, crossings, fishplates, soleplates, tie-rods, bolts, etc., for about five miles of tramways. Plans and specifications may be seen, and forms of tender obtained, on application to Mr. Edward R. S. Escott, C.E., borough engineer, Town Hall, Halifax. Tenders by Aug. 24.

Aberdeen.—The Northern Co-operative Company invite tenders for supplying and fitting up electric wiring and fittings at their loaf and small bread bakeries, meal mill, stables, etc., at Millbank, Berryden, Aberdeen. Copy of specification and schedule may be had from Mr. John Ferries, secretary, 54, Loch street, Aberdeen, with whom tenders are to be lodged by 6 p.m. on Aug. 24.

Glasgow.—The Corporation invite tenders for the supply of 2,000 tons of steel straight-track rails, 200 tons of steel curve rails, and about 120 tons of steel fishplates; or alternatively for 1,000 tons of steel straight-track rails, 100 tons of steel curve rails, and about 60 tons of steel fishplates. Specification, with form of tender and section, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by 10 a.m. on Aug. 22.

Darwen (Lancs.).—The Corporation invite tenders for the erection and construction of the iron and steel buildings in connection with their new refuse destructor at Robin Bank-road, within the borough. Specifications, schedule of quantities, and form of tender may be obtained at the office of the Borough Engineer, where also plans of the site and buildings may be seen during ordinary office hours on payment of £1, which sum will be returned on receipt of a bona fide tender. Tenders by 12 noon on Aug. 25.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Watford.—The Urban District Council invite tenders for the supply and delivery of (1) electricity meters and (2) main cut-outs, for 12 months from Nov. 1. Specifications may be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer to the Urban District Council, Mansion House-chambers, 20, Bucklersbury, E.C., on payment of £1. 1s. for each specification, which sum will only be returned on receipt of a bona fide tender. Tenders, sealed and marked "Electricity Meters" or "Cut-Outs," must be addressed to Mr. H. Morten Turner, clerk, Council Offices, Watford, and delivered by 12 noon on Aug. 31.

Potteries (Staffs).—The British Electric Traction Company, Limited, invite tenders for the provision of materials and construction of the track and permanent way of about 13 miles of tramways (in sections) in the Potteries district of North Staffordshire. Drawings may be seen, and specifications, stipulations, bills of quantities, forms of tender, and particulars obtained, on payment of a deposit of £3. 3s., which will be refunded on receipt of a bona fide tender and the return of the documents, at the Com-

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pany's Permanent-Way Engineer's Office, Donnington House, Norfolk-street, Strand, W.C. Tenders before 10 a.m. on Sept. 5.

Rochdale.—The Corporation invite tenders for the following plant: Specification No. 2: (Section A) boilers, fittings, etc.; (B) economisers; (C) condensing plant; (D) feed pumps, tanks, etc.; (E) steam and exhaust pipes; (F) travelling cranes; (Specification No. 3) switchboards; (4) accumulators; (5) cables. Specifications, forms of tender, and conditions of contract may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 12, Delahay-street, Westminster, on payment of £3. 3s. for each specification, which sum will be returned on receipt of a bona fide tender. Tenders (endorsed "Electricity Works") must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by noon on Sept. 6.

Hull.—The Electric Lighting Committee invite tenders for the supply and erection of certain plant in connection with their electric lighting works. Form of tender and specifications for the following are now ready. Contract 1: one high-speed engine, 750 i.h.p., Willans or Belliss type; (2) one high-tension continuous-current dynamo, with Eickemeyer-wound armature, 460 kw.; (3) two Lancashire boilers, 30ft. by 8ft., for 150lb. pressure. Specifications for any one of the above three contracts may be obtained from Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by noon on Aug. 25.

Patras (Greece).—On Sunday, Aug. 16-28, from 9-11 a.m., will be given out in submission, in the Town Hall of Patras, in presence of the Municipal Council, and in public session, the concession of the lighting of Patras and its suburbs. In case the lighting will be executed by gas, the period of the concession will be for 35 years, or in case the lighting will be executed by electric light or another light, the duration of the concession will be left to the discretion of the competitor, according to the conditions of advice No. 2,222 of this year and according to the register of Feb. 7, 1898, modified by the above advice No. 2,222. Offers are to be submitted under sealed cover. A copy of above-named documents, in Greek or French, to be had on application to the President of the Municipality.

Bangor.—The Corporation invite tenders for the supply and erection of the following plant: (Contract No. I.) two water-tube boilers, economiser, brickwork, and flues; (II.) steam, exhaust, and other pipes, steam pumps, and feed-water heater; (III.) two 60-kw. steam dynamos, balancer, boosters, and 5-ton overhead travelling crane; (IV.) switchboard and instruments; (V.) accumulators; (VI.) mains. General conditions, specifications, forms of tender, etc., may be obtained from Mr. F. Hastings Medhurst, B.Sc., M.I.E.E., the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., on payment of a deposit of £3. 3s. for each section, which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Electricity Works, Contract No. —," must be delivered to Mr. R. Hughes Pritchard, town clerk, Bangor, North Wales, by Sept. 10.

RESULTS OF TENDERS.

Leeds.—The Highways Committee have decided to recommend the Council to accept the complete tender of the British Thomson-Houston Company, Limited, for 50 complete electric cars. It will be remembered that the committee had previously proposed accepting a lower tender, subject to certain conditions as to the kind of material to be supplied thereunder.

BUSINESS NOTES.

Dumfries.—The Corporation are considering the advisability of supplying electricity.

Western and Brazilian Telegraph Company.—The receipts for week ending Aug. 12 were £2,808.

Bolton.—At a meeting of the Electricity Committee on Thursday week a new cable was ordered to be laid.

Newton Abbot.—The *Newton Advertiser* urges the Urban Council to apply for a provisional electric lighting order.

Stockton.—The Urban Council have approved of plans of the Imperial Tramway Company for a building to be erected in Bridge-road.

Darlington.—The application for an electric lighting provisional order is to be fully considered at the monthly meeting of the District Council.

Stirling.—Owing to the difficulties in the way of carrying out Mr. Yorke's electric supply scheme, the Council have decided to abandon the same.

Halifax.—The first car extension contract for the Corporation tramways has been placed with the British Thomson-Houston Company, Limited.

Heckmondwike.—We hear that the District Council have decided to give an interview to a representative from the British Electric Traction Company.

Colwyn Bay.—The District Council have made application to the Public Works Loan Board for the loan of £1,564 for a period of 25 years for the electric works just completed.

Winchester.—We hear that of the 5,000 £5 shares of the Winchester Electric Lighting Company offered for subscription, 2,145 have already been taken up, making a total of £10,725.

Plumstead.—The Vestry will next month consider at a special meeting whether an application should be made to the Board of Trade for a provisional electric order. Meanwhile an expert is to be consulted.

Blackpool and Fleetwood Tramway.—From July 14, when the cars were really got to work, to Aug. 6, the takings amounted to £3,085. 14s.—148 685 passengers—which means £12. 17s. per car for every day.

Llandudno.—The Local Government Board have conferred on the District Council the powers of a parish council, and sanctioned the borrowing of sums amounting to £25,000 in respect of electric lighting works.

W. T. Henley's Telegraph Works Company, Limited.—We are informed that the £25,000 of ordinary share capital offered to the shareholders of this Company, at a premium of £8 per share, has been largely over-subscribed.

Walsall.—The Town Council have decided to oppose the proposed application of the British Electric Traction Company, Limited, for a Bill to confirm a lease of the tramways of the South Staffordshire Tramways Company.

Ilkeston.—A committee of nine has been appointed by the Town Council as a permanent Tramways and Electric Lighting Committee, and all powers connected with those undertakings will be delegated to this committee.

Heywood.—A resolution has been passed to the effect that it is desirable to obtain a provisional order of the Board of Trade under the Electric Lighting Acts authorising the Corporation to supply electricity for public and private purposes.

Belfast.—Mr. G. F. L. Giles, engineer, said, at the meeting of the Harbour Board on the 16th inst., that the temporary arrangement for using the current from the County Down side in the York Dock would be completed by about Nov. 1.

Portsmouth.—The Tramway Committee have been authorised to spend a sum not exceeding £100 in visiting other places for the purpose of ascertaining and reporting to the Council the best system of traction to be adopted for working the tramways.

Buxton.—At a meeting of the Urban District Council on Friday last the Electric Lighting Committee's report was adopted, recommending that application be made to the Local Government Board for sanction to borrow £20,000 for installing electric lighting works.

Richmond.—The report of the committee appointed to take into consideration the question of lighting the asylum, and recommending that it was most expedient to light the asylum by electricity, the installation to be proceeded with forthwith, has been adopted.

Dover.—The tramway receipts last week averaged £45. 8s. 9d. per day. The number of passengers carried during the week was 65,431. It is stated that the expenses of the tram service per day, including repayment of instalment of capital and the interest on loan, was £22. 16s. 8d.

Bath.—Tenders have been invited from Messrs. Verity and Messrs. Singer for an electrolier for the Grand Pump-Room, according to the design presented by the surveyor of works, and the same firms have been also asked to submit their own designs and prices for an electrolier suitable for the room.

Change of Address.—We have been asked to note that in consequence of his appointment as district superintendent of the British Electric Traction Company, Limited, for Glasgow and district, and also (*pro tem.*) for the Newcastle district, Mr. Frank B. Lea's address will be at the company's local office, 45, Renfield-street, Glasgow.

Monte Video Telephone Company.—At an extraordinary general meeting to be held at the offices of the Company, 208, Gresham House, on Thursday next, at noon, resolutions dealing with the rearrangement of the Company's capital, which were passed at the extraordinary meeting held on 10th inst., will be submitted for confirmation.

Cardiff.—When we wrote our last note on the "tender" question, we were misled by a local report, and thought that the point had been definitely settled. However, it appears that the committee have held a further meeting, at which they reversed their former decision, and agreed to recommend the Council to adopt Messrs. Siemens's tender.

St. Helens.—As the result of tenders received recently, the St. Helens Tramways Company have placed an order with the British Thomson-Houston Company, Limited, for 16 complete motorcars. Eight of these will be large bogie cars, with top seats, to carry 68 passengers, and eight will be single-truck cars, with top seats, and adapted to carry 53 passengers.

Western and Brazilian Telegraph Company.—At an extraordinary general meeting of the shareholders in this Company held last week, a series of resolutions having reference to the joint works agreement entered into by them with the London Platino-Brazilian Telegraph and the Brazilian Submarine Telegraph Companies, and already reported by us, were confirmed.

Portishead.—The District Council have discussed the question whether Portishead should or should not be lighted by electric light when the present contract with the gas company expired, on Sept. 29. It was suggested that a small committee be formed to make enquiries in electric lighted towns as to the cost, advantages, etc., of the system, but the motion was not supported.

Lynn.—There was some talk about delaying the electric lighting scheme at the last meeting of the Town Council, but a motion to that effect had to drop on account of a technical matter. It is, however, possible that a special meeting will be called, when a proposition will be made that the proceedings of the Electric Lighting Committee should be stopped until the scheme has been further discussed.

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Leigh (Lancs.).—Mr. W. O. E. Meade-King, Local Government Board inspector, has held an enquiry into the application of the District Council for sanction to borrow £10,500 for electric lighting work It was stated that the works would be at the gasworks, and it was only proposed, at present, to supply the compulsory area, the whole of which was within half a mile of the generating station, under the Board of Trade order.

New Books.—"Electricity in Town and Country Houses," by Percy E. Scrutton. Cloth, 2s. 6d. Archibald Constable and Co., 2, Whitehall-gardens, Westminster.—"The Workmen's Compensation Act," by W. Addington Willis, LL.B. Fifth edition. Butterworth and Co. and Shaw and Sons.—"The Wonderful Century: Its Successes and Failures," by Alfred Russell Wallace. Swan Sonneschein and Co., Limited.

Runcorn.—At a special meeting of the Urban District Council last week it was unanimously resolved that application be made to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the Council to supply electricity for public and private purposes. A rumour that the Council intended to hand over these powers when obtained to the Runcorn Gas Company was contradicted.

Wednesbury.—The Town Council have passed a resolution expressing the desirability of all the local authorities within the district of the South Staffordshire Tramway Company taking steps with a view to purchase the tramway lines within their respective districts, and also of opposing the proposed application to Parliament of the British Electric Traction Company, Limited, for a Bill to confirm a lease of the tramways to that company.

Whitehaven.—The Town Council have decided to alter the amount in the application to the Local Government Board for borrowing powers on account of electric lighting from £7,500 to £12,000.—It appears that the committee have had numerous complaints of the constant breaking of lamps; and as the lamps now adopted are somewhat more valuable than ever they had been before, it is stated that in future the committee will be compelled to prosecute.

Accident.—At Oldham, while the electric light in the street lamps was being extinguished, a violent explosion occurred, it is supposed, by gas which had escaped into an electric wire main beneath the pavement becoming ignited. The footpath was torn up for a distance of 50 yards, and several persons were thrown into the roadway and sustained serious shock. Fortunately the explosion took an outward direction, otherwise the shops in the vicinity must have suffered.

Liverpool.—Sections of the cars for the tramways are being received every week at the Lambeth-road carriage works of the Liverpool Corporation, where they are being painted, decorated, tested, and finished prior to being turned out ready for practical use. It is expected that there will be altogether about 28 cars on the two routes, and these are of two descriptions—the "double bogie," with a central entrance, and the single four-wheeled vehicle, with an entrance at each end in the usual way.

Hastings.—The Guardians have discussed a report advising them to have an electrical plant to light the new buildings at a cost estimated at between £400 and £500. It was pointed out that the cost would not be so much as it appeared at the first glance, because it was proposed that the building should be warmed by hot water, and for this they would have to have a boiler and an engine. A man would have to be appointed to look after the boiler, and it was thought he could also attend to the dynamo. The wiring would cost £200. The Board did not agree with the proposition.

Newcastle.—At the meeting of the City Council on the 12th inst., in reply to the question whether the reports of the experts appointed to report on tramway traction had been received and when was it proposed to call a meeting of the committee, the Mayor said the report of Dr. Hopkinson, who reported on electrical traction, was received on July 16. They were waiting for the report of Mr. Colam, who was reporting on cable traction. He understood that Mr. Colam had been unwell, but his report was expected in a few days. It was agreed that each member of the Council should receive a copy of the reports.

Royal Palaces.—The work of lighting Balmoral Castle with electricity, which is now in progress, will not be completed until quite the end of this month. There are to be 600 lamps, and there will be more than 1,000 when the electric light is extended to the stables and outbuildings. The water is brought from the River Gelden through half a mile of underground pipes to the turbine-house, which is more than a mile from Balmoral. The current is to be transmitted to the castle by cables laid underground.—The stables and courtyard of Marlborough House have this week received a generous allowance of electric lamps.

Banbury.—The Town Council have received a notice from the Urban Electric Supply Company of their intention to apply for a provisional order for electric lighting within the borough. It appears that in order to obtain the Town Council's approval of that application the company would be prepared to insert clauses in the provisional order providing that the Council might purchase the undertaking, if they wished to do so, at an early period, and the giving of special terms for the supply of the electric current for public purposes. The matter has been referred to the General Purposes Committee to procure all information and suggested terms and report to the Council.

Mirfield.—At the meeting of the District Council last week, the following resolutions were carried: (1) "That in the judgment of the Council it is expedient that the Council should oppose the application proposed to be made by the Electrical Power Distribution Company for a provisional order to supply electrical energy in the district of Mirfield, and that the Council refuse to give their consent to the granting of the order by the Board of Trade." (2) "That in the judgment of the Mirfield District Council it is expedient that they should make application to the Board of Trade for a provisional order authorising them to supply electrical energy in the area of the Council's jurisdiction, and that the clerk be instructed to call a meeting to take the necessary steps for carrying out this resolution."

Blackpool.—It appears that telephonic charges run pretty high here. The total cost of altering, repairing, and maintaining telephonic communication between Corporation departments is £156. A local paper says: "The net profit on our electricity works is curiously enough put down on p. 60 of the borough treasurer's statement for the year at £1,414. 18s. 4d., but in Mr. Quin's report it is put down at £1,819. The following are the exact words of Mr. Quin's report: 'Actual revenue from supply and rentals, £12,631; and from other sources, exclusive of public lighting, £197; making a total of £12,827. Our expenditure on working account was £7,152, and amount set aside for interest and sinking fund was £3,856. The net actual profit was, therefore, £1,819.' It appears to be made up by £405, due for interest on suspense account, and for the replacement of old cables."

Bootle.—From the proceedings of the Watch Committee, which were confirmed last week, it appeared that the town clerk had reported an interview with Mr. Musker regarding deductions from the contract, and stating that he would undertake to complete the main building by Oct. 31, and the chimney by Dec. 31. The committee resolved that Mr. Musker should be informed that the committee could not agree to a lump-sum contract, and that he be requested to meet Mr. Reid with a view to an agreement being arrived at with regard to the proposed deductions; that the arbitration clause in the police buildings contract be inserted in Mr. Musker's contract; and that Mr. Musker be allowed to Nov. 30 to complete the chimney, provided the main building be completed by Oct. 31, and the proposed extension of time does not conflict with Messrs. Parker's contract. The question of the sufficiency of the specification was left in the hands of the town clerk, the borough engineer, and Mr. Reid.

Yarmouth.—The *Norwich Mercury* publishes a letter from the Rev. Canon Rogers, vicar of Yarmouth, written to his parishioners, and says his comments on the need for more trees and up-to-date trams is deserving of corporate attention. We quote from the letter a reference to Germany: "Almost everywhere are electric trams. They go well, they are cheap, they are not noisy, they have superseded the rumbling omnibus, they are much more adapted to meet the wants of the people of to day, and they go without accidents down very narrow streets. Why does not Yarmouth open its eyes and look how other towns go ahead? It seems that when some further development has taken the place of the present electric trams, the Yarmouth authorities will begin to adopt them, and I have grounds for my argument, for now that large numbers of towns are giving up omnibuses, Yarmouth is adopting them, therefore by parity of reasoning when trams are only used in sleepy and second-rate places they will be adopted here. Alas, if vested interests stop the public good."

Hardware Shelf Box.—Heller's steel boxes, now introduced by Messrs. James Keeves and Sons, Limited, of Shoreditch, into Great Britain for the first time, are useful for dealers who display upon their shelves small but heavy goods, and especially is this the case with ironmongers, tool dealers, and kindred trades. The body of the box is made of galvanised steel plate of sufficient strength to stand handling for many years without injury, front and back ends are made of ⅜in. wood, and wood ends are secured to the body by the steel plate being embedded into their substance on both sides and bottom; they are further prevented from parting company by steel wire brads, which are driven from inside of box through wood and steel, but not long enough to show outside, making the whole box very secure, and with the advantage of a perfectly smooth outside surface both front and back. They are made with a variety of ends, also plain, stained, or polished. On side of box a depression is stamped in the steel plate and painted with special preparation; the particulars of cost, selling price, etc., can be written upon it, and if contents or particulars are changed, former particulars can be removed and fresh instructions added. The use of these boxes ought to secure a great saving of room and time, and also improve the appearance of shelving by doing away with the dust-collecting paper parcels.

Huddersfield.—The town clerk has been instructed to renew the application to the Postmaster-General for a license under the Telegraph Acts to enable the Corporation to establish a competing telephone system and also to obtain the necessary parliamentary powers to enable the Corporation to carry out such license. The following was added to the minutes at the last meeting of the Town Council: "Unless the Government in the next session of Parliament introduces and passes into law a Bill authorising the Post Office authorities to grant licenses to local authorities for the installation of a telephone service containing borrowing powers and other powers similar to those afforded by the Electric Lighting Acts." A recommendation was also made that the town clerk be instructed to make an application to the Board of Trade for sanction to the borrowing of £7,454. 0s. 4d. for the construction of the Outlane tramway, and that the Board be asked to fix the period of 30 years for the repayment of the money. It was suggested that the manager take the necessary steps for obtaining the rolling-stock for the construction of the said tramway, and that he proceed with the construction. The Chairman of the Tramways Committee said it had not yet been decided to proceed with

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electric traction on the tramways. A great deal depended on the arrangement they made with the Linthwaite Council as to whether they took charge of the running over their lines. Should the Huddersfield Corporation decide to do so, then it would be for the Council to decide as to whether electric traction should be adopted.

Canterbury.—Mr. Hammond has reported to the Council that the boilers are completed and the engines well advanced. The dynamos have long been in a similar forward condition. He had also approved of a working model of the brush-holders. All details of steam-pipe work, etc., had been settled for many weeks past, and the contractors hoped to deliver in three or four weeks' time. They also hoped to deliver the feed pipes and tanks in four weeks' time. He had recently furnished the builders with a plan of cable ducts for leading the cables under the floor from the switch-board to the dynamos. The work of main-laying had been progressing satisfactorily. He had instructed the clerk of the works to use bricks for covering the cables instead of wood, as the former involved less expense. The present applications received for the supply of current represented the equivalent of about 2,200 8 c.p. lamps, distributed as follows: private consumers—2,200 lamps at 30 watts, 66 kw.; Beaney Institute, 200 watts, 6 kw.; school of art, 100 watts, 3 kw.; corn exchange, 100 watts, 3 kw.; public lights—incandescents, equivalent to 400 lamps at 30 watts, 12 kw.; arcs, 13 lamps at 550 watts, 7 kw., giving a total of 97 kw.; or, as compared with the working capacity of the generating plant, two 75-kw. plants, 150 kw.; less set in reserve, 75 kw.—total, 75 kw.; plus set of accumulators, 2½ hours' discharge, 75 kw. In the present building there was room for an additional plant of 150 kw. or 200 kw. capacity or even more according to design; 150 kw. would be the size best adapted for working in with the plant already contracted for. A new boiler would be necessary, and an extension of the boiler-house for same. The cost of one set of plant of the 150-kw. size would be: one 150-kw. steam dynamo (Belliss compound engine), £2,100; one 30ft. by 8ft. Lancashire boiler and stoker, £520; steam feed and exhaust pipe, £150; extension to boiler-house, £250; foundations for engine and boiler, £250; switchboard and connections, £90; fees and contingencies, £340—total, £3,700. There was no recommendation to borrow money before the Council.

Greenock.—At the meeting of the Police Board on the 16th inst. the report was submitted of the deputation appointed by the Electric Lighting Committee to visit various towns in connection with electrical matters. The report was of a favourable character, and concluded with a recommendation to appoint a resident electrical engineer at a salary of not more than £300. The Provost, in moving the adoption of the report, said, according to the *Glasgow Herald*, it was necessary they should proceed as soon as possible, because they had again the opposition of the North British Electricity Company, and it would also be necessary to make it plain to the Board of Trade that they were in earnest. He hoped therefore when the report was passed that the committee would at once proceed as indicated by them. Bailie Cook seconded. Treasurer Anderson remarked that, whatever personal views they might have on the subject, he feared that from a public point of view they had no alternative but to go on with the installation, and if that were not done they must be prepared to stand aside and let the company do it. He did not anticipate that there would be any need to levy a rate on the community, but rather that there would be a slight profit after meeting all charges. Mr. Nicolson moved as an amendment that the report be deferred for further consideration, which was seconded by Mr. M'Callum. These gentlemen contended that the ratepayers had not been properly consulted, or had the question adequately explained to them. Bailie Dr. Calder, who with Treasurer Anderson and Mr. Cameron had formed the Visitation Committee, spoke in favour of the report, pointing out particularly that where electricity had been introduced the gas consumption had increased. The Provost, replying on the discussion, said that ample opportunity had been given by advertisement for any opposition to the proposal before the deputation went to London. Only four persons had come forward; three were distinctly against electricity, and the fourth opposed it on the question of street lamps. But the North British Company had ascertained from them that there was a decided want in the town for an electric installation. On a division the report was adopted.

Appointments Vacant.—A large mill in Yorkshire require an engineer to take charge of high-speed engine and dynamo, accumulators, etc., and to do installation work. Only men of considerable experience need apply. Wages 35s. per week. Apply, stating age, experience, and with copies of recent testimonials, to E. F. M., 139-140, Salisbury-court, Fleet-street, London.—The Electric Lighting Committee of Watford invite applications for the appointment of an electrical engineer to superintend the laying of mains and the erection of the plant in the lighting station about to be erected, and afterwards to take charge of the station. Applicants should be good engineers, and competent to test mains, meters, etc. Experience in alternating-current plant essential. Salary to commence, £150 per annum. Applications, endorsed "Electrical Engineer," stating age and previous experience, together with copies of three recent testimonials, to be forwarded to Mr. H. Morten Turner, clerk, Council Offices, Watford, by 24th inst.—The Corporation of Derby invite applications for the post of engineer and manager of the Derby electric installation. Salary, £350 per annum, with privilege of taking two pupils. The Corporation provide office clerks, etc. The person appointed to devote the whole of his time to the duties of the office. An abstract of the principal duties, qualifications, and conditions of appointment may be obtained on application to Mr. H. F. Gadsby, town clerk, Town Hall, Derby. Applications, stating age, present occupation, and qualifications, with copies of not more than three recent testimonials, to be delivered to the Town Clerk, endorsed "Electrical Engineer and Manager," by 31st inst., at 12 noon. No canvassing allowed.—An electrician is required for cleaning, adjusting, and testing Brockie-Pell double-carbon arc lamps. Also, a meter clerk. Preference given to shorthand and type writer. Apply, stating age, experience, salary required, and enclosing copies of testimonials, to B. W., 139-140, Salisbury-court, Fleet-street, E.C.—The Northampton Institute require an electrical engineering draughtsman and designer to take charge of classes. For particulars of this and other vacancies we refer to our advertisement columns.

Sheffield.—The City Surveyor has reported to the Tramways Committee on the question of using macadam on streets where tramrails are to be laid. He says: "In accordance with the request of your committee I now give reasons for so strongly condemning the adoption of the system of constructing the tramways in suburban roads, either with a sett on each side the rail, and macadam in the middle, or with macadam only, as was suggested at the last committee. The chief disadvantages are: (1) the impossibility of keeping an even surface to the road where macadam and rails join. This is difficult in the case of macadam and setts, but it would be far worse if the setts were abandoned, because (*a*) the rails and macadam are of very different degrees of hardness, (*b*) it is scarcely possible to make a good joint between the two, (*c*) the vibration of the rails would soon shake the macadam loose. (2) The road would have to be constantly under repair, causing additional expense, as well as inconvenience to frontages along the routes. (3) The macadam between the rails could not be satisfactorily rolled and would always be loose. It would be difficult to put down on account of the setts or rails. (4) It would soon wear hollow and hold water. (5) On gradients this hollow would in times of heavy rain act as a watercourse, and the macadam would gradually be washed away. (6) The track could not be properly cleansed, and it would be nearly impossible to keep the rails free from mud in wet weather. This is much more important with electric traction than with horses, and the rails would wear much quicker. Before giving my opinion to the committee, I was quite conversant with the methods of construction adopted in nearly all the large towns of England, but I thought the members might like to have the opinions of the different surveyors. I have, therefore, written to them and obtained a large number of replies. Generally, the replies are most favourable, and my opinion is unaltered. Many of the surveyors speak of macadam paving for tramways in the most unfavourable terms, and I feel certain if the system is adopted it will prove a costly failure. In view of the above facts I feel bound to say I cannot take the responsibility of advising the committee to lay rails without paving of some description for the full distance between the rails and 18in. beyond. In all cases where the roads are narrow, I think it would be advisable and economical to pave them across from kerb to kerb. It is argued that when the electric trams are running they will practically monopolise the track. If this is the case, the objections to paving on the grounds of slipperiness and noise practically disappear." The report was ordered to be entered on the minutes.

PROVISIONAL PATENTS, 1898.

AUGUST 8.

17080. Improvements in electrical transcribing apparatus. Ernest August Hummel, 6, Lord-street, Liverpool. (Date applied for under Patents, etc, Act, 1883, Section 103, Jan. 10, 1898, being date of application in United States.)

AUGUST 9.

17113. Improved means for automatically sounding electric alarms or the like. Josef Werner and Josef Dietz, 18, Fulham-place, Paddington, London.

17161. Improvements in automatic switches and cut-offs. Francis Calvin McMillin, 321, High Holborn, London. (Complete specification.)

17162. An improved electric accumulator. Léon Lejeune, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Section 103, Jan. 25, 1898, being date of application in France.)

17163. Improvements in sound transmitting, recording, and reproducing apparatus applicable to telephones, gramophones, and the like. William Phillips Thompson, 6, Lord-street, Liverpool. (Emile Berliner and Joseph Sanders, United States.) (Complete specification.)

17191. An improved automatical contact breaker for electric railways and the like. Johann Christian Schäfer and John Lörintz, 18, Buckingham-street, Strand, London. (Complete specification.)

17193. Improvements in the method of and means of drying the insulation of electric cables, armatures, bobbins, and the like. Emil Passburg, 18, Buckingham-street, Strand, London.

AUGUST 10.

17225. Improvements in or relating to electric plug contacts. Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, London.

17253. Improvements in electric telegraphs. Walter Judd, Beechcroft, Hook-road, Surbiton.

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17267. Improvements in incandescent electric lamps and other electrical apparatus wherein glass bulbs or vessels are used. Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

17268. Improvements in secondary batteries or electrical accumulators. Oskar Behrend, 47, Lincoln's-inn-fields, London.

AUGUST 11.

17345. Improvements relating to electric bells. Georg Otto Lentschat, 18, Buckingham-street, Strand, London.

17354. Improvements in electrically-propelled vehicles for common roads. Charles Jeantaud, 47, Lincoln's-inn-fields, London.

17358. Automatic electric time switch. Arthur Booth Webber, 837, High-road, Leytonstone, Essex.

17359. Improvements in electrodes for electrically obtaining ozone. Dan Martini, Ivy Lodge, Tilford, Surrey.

17371. An improved electric battery and bell combined. Gustave Markt, 166, Fleet-street, London. (Markt Bros. and Co., Germany.)

AUGUST 12.

17378. Improvements in methods of electric haulage. George Cawley and Benjamin Howarth Thwaite, 29, Great George-street, Westminster, London.

17380. Improvements in drums for holding electric cable. Thomas Oxley, 18, St. Ann-street, Manchester. (Complete specification.)

17390. An improved clip and carrier combined for attaching to shades, globes, reflectors, and the like and for attaching the same to electric incandescent lamp holders. Edward Duckenfield, 31, Gold-street, Northampton.

17407. Improvements in and in apparatus for the magnetic separation of materials. Alexander Melville Clark, 53, Chancery lane, London. (The Metallurgische Gesellschaft A. G., Germany.)

17418. Improvements in or relating to electric tumbler switch appliances and their base plates. Charles Markt, 166, Fleet-street, London.

AUGUST 13.

17451. Improvements in electric current indicators. Thomas Wilcock Varley, 20, Bucklersbury, London.

17458. Improvements in primary electric batteries. Alec Alfred Beadle, Beadonwell, Belvedere, Kent.

17488. Improvements in electric secondary batteries. Illius Augustus Timmis, 2, Great George-street, Westminster, London.

17507. Improvements in or relating to switch devices for electric tramways. Ernst Andreas, 111, Hatton-garden, London.

17517. Improvements in telegraph apparatus. Maiche, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Louis Maiche, France.)

17522. Improvements in means for transmitting motion from electric motors to other machinery. William Geipel, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1897.

14741. Electric alarm apparatus for clocks. Skee.

17142. Electro-mechanical apparatus for the control of electric motors. Dulait.

17315. Process for electrolytically purifying and filtering saccharine liquids or solutions. Meygret.

17410. Method of and means for producing the synchronous rotation of two axes situate a considerable distance apart. Abel. (La Société Anonyme pour la Transmission de la Force par l'Electricité.)

17694. Electric generators for cycles and other vehicles, and a device for attaching and adjusting same. Moores and Farrell.

17695. Armature cores of permanent-magnet dynamo-electric machines. Moores and Farrell.

19696. Electrical ploughs. Edwards. (Gansel.)

20455. Electric igniter for internal-combustion engines. Jensen. (White and White.)

20943. Construction of guards or protectors for incandescent electric lamps and other glass or breakable articles. Dickson and Brown.

21366. Electric arc light reflector. Bolles.

21623. Electric connecting devices applicable to lampholders, wall plugs, and the like. Menges.

1898.

4903. Primary batteries. Fuller.

12636. Electric switches. Dixon.

13682. Electric incandescent lamps. Saglier and de Marçay.

13707. Electro-acoustic telegraph with Morse transmitter. Flechtenmacher.

13721. Suspended electroliers. Cunnington.

13781. Automatic electric block signal systems for railways. Werner.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended Aug. 15 were £1,743, as compared with £1,516 in same week of 1897, being an increase of £227.

Birmingham Tramways.—The traffic receipts for the week ending Aug. 13 were £3,687. 19s. 9d., as compared with £3 360. 7s. 2d. for same week in 1897, being an increase of £327. 12s. 7d.

Dover Tramways.—The traffic receipts for the week ending Aug. 13 were £259. 13s. 7d. The total receipts for the year 1898 are £4,571. 6s. 5d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending Aug. 12 were £2,869. 19s. 4d., compared with £2,706. 15s. 10d. for same period of last year, being an increase of £163. 3s. 9d.

South Staffordshire Tramways.—The traffic returns for the week ending Aug. 12 were £580. 16s. 3d., as compared with £577. 15s. 7d. in same week of 1897. The aggregate receipts for the year are £19,853 3s. 2d., as against £20,150. 13s. 8d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended Aug. 14 were £923, compared with £837 for same week of 1897, being an increase of £86. The total receipts for the half-year amount to £6,785, compared with £6,283 for the same period last year, being an increase of £502.

Dublin S.D. Tramways.—The traffic receipts for the week ending Aug. 12 were £1,039. 2s. 7d., as compared with £752 12s. 0d. in the corresponding week in the previous year, being an increase of £286. 10s. 7d. The number of passengers carried was 146 304 in 1898 and 109.611 in 1897. The aggregate returns for the half-year are £6 687. 17s. 6d., as compared with £5,347. 9s. 3d. last year, being an increase of £1,340. 8s. 3d. The mileage open is 9 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11 xd
Brush Company, Ordinary	2	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9½-10½
——	6	5⅞-6⅛
—— Pref. Half-Shares	1	1¼-1⅜
—— " "	5	4¼-4½
Charing Cross and Strand	5	12-13 xd
—— 4½ per cent. Cum. Pref.	5	5½-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	25-26
—— Prov. Cert. 90,001-100,000	5	24½-25½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70 72
—— Ordinary	3	2¾-3¼
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½ 15½
—— " " " '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— " " "	6	8½-9½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞ 2¼
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130 xd
—— Preference 5 per cent. Stock	100	142-145 xd
Edison and Swan United Ordinary	5	2½-2⅝ xd
—— 5 per cent. Debentures	5	4-5 xd
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2⅜-2½
—— 7 per cent. Cumulative Pref.	2	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅛ ¼
Elmore's Wire Company	2	1½-1⅝
W. T. Henley's Telegraph Works, Ordinary	10	21-22
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	112-117
House-to-House Company, Ordinary	5	8½-9½
—— 7 per cent. Preference	5	9½-10½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	6-6½
Oriental Telephone and Electric Company	1½	⅝-¾
Royal Electrical Company of Montreal	—	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	2	3-3½
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	100 103
Waterloo and City Railway, Ordinary	100	125-130
Westminster Electric Supply, Ordinary	5	15-16 xd
Yorkshire House-to-House	5	3½-3¾

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NOTES.

Great Gooseberries.—These are now in season, as is shown by the following extract from the *Electrical Review* of New York: "The bears of Maine are said to eat the insulators on electric lines, mistaking them for crab apples, of which they are very fond."

Mechanical Stoking.—An interesting test has just been completed by Mr. James Lang at the power-house of the Toronto Railway Company with a view to getting at the actual results of a mechanical stoker as compared with hand firing. A three-day test was made on an improved Jones underfeed mechanical stoker, resulting in a saving of fuel of 15·2 per cent., or an increased evaporation for equal fuel of 17·93 per cent.

Central-Station Tips.—We have always been impressed by the comparatively small faults which have occasioned breakdowns in electric lighting plant. We also have noticed that each central-station engineer has a particular regard for a particular way of guarding against what he considers likely to happen. A collection of these tips as to central-station management we propose to give from time to time in our "Notes."

A Franklin Institute Gold Medal.—The above institute is considering the advisability of awarding at each of its annual meetings a gold medal to the inventor or discoverer whose work has within the previous five years signally promoted the arts and manufactures. A special committee has reported favourably on the proposal, and from its report we know that the awards would not be confined to the United States.

Fatal Accident.—We regret to have to announce that Mr. Elward Edwin Glanville, of Trinity College, assistant to Signor Marconi, the discoverer of wireless telegraphy, met with a fearful death on Tuesday at Rathlin Island, off Antrim coast, by falling over a cliff 300ft. high. Signor Marconi and another assistant were at the time at Ballycastle, on the mainland, conducting experiments in wireless telegraphy with the deceased on the island, which is some miles off the coast.

The Pacific Cable.—At a recent meeting in Sydney of the Premiers of Queensland, New South Wales, and Victoria, the Pacific cable question was again discussed. It was eventually decided to make a definite offer, that if Great Britain and Canada would collectively guarantee five-ninths of the cost of laying the cable, the Premiers would recommend their respective Legislatures to contribute one-ninth each, while New Zealand will be asked to contribute the remaining ninth.

An Optical Exhibition.—The Spectaclemakers' Company has arranged to hold an optical exhibition in the ballroom at the Mansion House during the week commencing Oct. 3. The Lord Mayor will formally open the exhibition, which is to be for astronomical, mathematical and scientific, in addition to optical instruments. Mr. H. C. Kemp, of 7 and 9, Thavies-inn, Holborn-circus, has, by desire of the Court, undertaken all the details in connection with the exhibition, and full particulars can be obtained on application to him.

Champertous.—The committee of the Law Society have looked carefully into a case in which a solicitor acting for a client in a series of libel actions entered into an agreement with him to the effect that one-third the damages recovered were to go to the solicitor. After a full and exhaustive enquiry, the committee of the Incorporated Law Society found, with reference to this agreement, that, "although made *bonâ fide*, it was champertous and illegal and ought not to have been entered into." This is all very well, but surely some penalty can be attached to the illegal act.

The Projected Iceland Cable.—The long-projected scheme for the laying of a telegraph cable to Iceland, in which the Great Northern Telegraph Company of Copenhagen is largely associated, is now, says the *Financial Times*, about to be carried into practical effect. The cost is estimated at 450,000 kroner, of which the Telegraph Company will contribute 300,000, whilst the remainder will be provided by the Iceland Althing. The cable will be laid *vid* Scotland to the East Coast Islands in such a manner that it will be possible to place all the important parts of the island in telegraphic communication with the whole world.

New Cable to the Philippines.—It is stated on the rather weak authority of an American newspaper that "on July 20 the Executive Council of the Hawaiian Government signed a contract with the Pacific Cable Company to lay a cable between the United States, Hawaii and Japan, China and the Philippines, the contract being for a period of 20 years. The company has, it is said, been operating quietly with the co-operation of the Government and Hawaii, pending the annexation proceedings." It is added that the work of laying the cable is to be completed within six months, and that most of the surveys have already been taken. The price to be paid is said to be £2,000,000. We doubt if the Executive Council of the United States first foreign possession has the power to spend millions in the way indicated.

Brussels Lighting.—*L'Electricien* gives an interesting *résumé* of the electric lighting work done by the Municipality during the year 1897. At Dec. 31 there were three stations, with a total capacity of 1,650 kw. The cables were laid along 27 miles of street. This represents an increase of 22·6 per cent., while the number of connections made increased by 52·3. Of the 739 consumers there are 180 taking under 25 16-c.p. lamps; under 50, 223; 50, 233; 100, 207; 200, 40; 300, 35; 400, 22; 600, 10; 800, 2; 1,000 and over, 10. Including 770 arc lamps and 28 motors there was an equivalent of 47,371 16-c.p. lamps, or about one lamp per yard of street traversed by the cables. The maximum demand put upon the system was 8,765 amperes, equivalent to 17,530 16-c.p. lamps, or 37 per cent. of the total number. The total sales were 973,739 kilowatt-hours, producing £23,478, or 5·76d. per kilowatt-hour. The profits amounted to £8,900, or 4 per cent. on the cost of the installation.

The Oldham Explosion.—The true facts of this explosion in an electric light conduit were given last week by the gas and water works superintendent, Mr. Andrew, to the two committees interested. He stated that about 10 o'clock on the night of the 11th inst., an explosion of gas occurred in Bottom-o'-th'-Moor, by which the electric light culvert for a distance of 54 yards was damaged, and the footpath disturbed. The cause was a leak in the gas-main, the gas getting into the culvert. It was ignited by a spark from the switch in a lamp-post when the light was being extinguished. The work of repair was commenced shortly afterwards, and was so far completed the following day as to allow current to be again supplied in the immediate vicinity and the district beyond. The man who was turning out the light, and a girl who happened to be on the footpath at the time, were thrown down, and the latter sustained slight injury—principally from shock. No damage was caused to the adjoining property. The leakage of gas was 120 yards away from the point of the explosion, and where the ignition took place.

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Told in the Dynamo Room.—Under this title the *Electrical Review* of New York is publishing a series of anecdotes, written in the Sunday school dialogue style, in which Ned, Jim, and Gus are introduced. Some of the stories may be edifying, but the last one we have seen is utter bosh. Ned describes a case in which a boiler in an electric light station became so highly charged with static electricity that it was necessary to protect the hand with a bunch of waste when turning on steam. The story finishes in the following eloquent language: "Ned paused and waited for some remarks from either of his listeners. Neither spoke for a while. Finally, Benson said: 'Well, Ned, I think I am beginning to see the point. It was the escaping steam under high pressure that caused some of your static current to be generated, electrifying the piping.' 'Yes, that was it,' replied Ned. 'Simple, isn't it?' 'Yes, when you know how,' gravely remarked Gus." This is most edifying, and we only hope that Ned knew how to mount a boiler so that it had no attachments to earth.

Chesterfield and Midland Counties Institution of Engineers.—The annual general meeting of the above institution will be held on Saturday next, 27th inst., in the Stephenson Memorial Hall at Chesterfield. The business before the meeting will be as follows: the election of officers for the year 1898-99; the election of representatives of the institution upon the council of the Institution of Mining Engineers for the year 1898-99; the general report of the council and their financial report (with abstract of the audited accounts of the past year) will be presented, and then the president-elect (Mr. W. D. Holford) will deliver an address from the chair. The following papers will afterwards be open for discussion: "Suggested Rules for the Recovery of Coal Mines after Explosions," by Mr. W. E. Garforth; "Internal Corrosion of Wire Ropes," by Mr. T. G. Lees; "Explosions in Air Compressors and Receivers," by Mr. T. G. Lees; "Photographs of Flashes of Electric Detonators," by Mr. L. W. de Grave. The following paper will be read, or taken as read: "Electric Blasting" (Part IV.), by Mr. William Maurice.

The Advantages of Water Power.—In connection with our central-station tips, Mr. J. O. Ritter, the engineer of the electric light and power station at Limavady, in Ireland, sings the praises of a water-power plant. He evidently believes in Ireland, and from his remarks scarcity of water is not the trouble in Limavady that it has been in some of our English stations. Thus, Mr. Ritter has one man only to run the station, and his duties are simple. Between dusk and midnight he has to regulate the gate of the turbine to suit the load and to keep the voltage constant, but at midnight he goes to bed and lets the station run itself. The alternate-current system at 1,100 volts is used for lighting, and the station is 2½ miles from the town. In the morning the supply is stopped, and power distributed by direct currents from another machine. As a result of the above low labour charges and the absence of a coal bill, the station is easily able to compete with gas at 5s. 10d. per 1,000 cubic feet. The whole plant is an easy one to work, and the turbines give a very even speed, thus avoiding all flickering at the lamps. Mr. Ritter adds that he should like to have a 10,000-h.p. station on the same system in Ireland.

Earth Return for Telephones.—We are surprised to see that Major-General Webber, in a letter to the *Times* on the report of the Select Committee, questions the advisability of insisting generally on metallic returns for telephones. This, he considers, is not supported by any adequate evidence. Major-General Webber acknowledges that "one motive of the Post Office for advocating the use of 'double wires' is obvious enough. They do not wish to admit any subscriber to their exchanges who, by electing to confine the use of his telephone to his own locality, does not want to use their trunk lines, and who would thus (except in towns where the effects of induction may be serious) be entitled to claim to be charged at a lower rate for a 'single wire.'" Surely the writer, who is also a supporter of light railways, which, in certain cases, will be worked electrically, does not advocate the extensions of the earth return even for country districts. The noises arising from such returns have certainly given much trouble in towns, but with the spread of electric lighting and electric traction through the villages, it would not be wise to neglect the past warnings. We know of one town where an alternate-current supply is given through concentric cables, and where an earth-return telephone is practically useless when the street lamps are on.

Sir W. Crookes on the Periodic Law.—Sir William Crookes has recently submitted to the Royal Society some suggestive observations on the difficulty that has been experienced in placing the newly-found constituents of air in their proper niche in the scheme of arrangement of the elements which we owe to the ingenuity and scientific acumen of Newlands, Mendeléeff, and others. In order to facilitate this arrangement of the elements according to the periodic law, Sir W. Crookes has imagined them as ranged in space in a figure-of-eight spiral. The result is remarkably consistent. With regard to the new atmospheric elements, it is observed that until recently chemists knew no element which had not more or less marked chemical properties; but now, by the researches of Lord Rayleigh and Prof. Ramsay, we are brought face to face with a group of bodies with apparently no chemical properties, and forming an exception to the other chemical elements. Sir W. Crookes suggests that, in his proposed scheme, these elements—helium, argon, and krypton—naturally fall into their places. Helium comes between hydrogen and lithium; argon between chlorine and potassium; and krypton between bromine and rubidium. There are places for many more inert bodies, some of which, Sir W. Crookes suggests, will eventually be discovered in the solid form.

Dundee Institute.—We have received the annual report of the Dundee Institute of Architecture, Science, and Art, which is presented in a neat little volume. The illustrated descriptions of the visits paid by the students are most interesting, both from the architectural detail given in the illustrations, and also from the lively and well-written descriptions. As a sample of this, we give the following extract from the description of the visit to the Edinburgh and Blackpool Observatory: "Our special attention was called to a picture on the right-hand side of the platform, which is said to contain a likeness of the donor of the hall. The scene evidently represents a 'capping' ceremonial, but suggests the apotheosis of the 'sweet girl graduate.' A female figure sits at the top of a flight of steps, while another figure, apparently a male, is in the act of crawling up on all fours to receive the reward of his diligence. The scene seems to point to the far past, or is it prophetic? The sculpturing and decoration of the building is, of course, on a magnificent scale. Everything appears to have been done handsomely and regardless of cost. The organ, which, it may be remarked, was not in the original plan of the building, has been erected by the Hope-Jones Electric Organ Company, of Birkenhead. It is in seven different pieces, but has been so placed as not to look as if it was an afterthought."

Light When Wanted.—The lighting of a central station for the generation of electrical energy should always be carefully designed and the illumination should be ample.

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Visitors to the station are then impressed with the possibilities of lighting by electricity; but what is still more valuable, the staff will have plenty of light to work by. Another point is that dirty corners and ill-kept machinery always are more conspicuous in a good light, and are hence not likely to be met with in a well-lighted station. Another point sometimes overlooked, however, has been brought to our mind by Mr. C. Newton Russell, of Shoreditch. It is that the station lights should be supplied from an independent source, which will not be affected by a sudden breakdown of any one unit of the plant or by the bursting of a steam-pipe. Thus a breakdown in the main steam-pipe will shut down the station, and then to have the place in darkness is not conducive either to presence of mind or quick repairs. Mr. Russell has arranged at Shoreditch that the whole of the lights in the works are connected up to the storage battery independent of the main switchboard, so that if all plant was shut down, and the main battery fuses blown also, there would still be sufficient light in the works. This would enable the staff to put matters right. This, although a detail, is in our opinion a very important one.

Resistance of Steel.—Mr. A. Carnot has recently presented to the Académie des Sciences a note by Mr. Le Chatelier on the electric resistance of steel of various compositions—in fact, the author has repeated and extended the now historical researches of Dr. John Hopkinson on the same subject. Mr. Le Chatelier has conducted a large series of experiments, and in every case gives both the specific resistance of the sample and its chemical constituents. Taking the specific resistance (microhm-centimetre) of various samples with different proportions of carbon it is found to vary from 10 with ·06 per cent. carbon to 19 with 1·61 per cent. carbon. The other constituents, such as manganese and silicon, also vary, so that it is difficult to allocate exactly the effect on any one. Still, the author concludes that the specific resistance increases at least seven microhm-centimetres for every 1 per cent. of carbon by weight. Proceeding in the same way with samples having various proportions of silicon, the author finds that the specific resistance increases about 14 microhm-centimetres for each 1 per cent. by weight of silicon in the steel. With alloys of steel and manganese the increase is not regular, as has been shown by Mr. Hadfield. Still, the increase is about five microhm-centimetres per 1 per cent. of manganese by weight. Nickel also gives variable results, while chromium, tungsten, and molybdenum have little influence on the resistance of samples of steel.

A Canadian Power Scheme.—We understand from the *Canadian Engineer* that Mr. Henry Symons, Q.C., has just returned from England with the estimates he has had prepared here for the construction of the proposed works of the Welland Power and Supply Canal Company. This project involves the construction of a canal from the Welland River to the brow of the mountain at Thorold, a distance of eight miles; the construction at Thorold of a power-house, and from Thorold to Lake Ontario, a raceway by which to carry water into the lake. In addition to these different works, estimates were obtained for the construction of a transmission line from Thorold to Toronto by way of Burlington Beach. The estimates obtained by Mr. Symons were prepared by Dr. J. Hopkinson, F.R.S., Sir Douglas Fox, Mr. Edmund Wragge, late of Toronto, and Prof. W. C. Unwin. The estimate for the machinery to generate 100,000 h.p. is £125,000; for transmission line to Toronto at a voltage of 10,000 and delivery of 50,000 h.p., £801,600; for excavation and other work connected with the undertaking, £1,525,062. The total estimate therefore amounts to £2,452,162. If the amount to be delivered in Toronto is reduced to 20,000 h.p., the project would cost £200,000 less. It is also stated that if the contract could be secured from the cities of Toronto and Hamilton for a considerable quantity of power for a definite term, there would be little difficulty in raising money for the project in Great Britain.

A Controller with a Non-Magnetic Blow-Out.—The design of a lasting controller for putting motors in series or parallel connections is largely a question of contacts. Unless the arcing at the contacts is kept down, the controller will in time burn itself out. The magnetic blow-out is perhaps the neatest way of preventing this arcing, but when one firm owns the patents for the best way it behoves other engineers to devise alternative methods. On the Waterloo and City line Messrs. Siemens Bros. arrange that the contact is always broken by an auxiliary switch with carbon contacts, which are easily replaceable. The contacts of the controller then are only employed to make contact, and hence are not damaged. The breaking switch is actuated by the revolving of the main controller handle, which is turned about seven times in going through the complete cycle of connections. Mr. Robert Lundell, the designer of the Lundell motors, using a somewhat similar idea, has adopted the following details. The auxiliary switch is in this case driven electrically, and the blow-out in this switch is mechanical. An electro-magnet of the cup form, with a large-diameter plunger, gives the necessary stroke to the disc carrying the switch contacts. The iron plunger slipping into the centre of the solenoid acts as the ram of an air-pump, and delivers a blast of air just at the instant contact is broken. Auxiliary contacts on the controller complete the relay circuit which actuates this secondary switch.

Cork Electricity Works.—We have received some excellent electric lighting tables prepared by Mr. Charles H. Merz, resident engineer, Cork. From these we gather the ordinary house lights which are in use regularly four hours per day will can be charged at 2¾d. per unit, and that lights in basements and other dark places which are kept on all day will be charged at the very low rate of 1½d. per unit. The table gives the comparative costs of gas and electric light for various purposes, such as shop windows, hotels, outside lamps, etc. For instance, the cost of a gas-burner in a shop window, which is alight on the average two hours per day, would be 9s. 8½d. per annum, whereas an electric lamp under the same conditions would only cost 9s. 1½d., or a saving of 7d. per light per annum. The more light used, the greater reduction is made on the cost of gas. A lamp which is required to be used all day long costs but £1. 9s. 2d. per annum, against £5. 16s. 8d. per gas-burner, or a saving of £4. 7s. 6d. The system of charges so provides that, for the first two hours' average, 4½d. will be the price per unit, and all electricity over this will only be charged at 1d. per unit. Mr. Merz has also prepared a pamphlet explaining the advantages of installing electric motors in the place of ordinary engines. The average charge for motors installed in Cork would be from 1d. to 2d. per horse-power per hour. For those not wishing to purchase motors, these can be hired at various establishments in the city at a moderate rental, with the option of purchase at any time.

The Influence of an Engineering Training.—Mr. H. G. Prout addressed recently the graduating class of the Stevens Institute of Technology on the mental and moral influence of an engineering training. He said that "for some generations society had agreed to leave to the engineer the care of friction and gravity, but natural depravity has been left to ministers, lawyers, editors,

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teachers, the mother of families, to anyone, in fact, but the engineer; and this is where society made a mistake. The best corrector of human depravity was the engineer, because he must deal with conditions, while others may deal with symptoms. It was the good fortune of the engineer that sophistry and ignorance will surely kill him professionally, and that his success will be in direct proportion to what he actually knows and to his determination and power to reason straight. If he does not know the stresses in his bridge or engine, if he does not know the endurance of his material, if he does not design his structure according to what he knows, he cannot long pretend, even to himself, to be an engineer. Nature, calm and unrelenting, always stands looking at him. No other man in the world has such stern and unceasing discipline, and so it comes about that no other man is so safe a moral guide as the engineer, with his passion for truth and his faculty of thinking straight. This is no mere statement of a theory, but of observed facts. The speaker had over and over again discovered that he got a sounder opinion on any matter of human conduct from the engineers of his acquaintance than from men of any other calling; and this is chiefly because nature has taught them that their opinions are worthless unless they are severely reasoned from known facts. Other men, especially ministers and editors, get the dangerous trick of thinking that their opinions are valuable merely because they are their opinions."

Outside Assistants.—The battle between automatic gear *versus* hand gear is always being fought in our various electric light stations, and the advantages on one side or the other vary like the swing of a pendulum. The great point claimed for automatic appliances is that they are labour-saving devices, and that with them the labour charges are kept down to a minimum. This may be so, but in certain cases the labour required to keep the automatic arrangements in order is more than the cost of the labour required for the original operation. In one item Mr. H. L. P. Boot, of Tunbridge Wells, has obtained free labour to enable him to do by hand what would require some considerable automatic apparatus to do electrically. The operation is the turning on and off of the incandescent lamps on the arc lamp pillars. The arcs are turned off from the station about midnight, and the policemen then act as lamplighters, and switch on the incandescent lamps, which are connected to the low-pressure mains. As the police are on duty at all times of the night, the switching on of these lamps forms a pleasant diversion for them, and the operation may even be looked upon in the light of a time check. The system works well, and, what is more, it costs nothing. In a district of London another labour-saving device has been instituted, so that the working of the incandescent gas lamps in the streets may be properly supervised, which has our complete approval. In this parish the vestry have been furnished with a number of postcards on which complaints of any defective lamps can be made. In this way the revenue of the Post Office will be much increased, and also, we fancy, the revenue of the firm who has secured the contract for the supply of mantles. We know of no better preparation than the above for a number of councillors or vestrymen before asking them to vote on the introduction of arc lamps for street-lighting.

American Municipalities.—The League of American Municipalities held its second annual meeting at Detroit recently. From the reports which have reached us so far we do not gather that the league has yet made great progress in inducing the municipal authorities to dispense with the assistance of companies in the supply of public necessities. Still, the league is a step in the right direction, and it is the fault of individual municipalities that the municipal rights have in so many American cities been given away. At the above meeting Mr. T. S. Murray, mayor of Denver, read a paper on "Remuneration to cities for franchises rights in, over, and under public streets and alleys. What remuneration, if any, should be exacted from light, water, street railway, telephone, and subway corporations, and how should it be collected?" In support of the municipalisation of such work, Mr. Murray said: "The streets and alleys of a city are the heritage of the people, and should never be given away for the aggrandisement of any private corporation. Mayors and councils are merely trustees for the management of the business of a municipality, but they frequently act as if they themselves were the owners in fee simple of the public highways, and had the right to dispose of them at will, giving away the valuable possessions of the people without any consideration of the rights of their immediate constituents or of the succeeding generations. All the public utilities of the municipalities should be retained in the hands of and under the management of the people themseives, and no private corporation in any American city should have any more right to control the water we drink than the air we breathe." When, however the speaker came to the question of remuneration for franchises he was less clear, and did not adopt the bold course of advising the city either to do the work or else of letting a company do what the city rulers felt they were incapable of carrying out.

Gas Explosions.—The editor of the *Gas World* moralises in his last issue on the two recent explosions of gas in electric light conduits, and naïvely remarks that "the problem of ventilating electric light conduits has not been solved yet." He considers "that the explosion at Oldham was due to an accumulation of gas and a faulty electric conductor, and one in the St. Pancras district of the Metropolis to an accumulation of gas and a naked light. Fortunately, in neither case was there any damage done, beyond the tearing up of a portion of roadway. In the metropolitan case the electric light was cut off from a part of the area of supply for a short time, but that need not be called an exceptional occurrence. As is usual in such cases, the gas is blamed on one side and the electricity on the other, but, perhaps, the fairest thing would be to divide the blame between them. Although gas is not made to be blown into electric light conduits, it will get there on occasion, despite all precautions, and as a general rule it would be harmless there were the electricians' wires all that they should be. It would appear as if such accidents could only be avoided by making the electric conduits inaccessible to gas or by a thorough system of ventilation, but as both plans would involve considerable outlay, the chances are that the unoffending public will be allowed to unwittingly run the risk of being suddenly shot into the air for some time longer." Even on the *Gas World's* own showing, the latter explosion was not in any way due to the electric mains, as out of the two explosions electricity was only responsible for the ignition in one case. The calm way our contemporary regards the faults in gas-mains as incurable surprises us. The electric undertakers have spent and are spending much to keep down gas accumulations in their street boxes and conduits, and have a right to expect the gas companies to be equally careful to keep their mains free from leakage.

The Boiler-Room Staff.—Before the Canadian Electrical Association Mr. James Milne recently read a paper on "The Steam End of an Electricity Supply Station." This paper was an addition to a previous one by the same author advocating economy rather than low first

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cost in electrical machinery. The author's advice *re* the specification and purchase of steam plant is practically followed by our consulting engineers in England. We thoroughly endorse the policy advocated of giving bonuses for good steam consumption figures, and also wish that the penalty clauses were sometimes enforced. As regards stoking, however, the author's remarks are worthy of special note. He says: "Good men are scarce, and nowhere is this more noticeable than in the boiler-room. Good firemen are very scarce, coal shovellers numerous. In his estimation, credit is not given to the firemen that should be. If a plant is run fairly economically as far as coal consumption is concerned, the engineer is more apt to get this credit, but as a matter of fact all he does is to turn on the steam and see that the bearings are oiled. Now and again he may walk into the boiler-room to ascertain if the fireman is asleep or not. To have good firing the greatest of skill has to be manifested to get the best results from the coal, and where we are dependent on skill to get first-class results we are depending on a very uncertain quantity. Too much latitute is given the fireman in the matter of coal, and he has it in his power to make or lose nearly a dividend for the company that employs him. Attention is being given to this subject by the largest steam users in the country, whereby the duties of the fireman are being greatly relieved by mechanical devices; their action being positive and not dependent on skill, the machines thus taking the place of the brains of the fireman. This is a great step in advance, and makes central-station management very independent regarding firemen."

Gas-Engines.—At the end of last month Mr. W. Carmichael Peebles read a most interesting paper before the North British Association of Gas Managers, entitled "Some Notes on the Modern Commercial Gas-Engine." In a brief historical review of the past, Mr. Peebles took the invention of the Otto cycle as starting the era of practical gas-engines. This cycle was first suggested in 1862 by Beau de Rochas, a French scientist, who clearly recognised the advantages of compression. Still, nothing much was done till some 15 years after that date, when Messrs. Otto and Langen started to use the cycle for their engines manufactured at Deutz. Messrs. Crossley Bros. secured the patent rights to make these engines in England in 1878, and enjoyed the monopoly for nearly 10 years. The author summarises the great changes which have taken place in the engine since first brought out by Otto as (1) the method of igniting the charge; (2) the adoption of lift valves in place of the slide valve; (3) the increase of compression. These all appear exceedingly simple matters, and one is apt to wonder how so many years of constant endeavour and continuous work were required to bring about these changes. Those, however, who have done any original experimental work, and have a knowledge of the intricacies of the gas-engine theory, will allow that the great advance made within the course of 25 years or so has been well, and even quickly, brought about. Compression has been continually on the increase ever since the adoption of the lift valve. In the early days compression ranged between 25lb. and 30lb. per square inch, while now the ranges found are generally between 70lb. and 90lb. per square inch, depending on the size of the engine. The author proceeds to describe in detail the various other advances made in small parts connected with gas-engines, such as the use of firing tubes, whether of iron or porcelain. He advocates strongly the use of a timing valve for firing the charge. He concludes that there can be no doubt that a great deal has yet to be done to improve the action of the gas-engine. The main direction in which a change must be looked for is, he thinks, in the cycle. But this would seem almost impossible without introducing complicated mechanism. At present—at least with the smaller sizes—the successful competition of the gas-engine with the steam-engine is chiefly due to the convenience and economy with which the gas-engine can be operated, especially for intermittent work. With engines above 40 h.p. or 50 h.p., using producer gas, the cost of working, as compared with steam, is very greatly in favour of the gas-engine, as has been proved time after time. He thinks, therefore, that the large gas-engines will not stop at 400 h.p. or 500 h.p., but increase gradually year by year, until they compete in power with the largest steam-engines made.

English Traction Practice.—It is quite refreshing to find that, after all, the English practice in electric traction is not all taken from America. As Prof. A. B. W. Kennedy concisely said, "There is no fetish in electric traction, as one is asked to believe by certain experts." Good engineering with careful forethought is required, and this is more likely to be given in England than in the States, where the financial aspects rule. We take the following from the *Electrical World*, and are glad to see our contemporary acknowledges that "in one detail of electric traction work the English have standardised a practice superior to anything in the same line in America. This practice is the use of what are known in England as switch pillars. They consist of cast-iron cases, generally placed above the ground, located near the sectional insulators of the trolley line, and containing a group of switches by which any one of the various parts of the feeder and trolley system may be cut out if necessary. As a rule, each pillar contains four switches, by which the four lengths of overhead trolley wire running in the two directions on the up and down tracks may be connected or disconnected from a 'bus bar, and one or more switches by which the feeders passing that point may be tapped into the same 'bus. Obviously by opening the proper switches in adjacent pillars, which are generally about a half a mile apart, one section of the overhead trolley wire on one track may be opened in case of trouble without interfering with the current supplied to any other part of the system. If the feeders are looped into the pillars their sections may be similarly cut out. We gather that in the States several practices in this detail are to be found. Some roads tie their whole overhead system together, depending on the ability of their generating stations to burn out earth contact. Others insulate their various sections from each other absolutely at the sectional insulators, running separate feeders to each section. Some engineers favour the bridging of the sectional insulator by a connection brought through a box on the pole in which there may be a switch or fuse or both. In case there is a short-circuit on any section, as soon as the circuit breaker supplying the feeder of that section from the switchboard opens, the current taken by the short-circuit comes through the fuses and blows them, insulating the section and rendering its supply of power controllable by the station switchboard attendant. In case of fire or other trouble on account of which it may be desirable to take the power off from any section of the line, this can be done by the switches at the sectional insulators and the feeder switches at the main switchboard. By this arrangement the feeders help each other out to a certain extent on unequally distributed loads, and in case of trouble current supplied to the sections may be controlled by the power station." After reviewing the various methods of feeder connections used in America, the editor concludes that the English system is the best, as by means of the switch pillars all the feeders and the trolley lines are cross connected, utilising all copper in the most advantageous way for the conduction of current.

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BRADFORD CORPORATION ELECTRIC TRAMWAYS.

The Corporation of Bradford have the honour to have led the other municipalities in the matter of electric lighting, and, in spite of the pioneering difficulties to be overcome in the early days, have secured for the townspeople a good supply of cheap electrical energy. Encouraged by the success of this department, the Corporation have now started the first of their electric trams. Thanks to the advice available from the various officials of the Corporation, these trams have been equipped in the best possible manner, and the new departure bids fair to be quite as successful as that of the electric lighting of the town.

Ever since the opening of the first horse tramway in Bradford in January, 1882, the Corporation officials have been most earnest in their endeavours to enlarge and improve the tramway facilities of Bradford. The steep gradients were soon found to be prohibitive to the extension of the horse-car lines, and although horses are still used on the first tramway, all of the later lines have been operated by mechanical traction. The motive power has been steam, the trains consisting of a tramway engine of the usual type, drawing a double-decked passenger car. This system has held full sway for the last 15 years, and in the service offered the public has had all the advantages which careful and efficient management on the part of the steam tramway officials could secure. However, the disadvantages of steam traction for street service are two well known to require description here, and the Corporation are to be congratulated in having succeeded in introducing electric traction.

Of the two electric lines for which contracts were let in February last, one, the Bolton-road line, is now open to the public, and the second, the Great Horton line, is practically complete, and will probably be opened before the end of this month. Judging by the satisfaction with which the electric lines have been received by the Corporation and the citizens of Bradford, it seems to be not too much to predict that before many years this progressive municipality will enjoy all the advantages of a complete system of electric tramways, serving every part of the city and its suburbs.

JOSEPH COWGILL, ESQ.,
CHAIRMAN OF THE BRADFORD TRAMWAYS COMMITTEE.

MR. J. H. COX,
CITY SURVEYOR.

MR. W. H. S. DAWSON,
DEPUTY CITY SURVEYOR.

MR. ALFRED H. GIBBINGS,
CITY ELECTRICAL ENGINEER.

Before describing the new electric tramways, a few words regarding the other Bradford systems may be interesting. The Manningham section, built in January, 1882, was the first of the Bradford tramways, horses being the motive power, as previously stated,. The track is 4ft. gauge, and was laid on the Wimby and Levick system, which consisted in fastening the 65lb. per yard rail to a ½in. by 12in. continuous base-plate, and supporting the whole on a solid bed of concrete, the rails being held in position by the granite setts of the pavement. The gradients are light, the line extending from the top of Darley-street, along Manningham-lane, Oak-lane, St. Mary's-road, and

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North Bank-road to Victor-road, a total distance of about 2¾ miles. The Leeds-road section was built in January, 1882, and, although constructed as above described, was operated by steam-engines made by Messrs. Kitson and Co., of Leeds, and later by engines constructed by Messrs. Thomas Green and Sons, of Leeds. Both types of engines are now to be seen in operation. The route traversed was hilly, generally of over 1 in 20 gradient, and over two miles in length. In September, 1882, the Sun Bridge-road and Thornton-road line, extending from the centre of the town to Four Lane Ends, was constructed and operated in the same manner as the Leeds line. The gradients were somewhat steeper, being over 1 in 16. The total length of the line was 2¼ miles. With the construction of the Manchester line in September, 1884, the base-plate was omitted, and 103lb. per yard girder rail was used with tie-rods. The change in the method of construction was due to the lighter rails not standing the traffic of the heavy locomotives necessary to work the steep gradients. The steepest grades were 1 in 19, and the average 1 in 22, the line extending from the centre of the town to Bankfoot, a distance of a little over 3¼ miles. The Keighley road, opened in January, 1885, used horses for about three years over a distance of 1½ miles, but finally resorted to steam. The Allerton road, which was an extension of the Sunbridge-road section, extended from Four Lane Ends to the village of Allerton, something over 1½ miles distant. The Cheapside and Otley road, opened in October, 1888, extended from Forster-square on one side to Undercliff, and on the other along Cheapside and Manor-row, and formed a junction of the Manningham line at the end of the North-parade. The steepest grade was 1 in 15, and the total length a little over 3½ miles. The Bridge-street and Wakefield-road line was opened in July, 1893; was over 2½ miles long, with a steepest gradient of 1 in 14, and an average of 1 in 20.

The steam trams of Bradford make over 2,500 car miles per day, and over 30 engines are used. The Board of Trade speed regulation does not allow a maximum speed of over eight miles per hour. The permanent ways of all of the Bradford lines have been constructed by the Corporation. The larger portion is operated by the Bradford Tramway and Omnibus Company, Limited, under the supervision of Mr. Walter Vaux, manager. The Manchester-road line is operated by the Bradford and Shelf Tramway Company, with Mr. A. R. Fearnley as manager.

The Bolton Electric Tramway Line.

The construction of the Bolton-road section was commenced in March of this year, and the formal opening took place the latter part of July last. Commencing at Forster-square, opposite the General Post Office, this line extends along the Bolton-road, past Peel Park to Idle-road, a distance of 1 mile 1,517 yards. There are 1,727 yards of single-track line and 1,575 yards of double-track line. The total rise is about 326ft., and the steepest gradient is 1 in 16 for a distance of 70 yards. The track construction and the erection of the car barns was done by the Corporation under the direct supervision of the city surveyor, Mr. J. H. Cox, and his assistant, Mr. W. H. S. Dawson. The construction is the same as for the steam tramways, 103lb. rail with heavy fishplates and an extra plate fastened under the flange at all of the joints. Cast-steel points and crossings are used. A special feature is a short section of drain rail every few hundred feet, to prevent the water entering the concrete. This arrangement is patented by Mr. Dawson. The track is bonded with No. 4/0 B. & S. crown bonds, fastened in the web of the rail under the fishplates, and therefore being only about 6in. long. Cross bonds are used, and every precaution taken to get the full advantage of the conductivity of the rails.

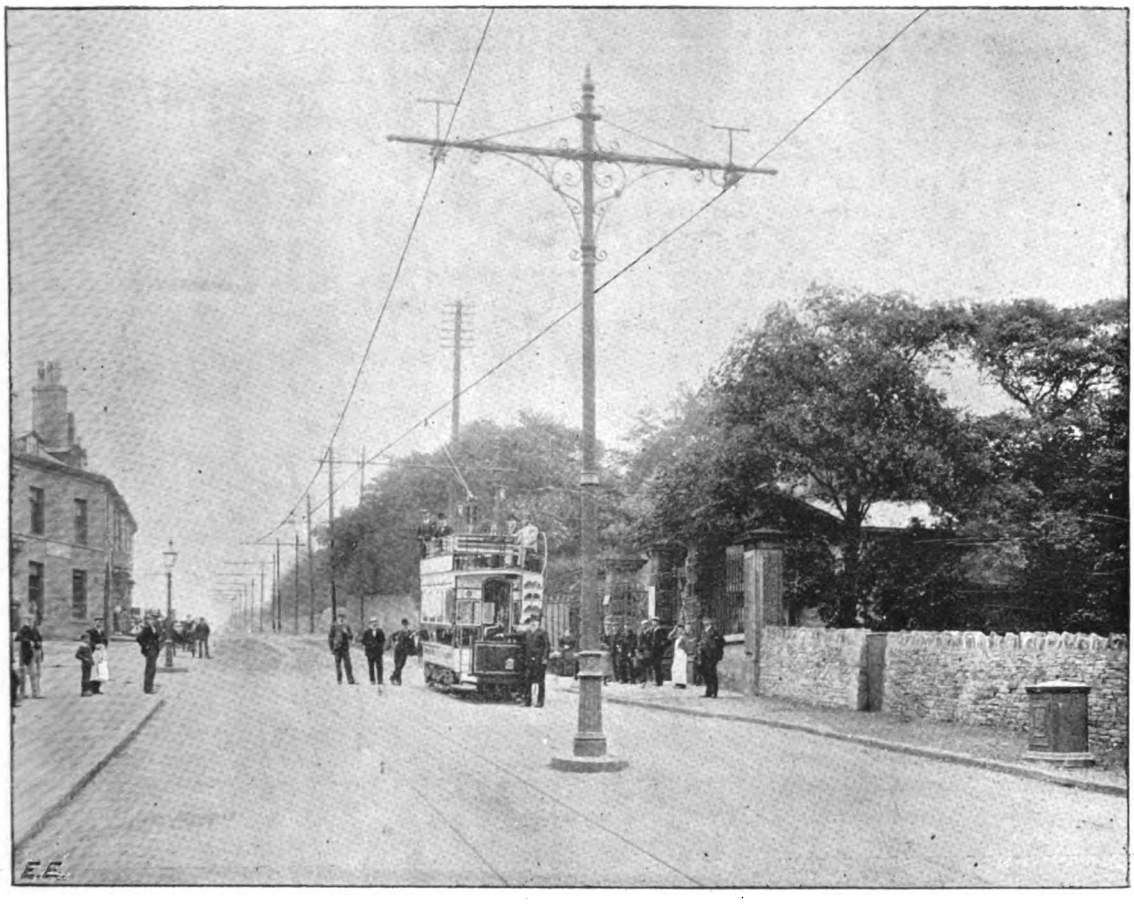

Fig. 1.—View of the Central-Pole Construction at Bradford.

Car-Shed.—The car-shed is situated at the Idle-road end of the line, and is a substantial piece of work, with a capacity for about 16 cars. It consists of a wrought-iron framework covered with corrugated galvanised sheet iron. The tracks are all built on piers, and ample space is provided below for inspecting the motors.

The Great Horton Line.

The Great Horton line, which will be opened to the public about Sept. 1, was commenced at the same time as the Bolton line, and the construction has been similar in every respect. The line starts from the centre of the town, and runs practically up-grade the whole distance

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of 3½ miles up to the terminus on the Great Horton-road, where the car-shed is situated. This building is very similar to the Bolton car-shed, but capable of holding 20 cars. There are 1,496 yards of single track and two miles 1,132 yards of double track. The total rise is 612ft., and the maximum grade about 1 in 14 for a distance of over 240 yards. The line also has many sharp curves, some of 38ft. radius. There is a loop line connected with the Great Horton-road which will supply tramway facilities to and from the Bradford Cricket and Football Grounds.

Power-House.—The power for operating these tramways is being supplied from the Corporation lighting station, the generators being arranged so that they may be used for either lighting or power work. This station has been thoroughly described several times in our columns during the past years. The tramway switchboard, however, is entirely new. It consists of seven panels—four generator panels of the usual type and two feeder panels, each arranged for the two feeder circuits. A Board of Trade panel with the requisite testing instruments is placed between the feeder and the generator panels. The complete board was installed by Mr. Robert W. Blackwell, of London. It is of black enamelled slate, and presents a very handsome and finished appearance.

Line.—In the line work on the Bolton and Great Horton roads both the centre-pole (Fig. 1) and the side-pole (Fig. 2) systems are used. The poles are 31ft. long and buried 6ft. deep and set in concrete. They are fitted with cast-iron joint rings, bases and tops, and wrought-iron ornamented brackets. The guards around the base of the centre poles, instead of being faced with stone in the ordinary way, consist of a heavy cast-iron ring, projecting about 5in. above the pavement, and of sufficient diameter to protect the pole from passing vehicles. The cast-iron ring is filled with concrete, and then faced off neatly with cement. The guard presents a very neat appearance. Fig. 1 gives a very good idea of the general construction of the line. On the right is one of the section boxes, in which are the switches and fuses controlling that section of the line. The whole line is divided up into half-mile sections, in accordance with the Board of Trade requirements, each section being connected to the feeders through one of these boxes. Guard wires, also divided into sections, are erected at all points where the line is crossed by telegraph wires. Fig. 2 shows the single-track construction, with side poles and brackets. There are no overhead frogs, the trolley wire being double throughout the entire length of the line. Copper trolley wire, 0·325in. diameter, is used. For the guard wire, steel cable is erected. The feeders are armoured, and are all underground. The trolley wire is connected to the feeders through the switches and fuses in the section boxes.

Lighting.—The lighting of the two tramway roads will be well provided for under the plan laid out by the Corporation's electrical engineer, Mr. Alfred H. Gibbings, by which the alternate poles throughout the line will be fitted with arc lamps.

Cars.—There are 16 cars—seven for the Bolton and nine for the Great Horton line. The car bodies were made by the Brush Electrical Engineering Company, Limited, at Loughborough. They are comfortable, and of handsome appearance. They are fitted with bell pulls both inside and out, and have both green and red signal lamps. The seating capacity is 22 inside and 23 outside. There are two incandescent lamps on the roof fixed in watertight globes, and two lamps for signal lights, and six lamps inside the car for general lighting. The trolley used is of the swivel type and is the standard Dawson trolley.

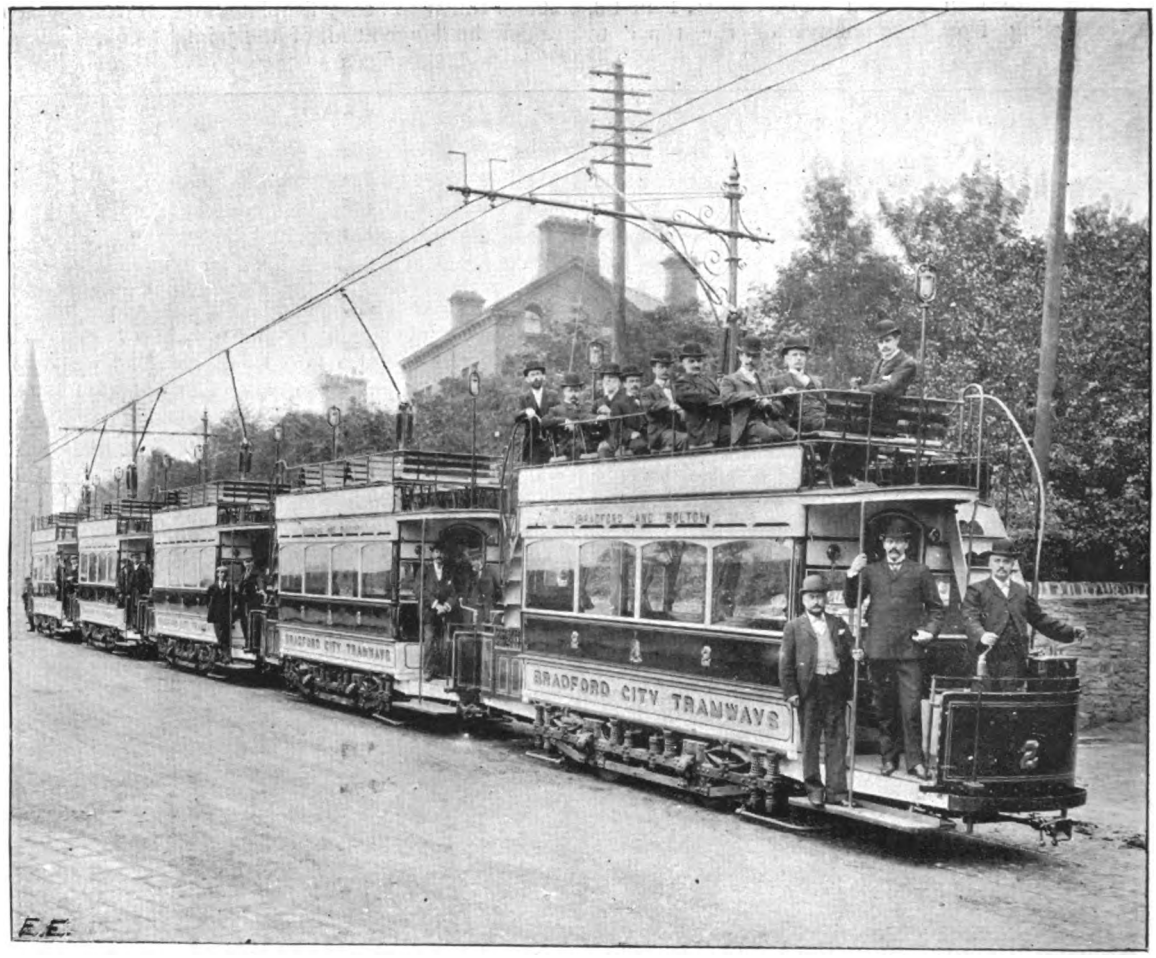

FIG. 2.—View Showing Side-Pole Construction.

Trucks.—The trucks are standard Peckham cantilever trucks; they are 15ft. long, and fitted with 30in. wheels, and equipped with roller bearings supplied by the Roller Bearings Company, Limited, of London.

Motors.—The motors are known as the Westinghouse No. 49 slow-speed, single-reduction railway motor. This type is completely enclosed, and is seen in Figs. 3 and 4. The field or stationary portion consists of two steel castings accurately fitted together, with four inwardly projecting laminated steel poles firmly held together and cast into the yoke. This method of construction ensures a very powerful magnetic field, and eliminates the losses due to

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eddy currents. The two halves are hinged together on the side opposite to the axle, and can easily be opened for inspection of the interior parts. The field coils, armature, commutator, etc., are completely enclosed. There is, however, an opening with a spring lid that permits of inspection of the brushes. The field coils, of which there are four, are machine wound and thoroughly insulated. The armature is of the drum type, the coils, which are machine wound, resting in slots around the periphery of the laminated core. Ample means are provided for ventilation of the core and conductors. The commutator is composed of hard-drawn copper segments, insulated from each other by sheets of mica, ample margin for wear being allowed. The brush-holders, which are especially strong and rigid, are secured to the upper field casting, and provision is made for adjusting them radially to allow for wear of the commutator. The dimensions of the bearings are amply large. The bearings and oil guards are outside the motor casing, thus rendering it impossible for oil to reach the armature field coils or commutator. Either grease or oil, or both, may be used for lubrication, the bearings having a grease cup above and an oil reservoir with wick feed below. The gears and pinions are wide faced and of ample size to stand the heavy strains of tramway service. They are enclosed in an oil-tight casing, and the lower teeth are continually submerged in oil. The motors are supported on the axle by bearings similar to those above described, and at the other end by a lug from the top field casting. This lug is secured by a link to a cross-piece, which is supported with spiral springs at each side of the truck.

Controller.—The controller (Fig. 5) is of standard Westinghouse manufacture, and is known as the No. 90 brake controller. It is of the series-parallel type, and is designed on the same general lines as the other controllers used by the Westinghouse Company in their tramway work. The special feature of this controller is that it is arranged so as to utilise the motors as electric brakes. The motors are reversed, and are thus made to act as generators, the current so generated being passed through graduated resistances. By increasing and decreasing the amount of resistance in the circuit the braking action may be regulated at the will of the driver. An excellent feature is that only one handle is used for both power and brake, the driver simply pushing the handle in one direction for driving the car ahead and in the opposite direction for braking. The operation of this method of braking is found to be most satisfactory. The car may be brought to a standstill very gradually and without the slightest jar or discomfort to the passengers. On the other hand, in case of emergency, the car may be stopped very quickly. The principle of converting the motors into dynamos and thus making use of their braking action has been applied before for the purpose of an emergency brake, but several operations have been usually necessary on the part of the driver to accomplish the desired result. By the system used at Bradford a thoroughly efficient brake for regular

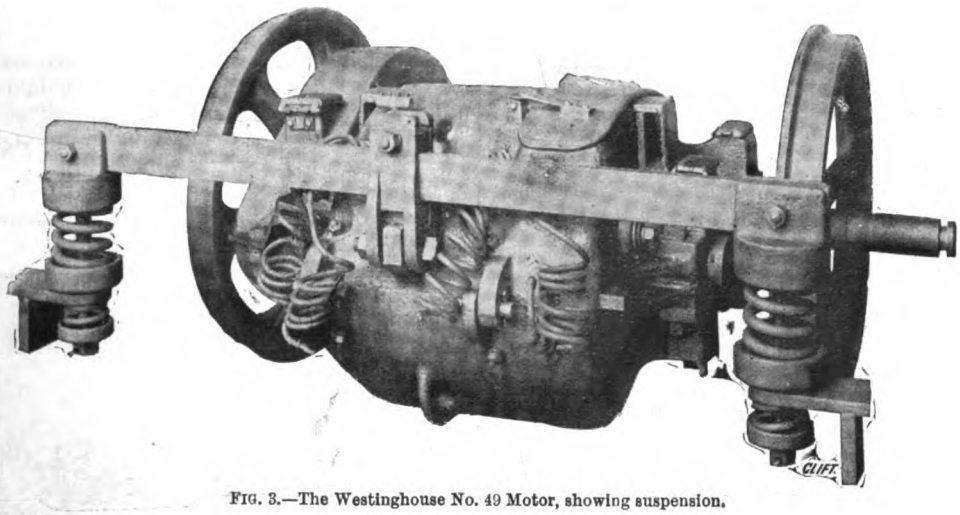

FIG. 3.—The Westinghouse No. 49 Motor, showing suspension.

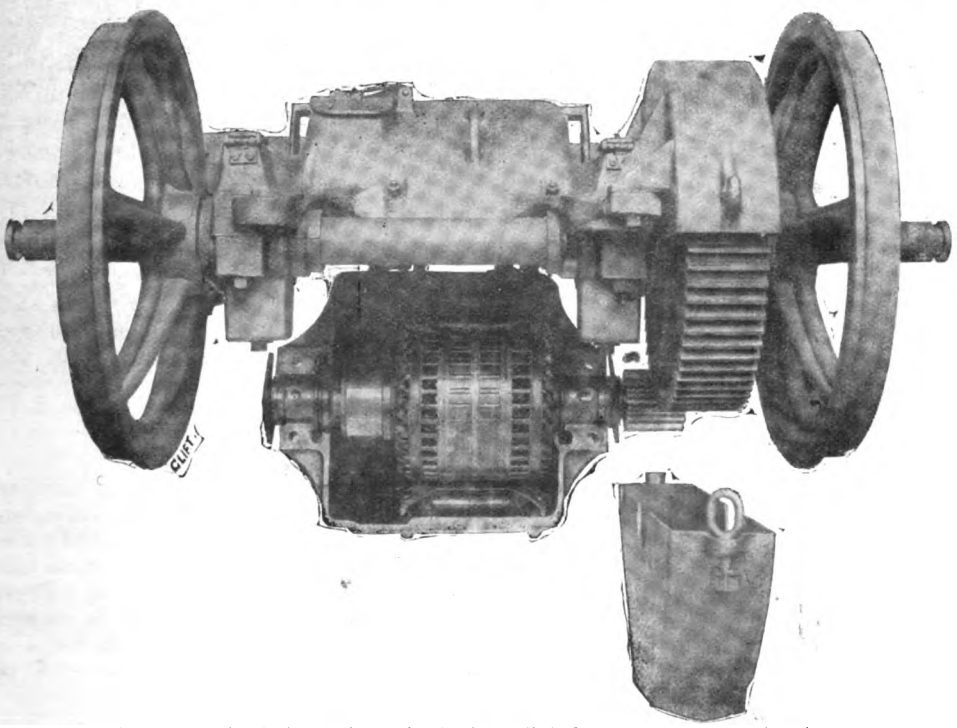

FIG. 4.—The Westinghouse Motor, showing Lower Field Dropped for Removing Armature.

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service is secured, and this without additional apparatus, and with an arrangement of the controlling handle which, so far from increasing the difficulties of manipulation, rather simplifies the duties of the driver.

Each car is fitted with a standard platform switch at one end and an automatic switch cut-out at the other end. Both switches are mounted on the platform of the car, and are in easy reach of the motorman. The automatic switch cut-out is fitted with a magnetic release, and is set to open when the current passing exceeds a certain amount. Fig. 6

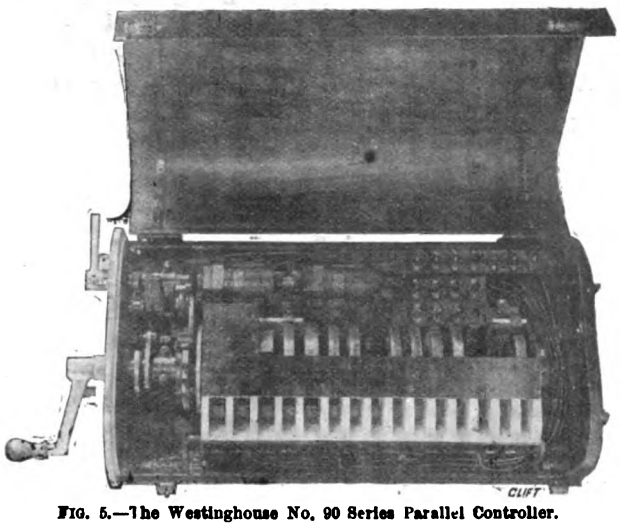

FIG. 5.—The Westinghouse No. 90 Series Parallel Controller.

gives a good idea of the appearance of these switches. The fuse block (Fig. 7) also used on the car, is iron-clad, being completely enclosed in an iron casing, except where the vent extends through the bottom. It is of the

mittee of the Corporation, under the chairmanship of Alderman Joseph Cowgill, who is seen driving the first car in Fig. 8, which represents the opening ceremony. The work of installation has been carried out by the

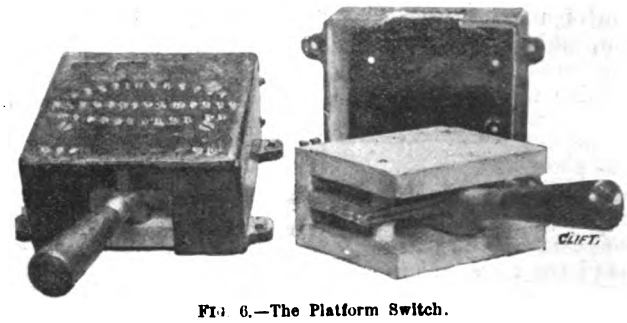

FIG. 6.—The Platform Switch.

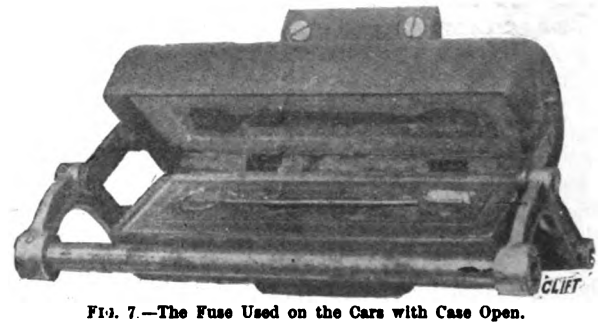

FIG. 7.—The Fuse Used on the Cars with Case Open.

contractors under the direction of Mr. J. H. Cox, the city surveyor, assisted by the deputy surveyor, Mr. W. H. S. Dawson, and of Mr. Alfred H. Gibbings, the Corporation electrical engineer. The principal contractors

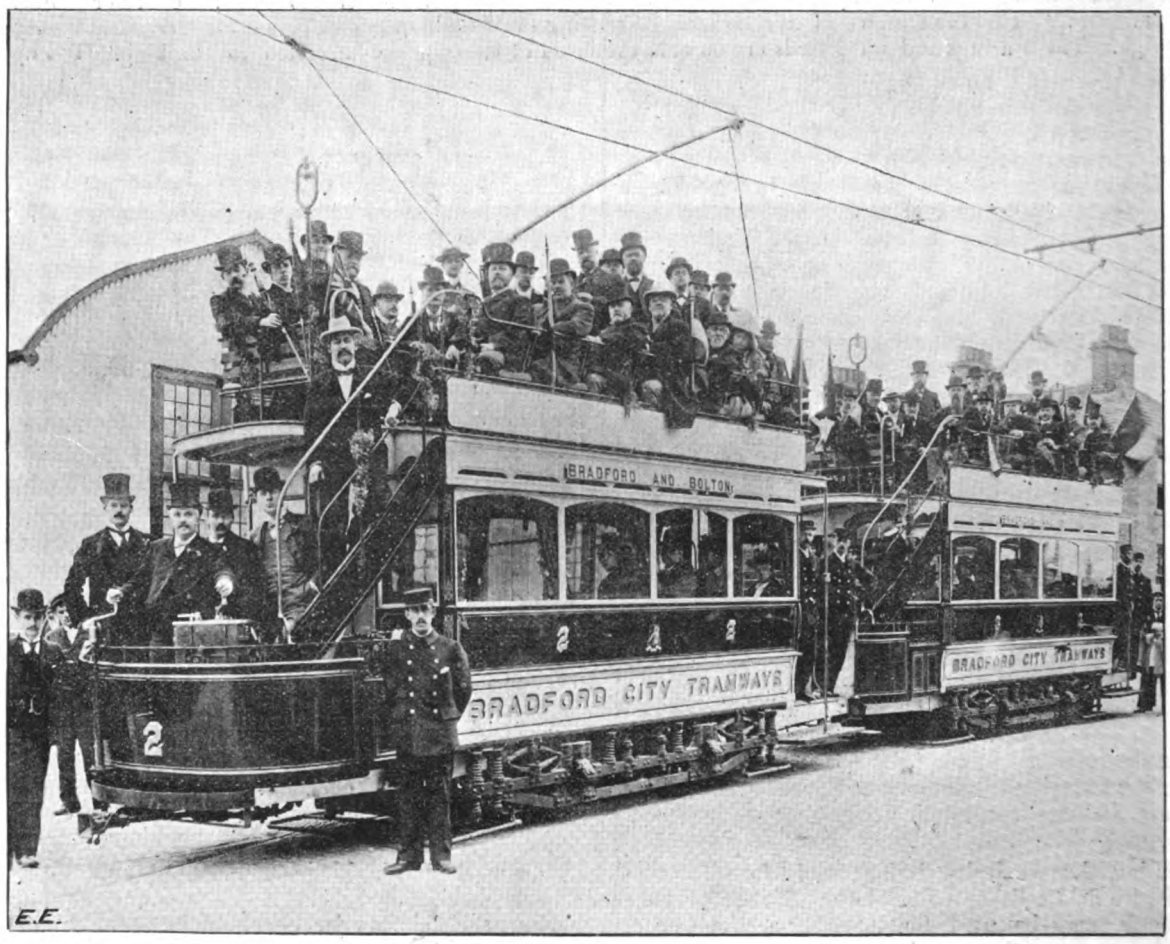

FIG. 8.—The Cars as Filled at the Opening Ceremony.

Westinghouse Company's latest pattern, and the quickness with which it may be re-fused is a great advantage.

The general supervision of the tramway business has, from the beginning, been in charge of the Tramways Com-

for the work were the Westinghouse Electric Company, Limited, of London; while Mr. R. W. Blackwell, of London, was the sub-contractor for the erection of the overhead line.

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INSTITUTE OF MARINE ENGINEERS.

As mentioned in our last issue, the Bristol Channel Centre of this institute held a meeting at Bristol recently. Through the kindness of Mr. G. Sloggett, the hon. secretary of this branch, we are able to give the following two papers, which were read and discussed at the meeting:

Electric Lighting Works.

BY NEVILLE APPELBEE, A.M.I.MAR.E.

The above title is so comprehensive that an elaborate treatise might well be written upon it. However, even if I were capable of doing this, it would, I feel, be out of place to-day. I propose, therefore, to very briefly sketch some of the more prominent points which have to be taken into account in designing the mechanical portions of steam-driven electricity works and the plant which is used in them. Some of these points are so intimately connected with, and dependent upon, the electric systems of the supply as to be inseparable from them, but with such exceptions electrical matters will not be touched upon.

The design of a successful electricity works is not quite so straightforward and simple a matter as it may appear at the first glance. At one time it would almost seem to have been thought that all that was required was a building in which to house a sufficient number of boilers, engines, and dynamos, and in consequence many unfortunate failures and disappointments have occurred. Now, there is not anything particularly strange about this, as all engineering undertakings in their early stages are largely experimental.

The great and rapid growth of electric lighting works may be said to date practically from 1888. It is true there had been such works before that time for several years or so, but they were works principally put down to exploit some particular system; and our Government, in their desire to prevent the formation of new great monopolies, put such restrictive legislation in force as to effectually stifle the growth of the new light. It was not until the Electric Lighting Act of 1882 had been amended by the Act of 1888 that real progress began to be made.

One of the most interesting of the early electric lighting works in my opinion was that of the Grosvenor Gallery Company. It was commenced in the first instance about 1887 to supply the building of that name in New Bond-street, London, and the neighbourhood, but rapidly grew into a large concern, supplying some 35,000 lamps in the West-end by means of over 100 miles of cable carried on poles over the house tops, and most successfully demonstrated the practicability of electric lighting by means of high-pressure alternating currents, and on which system Bristol, Newport, Cardiff, and many other towns are supplied to-day. It was evident from the demand for current from this station alone that there was an enormous business to be done, and the formation of electric lighting companies, each with its allotted area under parliamentary powers, proceeded apace. The various municipal authorities also entered the field, with the result, according to the latest returns, that out of some 283 provisional orders which have been granted by the Board of Trade, 202 are held by them and 81 by companies.

From the experience gained with the earlier works, there is now a large amount of information to guide the engineer how to lay down a station in the most suitable locality, and with the most approved plant for the system of distribution adopted.

Under the following various heads I will endeavour to give you a brief *résumé* of present conditions and practice:

Site and Buildings.—Though strictly of a mechanical nature, a suitable site on which to build is a matter of great importance. If it has been decided that the electric system of supply is to be what is known as a low-pressure one, the economical range for distribution is a comparatively small one, and it is therefore essential to select a site which is geographically approximately in the centre of the area to be supplied. As may easily be supposed, with such a condition as this controlling one's choice, it is often almost impossible to select a site to which coal in large quantities can be cheaply delivered, and from which ashes can be carted away, while water for condensing purposes is often simply out of the question. With a high-pressure system there is a much wider range; the works need not be in the centre of the area, but may be a mile or so one side of it, and can therefore be most conveniently placed on the bank of a river or other water, or adjoining a railway, with all their attendant advantages. Other points to be considered are the nature of the land and its suitability for carrying the heavy weights, ample room for the extensions which are certain to be required, and the character of the surrounding property to avoid action at law for causing a nuisance. The necessity for due consideration of these latter points is exemplified in the history of some of the metropolitan electric lighting companies, who constructed works a few years ago in the midst of London's population, and who are now seeking powers to construct new works further out. The buildings should also be constructed with a due regard to the larger units of plant which will certainly be required a few years after a supply has been commenced. Designers appear to often overlook this even in quite modern stations, and plant is in consequence housed in buildings neither wide enough or high enough. The buildings should also be of fireproof construction, and may well be arranged so that the boilers and engines are in two parallel rows. The coal bunkers are naturally opposite the furnaces, and contain, as it were, the raw material, which passes as steam to the engines, is converted into electricity, and after going through the measuring instruments on the switchboard is delivered to the town mains as the finished article.

Steam-Engines.—The electricity works engineer requires a great deal from his engines. The demands are most exacting, and have led to the development of special classes of engines for the work. They must be economical of steam on varying loads; their mechanism must not be too complicated; they must be strong, must govern well, must have a most equable turning moment, must not require too much attention, and must not occupy too much space. Almost every type of steam-motor has been employed for driving dynamos, and there still remains a wide difference of opinion as to which is the best to adopt. In the early days, owing to the high speed required by the dynamos, they were usually connected to the engines by ropes and belts, but direct-coupled sets are now the universal practice. For both safety and for economical reasons the generating units are often 10 or 15 in number, and may be anything from 100 h.p. to 2,000 h.p. in provincial stations. The principal types now employed, without having regard for valve gears, may be said to be three in number: (1) Slow-speed horizontal double-acting engines, with the flywheel between the high-pressure and low-pressure engines, as at Newport. This type is fairly simple, durable, and strong, but takes up too much space. (2) Moderate quick-speed vertical compounds and triples. By moderate quick-speed I mean 150 to 200 revolutions per minute. As a compound this type is usually arranged as No. 1; as a triple the three engines are placed closed together, as on shipboard, and the dynamo is connected to the shaft of the low-pressure engine, as the first four sets at Cardiff. (3) High-speed engines, either compound or triple, and which are usually tandem engines, as at Bristol. This type is used more than either of the first two. In the municipal lighting works the horse-power developed by the high-speed engines is more than double that of the other two put together. Of engines of the Willans type alone something like 60,000 h.p. have been supplied to such stations, and another 51,000 h.p. to company-owned stations. One need not go far to seek the causes of this preference, and I put them down to the following: (1) high speed means a minimum of capital outlay on the dynamo; (2) high speed means a minimum of floor space occupied in proportion to the power developed, and which keeps down the cost of buildings and foundations; (3) the high-speed vertical engine is universally a self-lubricating engine, and therefore requires but little attention when once started: it is also enclosed, which a horizontal never is, and therefore requires but little cleaning; (4) the cylinders and steam-chests are small: it is therefore quickly warmed up and set to work, which is a useful property. Other conditions applicable to all types are the necessity for accurate governing, a usual condition

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being that the speed must not vary more than 10 per cent. when the whole load is suddenly thrown off.

Boilers.—The conditions under which steam is required in the electric lighting works is different probably to those in any other commercial undertaking. In such towns as Newport and Cardiff artificial light is required on an average for only two or three hours per day. The boilers must be opened out on to the pipes as the hours of darkness come on, and after steaming for quite a short time, three-quarters or so of them are not required again until the next evening. The coal consumed in keeping a number of boilers in readiness for this intermittent duty is very considerable, and should be taken into account in deciding upon the class of boiler to be used. I find the Lancashire boiler, with all its brick flues, is at present more used than with the marine or water-tube types, as in 46 municipal lighting stations there are no less than 175 Lancashire boilers, and only 55 water-tube and 39 marine. The explanation of this seems to be that the well-known long life and comparative simplicity of the Lancashire boiler as compared with the two latter is preferred whether it uses more coal or not. In stations where there is any likelihood of fog or other sudden darkness a rapid-steaming boiler is absolutely necessary, and, in consequence, we find Lancashire and water-tube boilers side by side in the same works. It is my opinion that with the continual increases of pressure all shell boilers must eventually give place to the water-tube types, with their small parts and definite circulation as compared with the uncertain circulation and enormous plates of the former. Another consideration which should extend the use of the water-tube boiler is that it practically never becomes necessary to lower its working pressure—a property, when a number of boilers of different ages are working on to a common steam-main, which is a matter of no mean importance. It is also well adapted for being forced in cases of emergency.

Steam-Pipes.—Steam-pipes next merit consideration. One of the principal requirements is to so arrange matters that, if a section should fail, the supply of steam to engines can be maintained just as usual. To this end the steam-pipe is usually a ring main with stop valves between each engine and boiler, and thereby only throwing one or so of these out of use if a mishap occurs in any one section. There will also be usually an auxiliary ring main to supply steam to the feed pumps and other auxiliary plant, and which will be supplied from the main steam-ring in two or three places. The stop valves on these ring mains are invariably of the straight-through type, to facilitate opening them whichever side happens to be under pressure. In view of the fact that most of the steam-piping is idle for so many hours per day, a complete system of drains and steam-traps becomes necessary to carry off the water condensed in them. The materials mostly employed for the pipework are wrought iron and steel, either lap-welded or riveted, and having the flanges screwed and brazed or electrically welded. The tee-pieces are made of cast iron, and the bends are frequently copper. Expansion joints are not often used, the necessary freedom for the pipes being provided for by supporting them without restricting their movement. Automatic isolating valves are often fixed both on the boiler branch pipes and blow-offs to render the working of a number of connected boilers as safe as possible.

Condensers and Pumps.—Most electric lighting works are now arranged to work condensing even if there be no natural source of cold water for the purpose. The type of condenser is naturally largely dependent upon the question of a suitable supply of feed water. Where this is available, jet or ejector condensers are the rule. Speaking generally, the condensing plants are independent, self-contained sets, the pumps being driven by small compound engines or electric motors. The greatest disadvantage of this arrangement is the long lengths of exhaust-pipe which impair the vacuum. An exhaust to the atmosphere also has to be provided for use in case of emergency. An ejector condenser placed close to each engine I consider to be a good arrangement, no air-pumps being needed, and the long pipes under vacuum are avoided. The design of feed pumps is a matter which repays attention, the ordinary direct-acting pump being well known to be a steam-eater. Three-throw pumps driven by a small engine with a good flywheel, or an electric motor, are now usual. The feed pipes from the pumps, like the steam-pipes, are usually in duplicate.

There are a number of other auxiliary parts, such as feed heaters, filters, fuel economisers, coal and ash conveyors, etc., on which I should like to have said something, but time will not permit, and so I conclude here.

DISCUSSION.

Mr. Faraday Proctor, after conveying a hearty welcome to the institute to Bristol, said Mr. Appelbee seemed to have taken the Bristol example as his model electric lighting station. The Bristol station complied with most of his suggested requirements. It was alongside the water, it was in the middle of the area, and three-throw feed pumps, which he advocated, were used. Mr. Appelbee did not specifically declare which engine he preferred, but he mentioned that the Wilians engine was more largely used than any other make. His (the speaker's) experience supported the favourable view of the Willans engine taken by Mr. Appelbee for lighting work. In electric light work, the essential thing was to have the plant running in parallel. With a slow-speed engine, driven by ropes, parallel running was almost impossible. They could put the machines in parallel, but it was well-nigh impossible to run them satisfactorily. With the medium-speed engine they would run in parallel but the result was not so good as with the Willans and the Belliss type. For a high-speed engine it was better to get a single-acting, when they had absolutely no knocking. In the Willans engines which he used there were no top brasses at all. If there was no knocking, no noise, there was practically no wear.

Mr. M. W. Aisbitt proposed the health of and a vote of thanks to Mr. Appelbee for his valuable paper. He thought there was a distinct disadvantage arising from the tendency of every twopenny-halfpenny town being ambitious to put in and run its own electrical installation. The paper stated that in 281 towns the corporation was its own supplier of the electric light, compared with 181 towns where the work was entrusted to private firms. As a ratepayer, he should like to have seen the figures reversed. Supposing in the time of Stephenson 281 corporations had decided to run their own locomotives—what a nice mess they would have made of it!

Mr. T. A. Reed seconded the vote of thanks to Mr. Appelbee. Reading the *South Wales Daily News* the other day, he was amused and somewhat indignant on reading a report of certain proceedings of the Cardiff Corporation with regard to the electric lighting station. Here the Corporation had a talented engineer, and yet they would not take his advice. In Bristol the electrical engineer got practically what he wanted, and everything worked smoothly and to the advantage of the community. But in Cardiff there was a disposition on the part of members of the Town Council not to take the advice of their electrical engineer. "What do our councillors know about electricity?" asked the speaker, and the company's unanimous reply was "Nothing."

Notes on Traction by Electric Power.

BY PROF. A. C. ELLIOTT, D.SC.

The system of traction by mechanical power transmitted electrically, which now occupies a tremendous territory in America, on the Continent, and to a less relative extent in this country, has been practically developed within the experience of the youngest of us here present. It is 60 years ago, however, since the early experiments began with rude magnetomotors and primary batteries, the most notable, perhaps, being those of Robert Davidson, of Aberdeen, who between 1838 and 1842 did not a little work in this connection, and with an electric engine of his own construction ran long trips on the Edinburgh and Glasgow and other Scottish railways at speeds of four or five miles an hour.

The practical period commenced of necessity subsequently to the invention and introduction of the dynamo. In 1879 the Berlin branch of the Siemens firm constructed there a small experimental electric railway in the grounds of the exhibition of that year. The rolling-stock consisted of a small car and an even less bulky locomotive, which picked up its current from a middle rail, and returned it through the two ordinary rails. The shaft of the motor—an ordinary Siemens series dynamo—lay parallel with the line, and a double-reduction plain and bevel spur gear conveyed the power to the driving wheels. The load was 20 persons, and the speed eight miles per hour. Immediately many noteworthy experiments were undertaken, chiefly in the United States and this country, but Siemens were again to the fore with the Lichterfelde line, opened for business in 1881 as the first electrical tramway. It is still working. The method of picking up current by a third rail originally employed on this line is quite suitable, and now universally adopted for electric railways properly so-called. For obvious

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reasons, it is unsuitable for a tramway, which is distinguished from a railway by the condition that the surface between the rails shall be available for the accommodation of all kinds of traffic besides that peculiar to the tramway. The distinction was discovered at this early period, and to it belongs the advent of the single and double trolley. Anything like effective insulation of a third rail laid at surface level on a tramway is impossible. It appeared that the thing to do was to raise the third rail out of harm's way—in the sense of wet, mud, and snow, never to speak of horses and pedestrians not innured to substantial electric shocks—and to establish connection between it and the car by a flexible conductor and a little contact carriage. Hence the name "trolley." This third rail, or, so to speak, supply conductor, became for tramway work a stout copper wire suspended over the centre of the track by means of side posts and guys; and the trolley took the form of a swivelling, spring-supported steel tube mast carrying a slipper or pulley contact. Junctions and crossings were negotiated by "frogs" and more guys; all sorts of slings, clamps, brackets, shackle, and strain insulators were invented, cast, and erected haphazard by the thousand, till at last in some American towns neither the brightest moon at midnight nor the strongest sun at mid-day could penetrate the metallic cobweb overhead. But in the fulness of time and experience order and even beauty emerged, and there are now in existence scores of overhead electric tramway installations that neither offend the eye nor shut out the light of heaven.

On the double-trolley system it was proposed that the current should come by one overhead wire and trolley, and return by a second overhead wire and trolley—the word trolley now standing in a generalised sense for the connection between the moving car and the fixed conductor. Lines on this plan have been erected; but since one overhead conductor is better than two—all things being equal—and one connection between a moving car and fixed conductors is better than two—all things equal—it follows that if the condition all things equal can be realised, there is very little chance of the double-trolley system spreading.

Practically all electric trams use the ordinary rails for the return. In the early days of electric traction it was supposed that as the rails made what telegraph engineers call a "dead earth"; to get zero resistance in the return it was merely necessary to put one terminal of the dynamo to line and the other to a good earth. That this was a huge error might easily have been foreseen; what is good earth for a small current is by no means good earth for another a million or so times greater. The conviction, something wrong, was probably brought home by the coal bill; anyhow, the idea got abroad in America that their ancient suspicion that the terrestrial globe was rather a small thing could be proved a fact by measuring the resistance of a tramway earth. The rails were in some instances connected to gas or water pipes to secure a better return. This, it would seem, served to precipitate a crisis, water and gas pipes became sieves through galvanic action, and telephones which had before become inarticulate delivered shocks. Then came the later order of things: rail sections were increased to 70lb. and 80lb. per yard; electrical continuity at the joints was secured by substantial copper bonds or by welding; the negative terminals of the dynamos were connected not only to earth, but directly to the rails; and insulated return feeders were run exactly like supply feeders. The water and gas pipe trouble disappeared, much of the telephone trouble disappeared, and works costs were more satisfactory. In the early days a matter of 50 or 60 volts difference of pressure between the end of the ordinary rails and the negative terminal of the dynamo was a mere ordinary thing. Our Board of Trade now limits that difference to seven volts, and the return current is practically confined to the paths designedly provided.

The method of picking up through or by means of a slot was quite early in the field. The general appearance of the track exactly resembles that of a cable tramway; and, to carry the analogy further, the running wire rope of the cable tram becomes a fixed conductor and the gripper a contact carrier. This system has undoubtedly tremendous advantages compared with overhead pickup. On the other hand, the drawbacks to what is outwardly nothing short of a fascinating plan are only too well known to the electrical engineer. In a moist climate the insulation is prodigiously difficult to keep up to standard; repairs are heavy and, worst of all, difficult to effect in the confined and inconvenient space at disposal; and, lastly, at least the first cost is considerably greater. It is difficult to imagine the ordinary slot system working through a week of snow-slush and Cardiff road mud. Though I think there is at present a grave balance against the adoption of the slot system in this country for any important installation, I do not completely despair of its future. The insulation difficulty can be contended with by good design and by automatic section switching, and some others could be reduced by sinking more money. In a word, we as engineers know that it would be folly to set limits to the mechanical progress of the future, however strongly and justly we may hold opinions about the present state of affairs.

The separate locomotive for tramway traction has totally gone out. Sufficient power can be placed underneath the platform on the wheels of the otherwise ordinary passenger-car, not only to propel the car itself, but on occasion of heavy traffic to haul a trailer unprovided with power. Thus the gross load is considerably reduced, while the paying load remains as before. Two motors regulated on the series-parallel system—series for starting, parallel for straight running—are ordinarily employed. The motors may be mounted direct on the driver axles, but for ordinary tramway speeds and wheel diameter it is usually necessary, or at least preferable, to use single-reduction gear. For fast-running heavy traffic conveyed at infrequent intervals after the manner of a steam railway, the separate electric locomotive with direct-driving motors will be employed. The pioneer City and South London uses separate locomotives, but experience and reason points to the conclusion that even on railways of this character the motorcar is likely to prove the victor.

On a tramline with no exceptional gradients worked at 500 volts pressure, and an average speed of eight miles per hour, the average current for a seven-ton motorcar carrying 53 passengers seems to be about 10 amperes—6¾ e.h.p. The addition of a four-ton trailer brings the passenger accommodation up to 99 and the current to about 13 amperes—8½ e.h.p. During the operation of starting the current may run up to three times these values, showing the tremendous power available for starting and speeding up on an electric car as compared with the slow and painful process on a horse car. It will be noticed that electric cars are usually much heavier and have a far greater carrying capacity than horse cars, the simple reasons being that wherever electric trams are installed the traffic tends to become heavier, and it pays to have plenty of accommodation during hard pressure—sudden rain, going and returning to business and work hours, etc.—rather than be forced to refuse passengers, as on the old system, so sadly familiar to us all. Another way of regarding the amount of power required by an electric tramway is to reckon on it taking an average of 0·8 of a Board of Trade unit per car mile. A Board of Trade unit can be, as you know, delivered by the corporation electric lighting stations of Bristol and Cardiff for a works cost of about 2d. Hence it follows that the works cost of power—corresponding with the cost of keep of horses, renewals chargeable to revenue, and wages—is about 1½d. per car mile, the passenger capacity of the electrical car mile being about double that of the horse-car mile.

An electric power station does not differ much from an electric light station. The tram people have on the whole a very much more evenly distributed load, but variations of load are incessant, sudden as pistol shots, and very severe. In some of the early ill-governed and overloaded stations the plant used to plunge and stagger like the engines of a light ship in a heavy gale, or behave like Satan struggling through the chaos, as in the historic present of Milton, he "Swims or sinks, or wades or creeps or flies." But these experiences are to a large extent overpast. They pointed to large margins of strength and current capacity, to high-speed or, rather, short-stroke engines, and to governing by automatic cut-off.

I have already remarked on the folly of setting limits to future mechanical progress. The matter is recalled to my mind by an incident which occurs while I write. In

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search of a historical date, I have just made a reference to a now somewhat old work, to which, however, Lord Kelvin, Rankine, and many other great scientific men and engineers contributed. Speaking of electromagnetic motors as then known, the author of the article on "Electromagnetic Machines" says: "It is magnetic attraction alone that can induce rotation to become a source of mechanical effect, so that there is in the very source of this new power a cause of feebleness over which no mechanical ingenuity can even prevail." To-day the Baltimore and Ohio Railway Company possesses numbers of electric locomotives of over 1,000 h.p. each, by which it works the Baltimore tunnel, constructed to save the water transport they were formerly compelled to maintain across the harbour. These electric locomotives haul trains of 400 tons or more, together with the steam locomotive of, say, 100 tons, steam shut off over the approaches and through the tunnel, with its gradients a distance of about four miles at a speed of 35 miles per hour. There is but little doubt that the recent remit of the directors of the Metropolitan Railway to Sir John Barry and Mr. Preece means business, since it is backed by authority to spend £20,000 on experiments, and in more than due time we shall, without doubt, see the Underground worked by electric locomotives more powerful than the steam locomotives now in use on that most excellently managed line. Let it be clearly understood that I am not one of those people unfamiliar with railway working who are pleased to opine that the steam locomotive will be immediately superseded by the electric locomotive: if time served, I could show you very excellent reasons to the contrary. But in the peculiar circumstances of the Metropolitan Railway with regard to ventilation, I have for 20 years advocated electric traction as the only sure remedy for the really horrible state of affairs, which, having existed so long, is daily getting worse, and, if not speedily amended, will bring the directors of the Metropolitan Railway face to face with diversion of traffic due to the competition of other underground railways electrically worked, if, indeed, that has not already commenced.

Experience has shown that wherever a rapid and reliable tram service is placed at the doors of a community, the facilities offered are warmly welcomed, and increasing traffic makes glad not only the hearts of the promoters, but those of the townspeople and of all those who are watching the working of this comparatively new factor—mechanical traction—in city life. The business-man can afford to live in a district remote from the bustle and dust of the city where flowers and trees may flourish, where wide streets and open spaces make for the preservation of the health of his wife and the upbringing of sturdy children. In this way not alone the middle class is affected; the working-man has as much, if not more to gain. River steamers are better appreciated because it becomes easy and pleasant to journey to the piers and landing-stages. Likewise theatres, scientific institutions, colleges, schools, and churches increase their radii of accessibility and of usefulness. Even existing railways benefit, and give benefit, inasmuch as feeders are essential, and the more efficient the feeders the better for all. Bristol has set a splendid example, Cardiff is preparing to follow. But let the Cardiff people bestir themselves, let us have no more waste of time. The present tram system of Cardiff is a disgrace; there is, in fact, no town of equal importance in the country where the service is slower, more painful to witness, inadequate, and unreliable. It is unworthy, utterly unworthy, of the Welsh metropolis.

THE ELECTRIC TRAMWAYS OF BOULOGNE-SUR-MER.

[BY OUR SPECIAL CORRESPONDENT.]

Electric tram traction has only quite recently been introduced in Boulogne—indeed, horse traction has not yet been superseded on the line from Brecquerecque to the end of the Rue Nationale, which is the commencement of the Rue Victor Hugo; on the branch line in the Rue de la Lampe, and on the line from Châtillon to the Place Dalton. The electric traction is effected by the overhead (trolley) system, worked from the power station at Brecquerecque. A special interest attaches to this installation from the fact that portions of the route are very steep, having a maximum grade of as much as 1 in 10, and in other portions the streets are somewhat tortuous, the conditions being such as prevail in many of our seaside resorts, where electric traction will no doubt be adopted in the near future. A noteworthy feature is the mode in which the number of iron supporting poles is advantageously reduced to a minimum, and the adjoining houses utilised for the support of the conductors—a nominal rent of 1fr. per annum being usually paid for each house thus brought into requisition.

Although the establishment of electric tram traction must have improved the cleanliness of the streets and contributed to the convenience of the inhabitants, it was not effected without considerable opposition, and in many quarters still meets with strong disapproval. In conversation with several residents in Boulogne, I had to listen to some objections which were obviously without foundation—such as that of the great destruction amongst the feathered tribes due to the perching of birds upon the conducting wires, and the enormously-increased mortality amongst the canine race owing to their being run over—a thing that could scarcely happen unless the animals actually jumped over the *garde-corps* or cow-catcher with which every car is provided. Still, it may be suggested that this protective appliance might be more *en évidence*, it being at present so concealed beneath the car as to convey the impression that anything on the track must necessarily become crushed beneath the wheels. One of the objections—that regarding the danger due to the noiseless running of the cars—may be worthy of attention, and could no doubt be readily obviated, by means which would be liable to objection by those who dislike the sound of bell or whistle.

Another objection to the electric tramway is that the powerful currents employed seriously interfere with telephonic transmission. The mode of remedying this interference by equally exposing both telephonic conductors to the inductive effect of the current is well understood; but the question has arisen whether the tramway company or the owners of the telephonic lines should defray the expense of the necessary alterations.

Proceeding along the banks of the Liane nearly as far as the abattoirs, I was guided by the suspended conductors to the headquarters of the company. On presenting my credentials, I was courteously received by M. Carré, the directeur des Tramways de Boulogne, and was by him introduced to M. Henry Prim, the engineer of the company, a young Belgian whose studies had been pursued mainly at Liège. This gentleman was deputed to show me and a young friend, Mr. Philip Smythe, the son of Mr. Lionel Smythe, A.R.A., residing at the Château de Honvault, near Boulogne, over the works, and afterwards to take us for a trip over the most interesting portion of the tramlines.

In the engine-house, the appliances first to be noticed were four semi-tubular boilers, each having 120 square metres of heating surface, and provided with two injectors and a pump. Two of these only were actually in use, and these had been running only for a few weeks. Next there were three steam-engines supplied by the Maison Garnier of Paris, each of 220 i.h.p., and working at 85 revolutions per minute. The flywheels of these engines are 12 tons in weight, and the steam supply is regulated by Corliss valves. Next to be inspected were three Thomson-Houston dynamos, each of 150 kw.; these machines are hyper-compound, with six poles, and work at 400 revolutions per minute. Each machine can yield an output of 275 amperes at a pressure of from 225 to 250 volts. The dynamo brushes are of carbon, and give great satisfaction. The switchboard is of the latest construction of the General Electric Company, Limited, and the voltmeters and ammeters are of the Weston type, the former measuring up to 550 volts.

In connection with the switchboard are two underground feeders; one, having a section of 350 square millimetres, to the Rue Victor Hugo, and the other, with a section of 100 square millimetres, to the Rue de la Lampe. There is also an overhead feeder of 100 square millimetres section. Each feeder is, of course, provided with a separate ammeter.

Also in connection with the switchboard are three

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variable resistance coils, to be inserted respectively in the field coils of each dynamo.

Particular attention has been given to guard the various lines from the effects of lightning. For this purpose that beautiful instrument, the magnetic blow-out lightning arrester, manufactured by the General Electric Company, is extensively and solely employed. There is one for each feeder in connection with the switchboard and one at intervals of 550m. along each line. In this apparatus the magnetic effect produced by the discharge in a core of soft iron deflects and "blows out" the arc generated in the interval through which the discharge takes place. In order to prevent the passage of atmospheric electricity to the line, some 4½m. of the latter are wound helically, so as to constitute a *bobine de self-induction* (choking coil), which opposes the flow of current to line for a minute period, sufficient to allow of the discharge to earth through the lightning arrester.

The lines included in the Boulogne tramways are as follows: Line No. 1 (about 1,100m.), from the Place Dalton to the Casino. This line passes down the Rue Thiers, the trams returning by the Rue Victor Hugo. The rails are connected by the Chicago bond for the return current. Line No. 2, from the power station at Brecquerecque to the end of the Rue Nationale. Line No. 3, from Outrean to the Place Dalton, the central point. Line No. 4, from Châtillon to the Place Dalton; shortly to be worked by electricity. No. 5, from the Place Dalton to the Dernier Sou; worked by electricity.

It was on this last line, having the heaviest gradient (1 in 10), that M. Prim took us for a trip to exhibit the efficacy of the series-parallel controller as manufactured by the General Electric Company, and also that of the three kinds of brake that can be used in descending the somewhat alarming incline above referred to. The weight of the tramcar without passengers is 8½ tons, and with passengers about 10 tons. There are two motors for each car, and the usual speed is from 9 km. to 12 km. per hour, which could be increased to 40 km. In descending the incline towards the Place Dalton, it was noticeable that the car was perfectly under control even without using the brake power applied to the rails, and the car was twice stopped abruptly to demonstrate the fact.

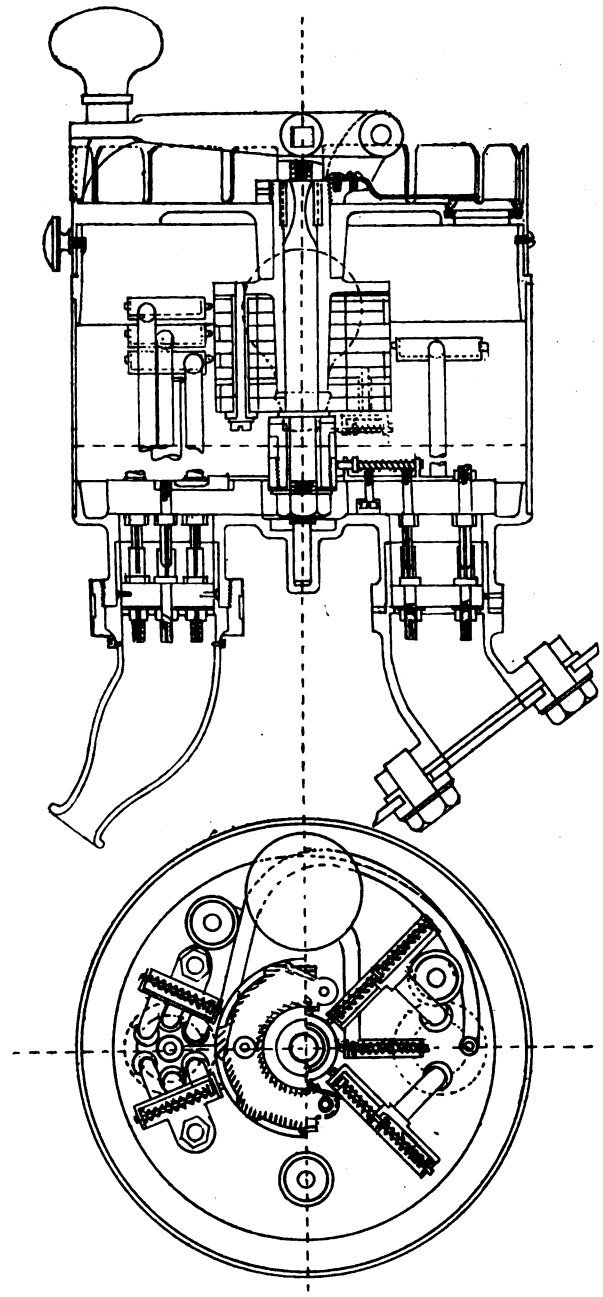
The two motors on each car may apparently absorb as much as 75 h.p., which, no doubt, is an excessive expenditure of energy for the purpose in view. But the installation is as yet hardly in permanent working order, and I hope on some future occasion to have the pleasure of again meeting M. Carré and M. Prim, and of discussing with them the various improvements which doubtless will have taken place in the working of the tramways of Boulogne.

ELECTRIC SIGNALLING IN THE GERMAN NAVY.

BY BEAUMONT PONTIFEX.

A system devised by M. Kaselovski, which is worked by various combinations of incandescent lamps, has been adopted for the vessels of the German navy. The whole design of the apparatus is based on the following considerations: (1) the use of *one* switch key only; (2) moving the key from one signal to another must break *both* poles of circuit; (3) great mechanical steadiness; (4) immunity from damp.

The most important item is the switch. On large vessels this is carried on a pedestal on the bridge, but on torpedo-boats, etc., it is fixed on the after side of the conning tower. The switch is contained in a cylindrical brass case, which carries on its base a flange for bolting to supports and a socket-union for the seven-pin end of the flexible cable, the flange being left hollow for the leads from source of supply, which is usually the incandescent lighting plant of the ship. The top cover of the switch contains the indicating discs, which are made of coloured and marked glass to correspond to the prearranged signals and give the proper direction to turn the key to indicate same. These glass discs are arranged in a circle round the edge of the cover, and are lit by an incandescent lamp inside the case. The actual contacts of the switch consist of plungers pressing against recessed gunmetal discs, fastened on a central spindle and insulated from it. The plungers are driven against the discs by spiral springs, but their travel is limited by collars, so that when a recess in one of the discs is brought opposite a plunger contact is broken. The recesses are so arranged that by turning the key the circuits are by turns closed and opened, whereby, according to arrangement, one, two, or three incandescent lamps out of six are lit in succession. There are also two plungers on the opposite side of the discs, which throw in and out of circuit one, two, or three lamps used as a compensating resistance. Two separate plungers pressing on the lower part of the spindle serve to break contact on the common return wire whenever the spindle is lifted to allow the key to move from one contact to another. The entire switch is easy to handle, and is quickly taken to pieces for repairs



or renewals of springs, plungers, etc. A seven-core flexible cable is used, one core being a common lead to all lamps, the other six being individually connected to the opposite pole of each lantern. There is a central steel wire to add strength to the cable, and the whole is thickly braided.

The lanterns are two-light fittings, the upper half white and the lower red, carried in a frame of flat iron. The glasses are of the usual "well" pattern, secured by rubber washers held in an iron rim by bolts. The lamps are hung one over another at fixed intervals on the mast, so arranged that the white lights are on top and the red underneath them. Each lantern has a two-way socket at the side, to which is screwed the connecting plugs on the cable.

When not in use, the entire gear is stowed in an iron box resembling both in shape and size the familiar household sanitary dustbin.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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FASHION IN ENGINEERING.

After the flattering note in our front columns as to the influence of an engineering training on the moral character as observed by Mr. H. G. Prout, we are loth to admit that engineers are, as a rule, creatures of fashion. In the address delivered by Mr. Prout before the Stevens Institute in America stress was laid on the fact that sophistry and ignorance will kill an engineer professionally. Furthermore, engineers are, we are assured, specially capable of looking at the root of physical problems, and by this they develop powers to reason straight. While the above is approximately correct, the fact remains that originality and the custom of comparing different methods of effecting the same object is wanting in the majority of engineers. In some cases even for a time the most successful men share these wants, and attribute their success to the fact that they are not attracted by so-called new-fangled ideas. Such men are engineers who believe above all in making money, and who prefer to sell machinery of old designs rather than to turn out new types and bear the cost and trouble of getting them thought out. In the long run the best prevail, and such engineers get left behind in the race. An instance occurs to us of a small dynamo builder in the early days who made the two-pole Gramme type of dynamo, which was the first to be introduced for practical work. These the maker turned out with the wooden hubs and other primitive details long after all other makers had taken to better designs. He had trouble with the machines, but from long experience had learned to love their unsightliness and bad qualities. The reason of his adherence to the old fashions was expressed somewhat in the following terms: "Yes, So-and-so makes a good dynamo, which does not spark or heat, but you know it does not look like a dynamo." The next step was that in an advertisement the public were informed that, in consequence of other types being preferred, they could be supplied instead of the old Grammes if the purchaser specially wished it. In other words, if the purchaser did not know better, he should be made a martyr to the fashion which had gone out. We need hardly say that the number of martyrs decreased somewhat rapidly, and that the orders in new types were apt to stray to makers who had originated them. This is not an isolated case, and other firms have lost much business by refusing to acknowledge that the best machine in, say, 1885 might be the worst in 1895. It was also the fashion in early days to compare dynamos together by ascertaining the length of wire required on the armature to produce one volt at the terminals. With due appreciation of the fact that the comparison was only of general interest no harm was done, but some engineers otherwise capable took up the idea that this, and nothing else, determined the commercial value of a dynamo. The result was more extravagant designs, which cost in other directions ten times more than the value of the few inches of wire saved per volt. These are only instances of what occur every day in business. Jones's special switch is recommended because it was supplied to some big hotel five years

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ago, or So-and-so's refuse destructor is said to be the only one that will turn rubbish into gold. There is no doubt in engineering matters that experience pays, and that the leading firms do advance in consequence. The practice, so often met with, of doing only what has been done before leads downhill; and fashion is the engineer's bugbear. Men who can reason down to bed rock, as the Americans say, are the men we want to lead the industry, and such men are being prepared by our best technical colleges in London and elsewhere. Students from these places get their first principles of engineering soundly laid, and then are able to apply them as they gain their practical experience in after life amongst ever-changing engineering problems. They may also be able thus to avoid what Mr. Prout says is specially common amongst ministers and editors—*i.e.*, "The dangerous trick of thinking that their opinions are valuable merely because they are their opinions."

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

CORK TRAMWAYS.

SIR,—In your issue of Aug. 12 appeared a paper written by me and read at a meeting of the County and Municipal Engineers held at Cork on the 5th inst. I wish to say that I am not the electrical engineer of the Cork Company, and that Mr. H. F. Parshall, M.I.C.E., is the consulting electrical engineer of the Cork Electric Tramways and Lighting Company, Limited, and that the British Thomson-Houston Company, Limited, have carried out the electrical part of the work. Your insertion of this explanation will be esteemed a favour by yours, etc., BEVERLEY GRIFFIN.

Cork, Aug. 19, 1898.

THE ZERMATT-GORNERGRAT MOUNTAIN RAILWAY.*

One of the most interesting and instructive railway undertakings of the year is the Zermatt-Gornergrat Mountain Railway, operated from a three-phase alternating-current circuit. Zermatt is a small village of 500 inhabitants in the Canton of Vallais, near the southern boundary of Switzerland and on a branch of the Jura-Simplon Railroad. It is at the base of the Gornergrat, and is a favourite resort for tourists. This project was conceived shortly after the Jungfrau Railway, both of which have excited world-wide interest.

The question of power was of primary interest, but the numerous waterfalls made the application of electricity desirable. After the engineers had studied the problem, it was decided that polyphase alternating currents would prove most economical in transmission, and the use of three-phase motors on the locomotives was advocated. Brown, Boveri, and Co. had made the plans for the street railway system in Lugano, and were satisfied with the operation of the alternating-current motors on the cars. A test was then conducted on a portion of the new Gornergrat railway which fully justified the adoption of the motors on the new line. The objection to two trolley wires over each track is not a serious one with the mountain road, as the speed of the car does not exceed five miles an hour, and the road passes through no thickly-settled places.

The line beginning at Zermatt extends 5·7 miles to the summit of Gornergrat, which is 10·791ft. above sea-level. The first 1,000ft. of track is level; it then crosses the Visp on a bridge of 98ft. span. From the bridge there is a grade of 12 per cent. for nearly a mile, and the road crosses over the Findelbach. About 300ft. below this bridge is the power station. After crossing this bridge is a grade of 20 per cent., which, with exception of the stations and a few stretches, continue to the end of the line. At five points along the road tunnels had to be driven, the longest being 380ft. The total rise in the whole distance is 6,849ft. The rails used are 4in. Vignolles, and between them an "Abt" rack is fixed. The track is 3ft. $3\frac{3}{8}$in. gauge.

The *Zeitschrift für Elektrotechnik*, of Vienna, gives the following information in reference to the design and construction of the road. Each train consists of an electric locomotive and two cars with a capacity of 110 passengers. This makes the weight of a train unit about 30 tons. There will be three trains in operation on the line, and it is calculated that 160 h.p. at the motors will be required for each one. If there are three trains in service, there will be one at least going down while the other two are ascending. Assuming an efficiency of about 60 per cent. for the generators, transformers, transmission, and motors, 510 h.p. should be developed at the turbines.

It was decided to instal three 250-h.p. waterwheels of American make direct connected to generators through flexible couplings. The speed is to be 400 revolutions per minute. The waterwheel governors are very sensitive, keeping the speed constant with variations in the load of 50 per cent. The head of water available is 330ft.

The alternating-current generators have stationary armatures and 12-pole rotating field magnets. The current is generated at 5,400 volts with a frequency of 40 cycles per second. The field current for the alternators is generated by 15-h.p. direct-current dynamos coupled direct to the shafts of the alternators.

The current is transmitted to the various transformer stations at the voltage generated and reduced to 540 volts for distribution the line. There are three of these stations, each of a capacity of 180 kw. The current is transmitted from the power station on three wires of No. 3 B. & S. gauge; this line does not follow the road, but takes the shortest cut across the country. The voltage is reduced to 540 volts at the transformer stations and passes to the line through feeders of No. 0 wire. The two trolley wires are suspended 16in. apart above the centre of the track, and the rails form the third branch of the circuit. Chicago rail bonds are used in connecting the rails.

From an electrical standpoint the details of the locomotive are of greatest importance. There are two synchronous three-phase 90-h.p. motors for each locomotive. The motors have wound armatures or rotors, contact rings, six poles, and a speed of 800 revolutions per minute. The reduction through the gearing is 12 to 1. Above the motors is arranged a resistance common to both, and the speed is controlled by cutting this in and out of the rotor circuit. Above the rheostat is a switch for opening the car circuit. There is a double set of current collectors on top of the car to provide for the heavy currents taken at times. The motors are mounted on the truck, with pinions at either end of the shaft which engage with the two large gears, which in turn drive the gear on the axle. There are two driving axles, and each motor works separately upon an axle.

Owing to the excessive grades, extreme precautions had to be taken with the brakes, and two independent sets are provided. The first system is operated by hand, and each can be applied by hand upon the two driving axles independently of each other. The friction band brakes applied to wheels on the motor shafts are operated either by hand or automatically so soon as the car exceeds a certain speed, or whenever the current is interrupted from any cause. This is accomplished by means of a solenoid which, so long as the current is passing through it, loosens the brake, but throws it on the instant the current stops. The motors also have a powerful braking effect.

In going down grade the motors can be controlled in two different ways. They may be connected in the same manner as going up grade with the resistance inserted in the rotors, or the rotor windings may be short-circuited. The train has the same speed going down hill as going up; they have

* From the *Street Railway Review*.

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to keep in step or in synchronism with the alternators. The motors act as generators going down hill and return current to the circuit. It was necessary to make provision for this at the power station, for if all the trains on the line were descending, the locomotive motors would generate so much current that the alternators at the station would run as motors from the line currents. A liquid resistance is automatically inserted in the circuit when the alternators exceed a certain speed.

The fact that the motors will return energy to the line was demonstrated by experiments last November on a completed portion of the line a mile in length. During the tests a fully loaded train was run down hill with the motors connected as generators, and the train maintained the same speed as in going up-grade, without any application of the brakes. The excess current was absorbed at the power station by a water rheostat. The test also showed that a locomotive hauled a fully loaded train over every grade evenly and smoothly, and when the rotor resistance was out of circuit the speed was independent of the grade or load.

The cars, station, building, etc., are all lighted by electricity, there being small transformers at the stations to reduce the transmission voltage to 540 volts. The lamps on the cars are connected three in series. This important work, now practically completed, will be the first electric rack railway driven by three-phase alternating currents. However, this will be followed in a short time by several similar roads, such as the Jungfrau and the Stansstadt-Engelberg. The successful operation of the Lugano street railways and the preliminary tests on the Gornergrat indicate that multiphase alternating currents can be employed both in the operation of mountain roads and ordinary street railways, and there may be important developments in the future along this line.

ELECTRIC TORPEDO BOATS.*

BY CHARLES T. CHILD.

The very interesting problem of the electrical operation of torpedo boats has been briefly discussed in these pages, but without bringing out fully the very great advantages of such a method for the operation of these terrors of marine warfare, or the enormous difficulties in the way of a successful solution of the problem. To fully understand the necessities of torpedo boats, it is necessary to give some account of the history of their development and the tactics prescribed at present for this use.

The first craft that can be called torpedo boats were used in the American Civil War, both parties to that struggle making use of them with such success that they became recognised as offensive naval weapons on all sides, and their development as legitimate naval accessories was begun simultaneously in the shipyards of several of the maritime Powers of Europe. The torpedo of that day was the "spar torpedo," a quantity of explosive attached to a spar and fired by contact with the hull of the enemy's vessel or by electrical means when brought sufficiently close to accomplish its purpose. Before the days of rapid-firing guns this method of attack was much more often successful than now seems possible, as many instances in the war of 1861-65 attest. Even rowboats were used, and under cover of darkness or fog these small steam launches accounted for many vessels of the belligerents in that conflict. No less than 30 vessels belonging to the Federal authorities were destroyed or disabled by torpedoes during the four years of the civil war.

It was not for several years that the torpedo boat as a separate type of naval construction was seriously undertaken. The first steps taken in this direction were in England, where two famous builders, competing with each other, turned out craft of about 7½ tons, with speeds as high as 15 knots. This was in 1873, and in 1878 boats of 75ft. length and 18 knots speed were the standard.

The automobile torpedo was introduced and developed simultaneously with these early types of torpedo boats, and in the course of a few years had made such progress as to find advocates in several navies. Still, the spar torpedo held its ground, however, and it was not until the introduction of rapid-fire guns of great accuracy demonstrated the impossibility of a successful torpedo attack of this sort that the spar gave way to the launching tube for the automobile torpedo as the proper equipment for this class of vessels.

For 20 years the progress of torpedo-boat construction has been marked by a gradual increase in the size of the boats and an enormous increase in their speed, and has been attended by the development of at least three types of these boats, differing in size, speed, and armament, and intended for widely different uses. The engines of 90 h.p. and locomotive boiler of the early types have given place to the water-tube boiler and high-speed triple-expansion engines of 6,000 h.p. of the modern "destroyers." An almost equally great development has brought the torpedo itself to its present standard of great perfection.

The conditions of torpedo warfare are best summarised as the attack upon a large costly vessel by a small and inexpensive one, and the risking of a relatively small amount of property and lives in the effort to destroy a relatively large amount. The fear of such an attack has produced the type of large and fast torpedo boats adapted to attack and destroy other torpedo boats, and called in the English navy "destroyers."

All these types of vessels are necessarily of the highest attainable speed, sacrificing for this essential all forms of protection and nearly all defensive weapons. They are practically certain of destruction if discovered, but their protection is in their small size and attendant small visibility, and in their ability to run away from a dangerous neighbourhood. Discovery means certain failure and probable destruction, so that the chosen hour of the torpedo boat is the dead of night, preferably when the obscurity is heightened by rain or fog. It has recently been demonstrated that the torpedo boat is useless and helpless and foredoomed to destruction in a daylight attack.

The reason for the high speed demanded of these boats is that they may overhaul their prey, and that they may escape if detected. It is, however, very much to be doubted if speed attained by the sacrifice of invisibility is desirable. For harbour boats, or those whose function it is to attack blockading vessels or vessels under ordinary way, the highest speeds are not necessary for purposes of attack. For flight, the higher the speed the better the chances of the boat and its crew, of course, but if the higher speed is attained by the use of a larger and more readily discovered hull, it will avail the boat little in these days of searchlights and rapid-fire guns. It seems, therefore, that all the considerations point to the necessity of keeping the size of the boats small and doing this even at the sacrifice of some speed. It must not be forgotten that these boats have nothing to fear as long as their movements are secret, but that as soon as they are discovered they become targets for the fire of machine guns and other quick-firing small pieces, whose ranges are far greater than the striking distance of a torpedo.

Outside of the "destroyer" type there have been developed two types of boats, sea-going and harbour-defence boats, whose names sufficiently indicate their differences. The sea-going boats are larger and of deeper draught than those intended for harbour and coast line defence. The latter need not go far from their base of supplies, and hence have no need for a large coal-carrying capacity. The sea-going boats must be heavy enough and large enough to withstand rough weather at sea, and must contain sufficient fuel capacity for any ordinary cruise. While there is no very sharp line of demarcation between the two, it is generally recognised that boats smaller than about 140ft. over all and about 110 tons displacement are not fitted for long voyages.

The necessities for a harbour-defence boat are good manœuvring qualities, fair speed in deep and shallow water, the smallest possible draught, and a sufficient armament. The gun armament of such a boat may be reduced to very narrow limits, the only antagonists for which it is provided being small boats or other torpedo boats. A battery of two or three machine guns fulfils all the requirements. The advantage of shallow draught is

* From the *Electrical World* (New York).

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the ability of the boat to elude pursuit by going into shoal water where the enemy cannot follow.

These considerations have been carefully worked out by the designers of steam-driven torpedo boats, and the results that have been attained challenge the warmest admiration. The table below gives some data of typical modern boats.

Name.	Navy.	Length.		Displacement.	Speed.	I.H.P.	Weight of hull.	Weight of machinery
		Ft.	In.	Tons.				
Cushing ...	United States	137	6	105·3	22	1,760	33·7	54 5
Farragut ...	United States	210	0	240	30	5,600	85	120
Porter	United States	175	6	165	28½	3,400	56·5	76·8
Aluminium	France..	60	0	9·5	20½	300	2 0	4·5
Forban	France..	144	3	124·8	31	3,945	45·39	62·67
Sokol	Russia..	190	0	240	29¾	3,700	—	—
Virago	England	210	0	300	30	6,425	—	144·3

It will be seen that a performance as good as 1 i.h.p. from 5lb. of propelling machinery has been attained—propelling machinery including boilers and water-piping, engines, pumps, and condensers. The weights of stacks, screws, and shafts are included in the weights of the hulls.

In attempting to design a torpedo boat for electrical propulsion, it must be remembered that there can be little or no further reduction in the weight of the hulls. The problem resolves itself into replacing the steam machinery with electrical machinery of the same or less weight, which shall give results sufficiently better than those already attained to warrant the substitution. At the first sight this appears impossible, but the factor of visibility is the most important to consider, and with this the general effectiveness of the two types of boats.

Assuming that two boats of equal size and speed are driven respectively by steam and electricity, the electric boat will have an almost immeasurable advantage in her freedom from smoke, steam, noise, and possibility of flaming smokestacks. In all the types of steam torpedo craft now in use forced draught is resorted to for the attainment of the highest speed, and this very often means that unless the greatest care is used a flame is driven out at the stacks instantly proclaiming the presence of the boat and lighting the way for its destruction. This has happened in actual warfare, as at the attack on Wei-Hai-Wei by the Japanese torpedo boats in the recent Japan-China war. At that battle the attacking torpedo boats flamed under their forced draught, and in a few seconds were targets for a fire so hot that but for the incredible badness of the Chinese gunnery they would have inevitable perished.

Perfectly free from this danger the electric boat has the further great advantage of having no smokestacks, which add to the visibility of the steam craft, and no smoke to make it evident to the eyes or noses of the watch on the attacked vessel. Having no boiler or steam-pipes it cannot be put *hors de combat* by a single shot through its upper works, as was the Spanish "Terror" at San Juan de Puerto Rico recently. Indeed, all the machinery of an electric boat can be put below the water-line, so that in smooth sea the upper works of such a vessel could be riddled with shot without putting the boat out of service if enough of her crew were left to operate the machinery.

Of two vessels alike in other respects that one having the greatest manœuvring ability and the quickest response to the desires of her navigator will be best suited for torpedo purposes, and it is in this direction that the advantages and superiority of the electric boat are pre-eminent. There is no necessity for any sort of intermediate signalling between the conning tower and the helm or engine-room on the electric boat, for steering and speed regulations as well as direction are in the hands of one man, through the agency of small appliances not more difficult to work than a street-car controller.

For this summary of the more apparent advantages of the electric type it is at once seen that the gain in secrecy will compensate for the loss in speed that is entailed; for it is not possible to develop a horse-power for any length of time with 5lb. of any sort of electrical machinery now in vogue. There is also a difference in cost of construction in favour of the steam vessel, while the difference in cost of operation is largely in the same direction. The radius of action of the steam type is also much greater, but despite all these sacrifices the superior secrecy of the electric boat, its manœuvring power and instant control, and its safety from annihilation by a single well-directed shot leave the balance in its favour.

After this somewhat lengthy preamble the discussion of the various types of electric boats may be condensed into comparatively small space. Taking a definite example is probably the best way to bring out the nature of the problem offered to torpedo-boat designers who attempt to supersede steam by electricity.

Of recent torpedo boats the U.S.S. "Davis" is an excellent type of the small sea-going variety. This vessel is 146ft. long, 14ft. 6in. beam, and about 5ft. 2in. draught. Her displacement is 110·4 tons, coal capacity 40 tons, radius of action at cruising speed about 4,000 nautical miles, horse-power (indicated) 1,750, and speed 22½ knots. She carries two triple-expansion engines and two Thornycroft boilers. The engines and condensers, with their accessories, weigh 30·22 tons, and the boilers and their accessories weigh 26·78 tons. The hull weighs 42 6 tons. The armament consists of three 18in. torpedo tubes and three one-pounder rapid-fire guns. The boat has quarters for four officers and 20 men.

Suppose the motive-power equipment of this boat to be replaced by electrical machinery for the same purpose of the maximum power for the allowable weight, what would be the result as to the speed, visibility, and effectiveness of the boat?

There are two methods of supplying electric energy to the motors that work the screws—from primary batteries or from accumulators. It is well to look closely into the relative value of these for this purpose, of course without reference to the cost of operation. Singularly enough, for service of this sort, cost of operation is a factor not to be regarded unless so high as to be utterly out of the question. Success is what is demanded of torpedo boats, even if the cost be very high.

The motor equipment should consist of four motors of 400 h.p. each, weighing about 7,000lb. each. These motors would be of a two-pole type, having forged or laminated iron fields of simple shape, and provided with powerful ventilating devices, for it is proposed to work them at their utmost maximum. Their speeds would range up to about 1,500 revolutions per minute, which would necessitate an arrangement of several screws on each shaft, such as experience with the "Turbinia" has shown to be desirable with very high-speed propelling machinery. The aggregate weight of these motors would be 28,000lb., or 12·9 tons. The propelling machinery and coal of the "Davis" weigh together 97 tons, so that in replacing this with electrical machinery of the same weight the allowable weight for batteries, controllers, and wiring is about 84 tons, or 188,160lb. Assume, first, that primary batteries are used. It is well known that of all types of primary battery the element using zinc and black oxide of copper in a solution of caustic alkali gives the largest output of energy for the total weight of materials. In such a cell the materials combine exactly when they are in the ratio represented by the following weights: zinc, 17lb.; copper oxide, 24lb.; caustic (70 per cent.), 21lb.; water, 60lb. These quantities are capable of giving an output of 4,800 watt-hours, or 6·4 horse-power hours, assuming the average E.M.F. to be 0·75 volt. The cells should be designed of the largest size consistent with easy handling, and yet not too large to reduce their number and the terminal E.M.F. to such a point that the current output becomes difficult to handle. The mean seems to lie in cells of about 30in. by 30in. by 26in. size all over. If these are made up in sheet-iron composition-lined tanks, each containing 11 zinc plates and 10 copper oxide plates, 18in. square, they will weigh, complete, with connectors (aluminium) and covers of iron and porcelain, about 1,500lb., and each cell can give 1,000 amperes at 0·75 volt for 6·4 hours.

Using such cells as these it is seen that the "Davis" could carry about 116 of them, allowing about 14,000lb.

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for controller and circuits. This would give only 116 h.p. for 6·4 hours, or 730 h.p. for one hour, corresponding to a speed of about 13 knots. Of course this figure, coupled with an endurance of only one hour, makes this kind of equipment out of the question, the figures being given merely to show its fallacy.

With storage batteries the case is somewhat different. Among the various types of light batteries adapted to withstand large discharge currents which have been brought out for traction and automobile vehicles, the lead-zinc-cadmium cell of Werner seems as promising as any. This cell consists of a positive plate of the usual lead grid type and a negative plate of zinc, the electrolyte being a solution of cadmium and zinc sulphates, with a little magnesium sulphate. In recent trials of electric carriages equipped with this battery 30 cells, weighing 334 kg., gave 30 amperes for six hours. This rate of discharge corresponds to about 1·5 h.p. after allowance is made for all losses in the motor and circuits. At this rate of discharge, then, the battery gives 1·5 h.p. for six hours from 735lb. of cells, corresponding to 6·5 h.p. for one hour from the same weight, or 1 h.p. for one hour from 113lb. of cells, these figures making allowance for the less capacity of the battery at a high rate of discharge. Assuming that the "Davis" can float 175,000lb. of batteries, this means that with cells of this type the mechanical energy at the screws would be 1,530 h.p. if the battery is discharged in one hour, corresponding to a speed of about 22 knots. This would be the rush speed for attacking. The battery could maintain an effort of 250 h.p., corresponding to a speed of about 10 knots, for more than 10 hours, thus giving the boat a cruising radius at that speed of about 100 nautical miles. It will thus be seen that the electrical equipment of the boat has cut down its radius of action from 4,000 to 100 miles, left its speed unchanged, and decreased its visibility by a considerable amount. If it be assumed that the distance at which the vessel become visible is that at which its area of exposed surface subtends a certain definite solid angle, this boat with its new equipment would come 1·47 times closer to the enemy than before without danger. This figure does not include the area of the smoke that is certain to be given out by the steam apparatus, nor does it make any allowance for the chance of flaming funnels.

By sacrificing so much of the cruising radius that the vessel is tied closely to its base a gain of a considerable amount is made in both invisibility and the manœuvring power of the boat, while its attacking speed is but slightly diminished. It seems, therefore, that the value of this boat, once in action, is much greater than when equipped with steam machinery, but that its ability to get into action is limited on account of its small cruising radius. The obvious remedy for this trouble is a tug. Such a boat if needed for service at a distance could be towed at fair speed to a point near the scene of operations, to which it could return after completing its mission. Naturally, such a boat would be useless as a dispatch boat or patrol boat, but for its purely legitimate functions as a torpedo boat there is no question at all that it is a better boat than if equipped with steam machinery.

THE ARCHÆOLOGY OF SUBMARINE TELEGRAPHY.

BY J. J. FAHIE, M.I.E.E.

Messrs. Crosby Lockwood and Son have recently published a bulky volume on *Submarine Telegraphs: Their History, Construction, and Working*, in nearly 800 pages, very fully illustrated.

A work on this subject by any capable writer would, I feel sure, be hailed with pleasure throughout the profession, and possibly also by the general public in English-speaking lands, seeing that submarine telegraphy is entirely a product of British enterprise and skill; but when it is added that the author of the work referred to is a son of Sir Charles Bright, one of the pioneers of Atlantic telegraphy, that he is the possessor of his father's electrical library, as well as all his MSS. notes, and paper cuttings from 1847 onwards, and that he has himself been actively engaged in cable work for many years, it will be seen how well qualified Mr. Charles Bright is for the task that he has undertaken. That he has done it well I am, perhaps, in a better position to judge than most people, for I have myself been engaged for many years in collecting materials with a view to a very similar publication—even to the title.

In my *History of Electric Telegraphy to 1837*, published in 1884, the following passage occurs: "Soon after joining the telegraph service, in 1865, my archæological bent took another turn, and I now began to collect books and scraps on electricity, magnetism, and their applications—particularly to telegraphy. In 1871, having amassed a large number of notes, scraps, etc., on submarine telegraphs, I began a work on the history and working of the Persian Gulf cables, with which I had then been connected for over three years. Gradually this developed itself into an ambitious treatise, which I styled 'Submarine Telegraphs: Their Construction, Submersion, and Maintenance, including their Testing and Practical Working.' Of this some 300 pages (foolscap) are now lying 'submerged' in the depths of my trunk, to be, perhaps, 'recovered' at some future day." (Preface, p. viii.)

Having lately retired from active service, I was about to resume the undertaking, when I saw the announcement of Mr. Bright's treatise. I at once offered to join forces with that gentleman, but, unfortunately for me, his work was too far advanced to admit of such an arrangement. After an examination of Mr. Bright's work, I must say, and I say it ungrudgingly, that the profession and the general public will lose little, if anything, by the non-success of my negotiations. True, it was my intention to go more fully into the early history of the subject, with its many debatable incidents, than is done by Mr. Bright, but after all, his presentation may be considered ample for all practical purposes, and he acts wisely, perhaps, in not recalling too minutely the many burning questions which embittered the relations of some of the early pioneers.

Mr. Bright's references to pre-practical history are very slight—indeed, he disposes of it in a couple of sentences. He then takes up the account of Wheatstone's proposals of 1840, and from this point onward his history is as full as could be expected in a work of such a comprehensive character. In the belief that it will not now be uninteresting to supplement some of Mr. Bright's deficiencies, I have collected the following notes on what I may call the archæology of submarine telegraphy.

Tiberius Cavallo—1795.

The first proposal for an electric telegraph of any sort was contained in a letter to the *Scots' Magazine*, Edinburgh, dated Feb. 17, 1753, the author of which is only known to us by the initials "C. M." In the next 40 years many other proposals were made by various authors,* and in three of these underground wires were contemplated—viz., by Bozolus, in 1767; by an anonymous French writer, in 1782; and by Le Sage, also in 1782. But it was not until 1795 that Cavallo, an Italian philosopher, then resident in London, first distinctly foresaw the possibility of transmitting electric signals under water through insulated wires.

In his *Complete Treatise on Electricity* (London, 1795), he says: "The attempts recently made to convey intelligence from one place to another at a great distance, with the utmost quickness, have induced me to publish the following experiments, which I made some years ago. The object was to fire gunpowder, or other combustible matter, from a great distance, by means of electricity. At first a circuit was made with a very long brass wire, the two ends of which returned to the same place, whilst the middle was at a great distance. At this (middle) point an interruption was made, in which a cartridge of gunpowder mixed with steel filings was placed. Then, by applying a charged Leyden phial to the two extremities of the wire, in the usual way, the cartridge was fired. It proving very troublesome to keep the wires from touching, the experiment was tried with one wire only. A brass wire, one-fiftieth of an inch diameter, and 200ft. long, was laid along the ground, and one end was inserted in the cartridge of gunpowder and steel filings. Another piece of the same wire had, likewise, one end inserted in the cartridge, whilst the other was thrust into the ground. The distant end of the long wire was then connected to the inner coating of a charged jar, while the outer coating was touched with a ground wire. The discharge took place as before, and the powder fired."

Cavallo next directed his attention to the best means of insulating the communicating wire, and at last so contrived that it might be laid indifferently on wet or dry ground, *or even through water*.

"A piece of annealed copper or brass wire," he says, "being stretched from one side of a room to the other, heat it by means of a flame of a candle, or of a red-hot piece of iron, and, as you proceed, rub a lump of pitch over the part just heated. When the wire has been thus covered, a slip of linen rag must be put round it, which can be easily made to adhere, and over this rag another coat of melted pitch must be laid with a brush. This second layer must be covered with a slip of woollen cloth, which must be fastened by means of a needle and thread. Lastly, the cloth must be covered with a thick coat of oil paint. In this manner many pieces of wire, each of about 20ft. or 30ft. in length, may be prepared, which may afterwards be joined together, so as to form one continued

* For an account of all of these, and many other later ones, the reader is referred to my *History of Electric Telegraphy to 1837*.

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metallic communication ; but care must be taken to secure the places where the pieces are joined, which is most readily done by wrapping a piece of oil silk over the painted cloth, and binding it with thread. When a long wire has been thus made out of the various short pieces, let one end of it be formed into a ring, and to the other adapt a small brass ball.

"Through the wires so prepared the flask of inflammable air was always exploded, and whenever the discharge was passed through a flask of common air a spark was seen, and by sending a number of such sparks at different intervals of time, according to a settled plan, any sort of intelligence might be conveyed instantaneously" (vol. iii., pp. 285-96).

Francisco Salva—1795-1804.

The next proposal with which we have to deal in these articles is to be credited to Don Francisco Salvá, of Barcelona, who of all the pioneers of electric telegraphy in the last century deserves most honourable mention, as well for the extent and completeness of his designs as for the zeal and intelligence with which which he carried them out. His proposals are described with great clearness in a memoir which he read before the Academy of Sciences, Barcelona, Dec. 16, 1795, and from which we cannot do better than make some extracts :

"If," he says, "there were a copper wire from this city to Mataro, and another from Mataro back, and a man were there to take hold of the ends, we might, with a Leyden jar, give him a shock from this end, and so advise him of any matter previously agreed on, such as a friend's death. But this is not enough, as, if electricity is to be of any use in telegraphy, it must be capable of communicating every kind of information whatsoever; it must, in a word, be able to speak. This is happily of no great difficulty.

"With 22 letters, or even with 18, we can express with sufficient precision every word in the language, and thus with 44 wires from Mataro to Barcelona, 22 men there, each to take hold of a pair of wires, and 22 charged Leyden jars here, we could speak with Mataro, each man there representing a letter of the alphabet, and giving notice when he felt the shock.

"It is not necessary to keep 22 men at Mataro, or 22 Leyden jars at Barcelona, if we fix the ends of each pair of the wires in such a way that one or two men may be able to discriminate the signals. In this way six or eight jars at each end would suffice for intercommunication, for, of course, Mataro can as easily speak with Barcelona, as Barcelona with Mataro.

"It appears, however, little short of impossible to erect and maintain so many separate wires, for, even with the loftiest supports, boys would manage to injure them ; but as it is not necessary to keep them far apart they can be rolled together in one strong cable, and placed at a great height. In the first trials made with a cable of this kind I covered each wire with paper, coated with resin, or some other idio-electric substance, then, tying them together, I bound the whole with more paper, which effectually prevented any lateral escape of the electricity. In practice the wire cable could be laid in subterranean tubes, which, for greater insulation, should be covered with one or two coats of resin."

In selecting Barcelona and Mataro, distant about 13 miles, Salvá did not imply that this was the limit at which his telegraph would be practicable : on the contrary, he thought it very probable that the distance at which the electric discharge would be effective was proportional to the number of jars, and therefore that with a large battery telegraphic communication may be established between Barcelona and Madrid, and even between places 100, or more, leagues apart.

After showing the superiority of an electric telegraph over the optical (semaphore) system then in use, he lays special stress on the advantages of the former as regards communication between places separated by the sea, and adds :

"In no place can the electric telegraph [wires] be better deposited. It is not impossible to construct, or protect, the cables with their 22 [pairs of] wires so as to render them impervious to the water. At the bottom of the sea their bed would be ready made for them, and it would be an extraordinary casualty indeed that should disturb them. . . . .

"In 1747, Watson, Bevis, and others, in England, showed how the water of the Thames may be made to form part of the circuit of a Leyden jar, and this makes us consider whether it would not suffice for our telegraph to lay a cable of 22 wires only across the sea, and to use the water of the latter in place of the return wires."

In the experiments with which Salvá illustrated his paper, the 17 essential letters of the alphabet (for he omitted those little used, or whose power could be represented by others) were cut out of parallel strips of tinfoil, pasted on bits of glass, after the fashion of spangled panes, and to the ends of each piece of tinfoil were attached the extremities of the corresponding pair of wires. All the wires were bound up in two cables, which were prepared in the way before described, the outgoing wires being collected in one cable, and the return wires in the other.

To indicate a letter, A, for example, it was only necessary to take the ends of the corresponding pair of wires, and connect one end with the outer and the other with the inner coating of a charged jar. Immediately on thus completing the circuit, the observer, at the other end of the cable, heard the noise of the spark, and saw it illuminate the letter A in its passage across the breaks in the tinfoil.

From 1796 to 1799 Salvá resided at Madrid, having been invited by the Academy of Sciences of that capital to engage in some experiments of great public interest. There he had the *entrée* of all the *salons*, and was courted by everybody of consideration—amongst the rest, by the Infante Don Antonio, who appears to have assisted him in perfecting his telegraph. The favourite Godoy, Prince of Peace, was another good friend, to to whom Salvá was indebted for an introduction to the King, Charles IV., as we learn from the following paragraph in the *Gaceta de Madrid*, Nov. 29, 1796 : "The Prince of Peace, who testifies the most laudable zeal for the progress of the sciences, understanding that Dr. Francisco Salvá had read at the Academy of Sciences, at Barcelona, a memoir on the application of electricity to the telegraph, and presented at the same time an electrical telegraph of his own invention, requested to examine the apparatus himself. Satisfied with the exactness and celerity with which communications may be made by its means, he introduced the doctor to the King of Spain. The Prince of Peace afterwards, in the presence of their Majesties and the whole Court, made some communications with this telegraph, completely to their satisfaction. The Infante Don Antonio proposes to have one of them of the most complete construction, which will possess power sufficient to communicate between the greatest distances, by land *or sea*. With this view, his Highness has ordered the construction of an electrical machine, the cylinder of which is to be more than 40in. in diameter. He intends, as soon as it is finished, to undertake a series of curious and useful experiments in conjunction with Dr. Salvá. This is an employment worthy of a great prince. An account of the results will be given to the public in due course."

Notwithstanding this promise, the subject is not again referred to in any succeeding number of the *Gaceta* ; but according to Dr. Balcells, the friend of Salvá, a modification of his telegraph, which required only one wire, was actually constructed in 1798 between Madrid and Aranjuez, a distance of about 26 miles. Humboldt, at p. 14 of Gauss and Weber's *Resultate* for 1837, refers to this line, but credits it to Bétancourt, a French engineer. This is clearly a mistake, into which the great traveller might have been led by the probable fact that an engineer of that name was employed to superintend the work.

Dr. Balcells, whose evidence as just quoted should be conclusive on this point, says, further, that the remains of Salvá's telegraph, which at first were destined for Don Antonio's museum, were presented in 1824 to the College of Pharmacy of San Fernando, of which he (Balcells) was then the adjutant.

Salvá has the further credit of being the first to employ current or dynamic electricity for signalling, an honour which is generally attributed to another distinguished physicist and telegraph pioneer, Sömmerring, of Munich, but whose proposals came several years later, 1809-12. At a meeting of the Academy of Sciences (Barcelona, May 14, 1800) Salvá read a second paper, entitled *Galvanism and its Application to Telegraphy*, in which he said that since his first paper was written in 1795 he had often meditated on galvanism, and on the best way of applying it to telegraphy. He relates the experiments made for this purpose at his house with a line some 350m. long, stretched to and fro in his garden, and fastened at the ends to varnished glass insulators. On touching with the ends of the wire the leg and thigh of a frog he produced the well-known convulsions of the animal's body, notwithstanding the great length of the conducting arc, and he expressed the conviction that the same effect would be possible through wires of several leagues in length.

Thus, by substituting for the tinfoil letters of 1795 as many frogs, suitably connected as to their nerves and muscles, one could easily construct a galvanic telegraph, with the advantage of greater simplicity and durability. "Both plans," he says, "demand the same arrangement of wires, but the spark form requires a powerful electrical machine, Leyden jars of great capacity, and much time in charging them. The galvanic telegraph, on the other hand, is always ready and instantly effective. Frogs are animals of little value, and can be kept alive for several months in a basin of water, and although it may be necessary to change those in use every two hours, the trouble would be slight.

"Certain physicists are now occupied in studying the phenomena of galvanism in man and other living animals, and it may not be difficult to find an animal more advantageous to the telegraph than the humble frog."*

On Feb. 22, 1804, Salvá read before the Barcelona Academy a third paper, called *The Second Treatise on Galvanism Applied to Telegraphy*. In this paper, he says that when he read the previous one in 1800, he had not heard of the apparatus invented by Volta, called *Volta's column or pile*, which is not strange, con-

* Salvá was not alone in this expectation. See Highton's *Electric Telegraph: Its History and Progress*, p. 22. London, 1852.

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sidering its so recent invention, and that it was not made public at all until the middle of the year 1800, when it was published in *Nicholson's Journal*. After many valuable observations on the theory and action of the pile, he concludes that nothing could be better adapted as the motive force of his telegraph, especially as he clearly foresaw the eventual obtainment of piles of greater strength and constancy.

As to the mode of indicating the signals, Salvá alludes parenthetically to the convulsions of frogs under the action of the pile, through long lengths of wire, and then says, "Certainly, the combustion of metals, and the decomposition of water by the voltaic pile, are the effects with which we should concern ourselves. Up to the present no one has produced combustion at a great distance, but it seems probable that water could be decomposed through long conductors as effectively for telegraphic purposes as it had been done through short pieces of wire. It would suffice for the ends of each pair of wires to be inserted through a cork, 1in. apart, into a glass tube containing water. As the wire that communicates with the copper or silver disc of the pile is covered with bubbles of hydrogen gas, and the other is oxidised, these actions would economise, in the difference of their effects, one half the number of line wires, since in applying the wires in a certain way to the poles of the pile, the letter A, for example, could be indicated by the bubbles appearing on one wire, and by reversing the contacts the letter B would be indicated by the bubbles now appearing on the other wire. Six pairs of wires would thus be enough for a telegraph, which would greatly reduce the expense and simplify the installation."

Samuel Sömmerring—1809-12.

The name of Dr. Samuel Sömmerring, of Munich, is sometimes mentioned in connection with early attempts at subaqueous telegraphs, but without any reason. The claim was probably based on experiments which are thus described in Hamel's *Historical Account of the Introduction of the Galvanic and Electromagnetic Telegraph into England* (Cooke's Reprint, London, 1859, p. 17): "On the two following days [June 6 and 7, 1811] Sömmerring made, together with Baron Schilling, first across a canal on the River Isar, and then along the river itself, experiments similar to those made by Galvani's nephew, Giovanni Aldini, in 1803, near Calais in the sea, and near Charenton on the River Marne."

Now, a representation of the Calais experiment is given in Aldini's book, *Essai Théorique et Expérimental sur le Galvanisme* (Paris, 1804), and clearly shows that this was not a submarine experiment as we now understand the phrase, but simply an early (indeed, it was the first on record) use of the earth and water to complete the circuit for current electricity, as had long been the custom in experiments with electricity in the static form. In Aldini's experiment the conducting wire was supported on the masts of boats, and probably Sömmerring adopted a similar contrivance—that is, if he needed it at all.

Again, had Sömmering really laid his wires under the waters of the canal, and signalled through them in the presence of his friend, Schilling, the latter need not in the following year, 1812, have zealously endeavoured (as Hamel says he did) "to invent an electrical conductor and an apparatus with which he might ignite gunpowder at a distance, not only through moist earth, but even through water." Nor would Sömmering have thus referred to Schilling's quest in his diary: "8th April, 1812—Schilling arrives, almost out of breath, with his idea about blowing up mines. Take care!" "13th May, 1812—Schilling is quite childish about his electro-conducting cord and apparatus for igniting gunpowder."*

Johann Christian Schweigger—1811.

Although, then, there is no basis for the claim set up for Sömmerring, of a subaqueous telegraphic experiment, still his inventions have the credit of being the immediate cause of such a suggestion by his friend Prof. Schweigger, of Nürenberg, afterwards so well-known as the inventor of the galvanometer, or, as he called it, the electromagnetic multiplier (1820).

In his account of Sömmerring's telegraph in the *Journal für Chemie und Physik*, 1811, vol. ii., p. 240, he shows how the number of wires might be reduced from 35 to 2, and then adds: "A reduction of the number of wires recommends itself for various other reasons, and there would be no objection to selecting the best brass wire, superficially oxidised, then carefully varnished and wound with cords, boiled in oil. Such wires might be safely placed in the muddy beds of rivers."

This, however, was not more than a bare suggestion, thrown out *en passant*, for he did not expect "that there would be a demand for more than telegraphic communication between the distant parts of a fortress, or at most between several fortresses, for which purpose the wires ought to be kept as secret as the mines of ordinary warfare."

* For a full account of Sömmerring's telegraph, which was based on the same water-decomposing principle as Salvá's, and was not very dissimilar in detail, see the writer's *History of Electric Telegraphy to 1837*, pp. 227-43.

J. R. Sharpe—1813-16.

The next to propose a subaqueous telegraph was John R. Sharpe, of Doe Hill, Derbyshire, but, unfortunately, we have no account of his *modus operandi*—at least, I have not succeeded in finding anything beyond the following meagre paragraph in the *Repertory of Arts* for June, 1816:

"On the Electric Telegraph." Communicated by Mr. J. R. Sharpe, of Doe Hill, Alfreton. In the *Repertory of Arts*, vol. xxiv., second series, p. 188, is an account of an electric telegraph by M. Soemmering. This account I did not see till a few weeks ago. Without the slightest wish to throw a doubt over the originality of M. Soemmering's invention, I beg leave to mention that an experiment, showing the advantages to be obtained from the application of the certain and rapid motion of the electric principle through an extensive voltaic circuit to the purposes of the ordinary telegraph, was exhibited by me before the Right Hon. the Lords of the Admiralty, in the beginning of February, 1813."

My Lords are said to have approved the design, but put it aside, as they had done many others, with the remark that "as the war was over, and money scarce, they could not carry it into effect."*

Mr. Benjamin Sharpe, writing in 1861 (*A Treatise on the Construction and Submersion of Deep-Sea Electric Telegraph Cables*) says, in reference to the above extracts, "In the general progress of deep-sea telegraphs I naturally take a deep interest, as an uncle of mine was the first inventor of submarine telegraphs, having as early as the year 1813 conveyed signals a distance of seven miles under water" (p. 16). In the hope of getting further information, the present writer entered into correspondence in 1883 with this gentleman, but, unfortunately, he could add nothing to the above-mentioned facts.

It was probably anent Sharpe's proposals that the following squib was published in *The Satirist* for September, 1813:

"Our telegraphs, just as they are, let us keep,
They forward good news from afar,
And still may send better—that Boney's asleep,
And ended oppression and war.

Electrical telegraphs all must deplore,
Their service would merely be mocking;
Unfit to afford us intelligence more
Than such as would really be *shocking*!"

Baron Schilling—1812-37.

The inventions of Baron Schilling, the friend, as we have seen, of Sömmerring, form a very interesting episode in the history of telegraphy, not only because his proposals were by far the most practicable of those that had hitherto been made, but because his instrument was the prototype of Cooke and Wheatstone's first needle telegraphs, and was the immediate cause of the introduction of electric telegraphs into England.†

According to Dr. Hamel (*Historical Account*, etc., Cooke's reprint), Baron Pawel Schilling (of Canstadt), then an *attaché* of the Russian Embassy at Munich, saw for the first time on Aug. 13, 1810, a telegraph (Sömmerring's) in action, and so impressed was he with the beauty and utility of the contrivance that from that day electricity and its applications became one of his most favoured studies. In the following five or six years his duties frequently took him to Munich, and at these times he was a constant visitor at Sömmerring's house, whither he delighted to bring his friends from all parts of Europe to witness the performances of the telegraph. Indeed, during much of this time he may be said to have lived in an electrical atmosphere in the society of Sömmerring, Schweigger, and other kindred spirits.

(To be continued.)

The Leakage Field in Coupled Sets.—Mr. J. F. Kelly, of the Stanley Company, of America, has patented a device for preventing the leakage of lines of force from a dynamo or alternator into the engine coupled to it. The patent illustration shows an inductor type of alternator with a single coil. In this case the shaft is magnetised, and leakage lines tend to pass through the working parts up to the cylinders and bed-plate, and hence back to the alternator frame. To prevent this Mr. Kelly proposes to use a second coil round the shaft near the coupling, and to so proportion the ampere-turns in it that the magnetomotive force of the large coil is neutralised.

* *Saturday Review*, Aug. 21, 1858. In the early years of the century, my Lords were evidently pestered with electric telegraphs. Wedgewood, 1814; Ronalds, 1816; Porter, 1825; "Corpusculum," 1832; and Alexander, 1837, all submitted proposals, and all were snubbed in the same laconic way as Mr. Sharpe.

† See Cooke's *The Electric Telegraph: Was it invented by Prof. Wheatstone?* London, 1854, pp. 24-6.

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GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE II.

(Continued from page 247.)

Chemical Washing Process.

We must now briefly consider the chemical washing process. Charles Hancock, in his patent specification (No. 11,208 O.L.) of May 15, 1846, proposed to steep the raw guttapercha, after it had been cut up into small pieces, in a solution of caustic alkali or choride of lime to neutralise the acidity and remove any unpleasant odour. If a hot solution of caustic alkali is used in the washer in place of water, the material becomes much cleaner and attains a lighter colour. I have here two specimens of the same guttapercha; the one which I hold in my left hand has been washed with water in the usual way; the other, in my right hand, has had an additional washing with a weak solution of sodic hydrate, and you observe the notable difference in colour. I have made numerous experiments on the chemical washing of guttapercha, but will content myself with describing the result of one of them. A particular raw guttapercha belonging to the class of materials which do not readily part with their impurities, was twice washed with water, then rolled out into sheet and analysed. It was found to contain 12·7 per cent. of water and 1·7 per cent. of dirt. Another portion of the same raw material was washed with a 5 per cent. solution of sodic hydrate, then with water, rolled out into sheet, and analysed as before. The analysis now gave only 5·2 per cent. of water and 0·4 per cent. of dirt. This experiment clearly shows that the treatment with the alkaline solution not only reduced the percentage of dirt to less than one-fourth of the original amount, but it also affected the capacity for retaining mechanically enclosed water. The treatment of guttapercha with hot alkaline solutions, or lyes, or in fact with any other chemicals, requires great care and judgment, and the subsequent washing with water must be done very thoroughly, otherwise the material may be detrimentally affected and perish after a comparatively short time.

Chemical Hardening Process.

I will now describe the process for hardening guttapercha which I introduced about 16 years ago. As you will remember, I pointed out in the last lecture that the really valuable constituent of guttapercha is the gutta, and the more a material contains of it the better it is, provided the gutta itself is of good description. Now, for certain purposes, it is advantageous to improve the hardness and other mechanical properties of guttapercha, and this can be done by extracting the resin with a suitable solvent which leaves the gutta itself intact.

I have here some cubes of raw guttapercha immersed in different liquids, and you observe that they have retained their original form and sharpness of outline; but if you were to examine the liquids you would find that every one of them was charged with the resinous substances originally contained in the guttapercha. One of the liquids is ether, the other a saturated solution of carbon disulphide in alcohol, and the third light petroleum spirit. It is the last-named liquid, variously known as lythene, rigolene, gasolene, etc., and having a specific gravity of 0·65 to 0·67, which I use for my hardening process.

Fig. 31 gives a schematic view of the various apparatuses employed for that purpose. In those on the left, the different preparatory processes are carried out and in the others on the right, the actual treatment takes place.

The raw guttapercha is first chopped, then thrown through a screen, *s*, on to a long drying platform, P_1, gently heated from below by a system of steam-pipes. The material is shovelled along, and thereby continuously turned over, until it reaches the other end of the platform, where it is thrown on to a second and lower platform, P_2, and there similarly moved along to the other end. By this time the guttapercha should have become fairly dry; but in order to complete the drying, it is now thrown into the hopper, h_1, of a long iron drum, D, provided with narrow shelves, which takes it round for a certain distance, when the drum is rotated and at the same time move it along, since the axis of rotation is slightly inclined towards the other end. A gentle current of warm air, passed through the drum in the opposite direction, carries away the moisture given off by the material, and thus accelerates the drying. After leaving the drying drum, the pieces enter the sifting drum, S, the finer particles falling through the openings, and the coarser pieces moving along inside, until they are discharged at the other end of the drum, where they fall into an upright iron vessel, V, provided with a suitable distributing arrangement. The finer material, on the other hand, drops on to an endless band, *t*, and is carried along by it to a bin, B. The coarse and fine materials are thus effectually separated. The galvanised-iron tank, *a*, provided with a hinged lid and a movable plate in front, can be carried about by an overhead travelling crane. The tank is charged first with a layer of coarse pieces from the vessel, V, then with finer stuff from the bin, B, and finally again with coarse pieces, the depth of each layer depending upon the particular material to be treated. This is done to facilitate the percolation of the solvent during the extraction process. The bottom of the tank, *a*, is perforated and covered with wire gauze. After the tank has been charged, as just described, it is carried over to the other side and deposited in one of the larger tanks, A, B, or C, of which there may be any number connected up *en cascade* by a system of pipes. These tanks, after having each received one of the smaller ones, *a*, filled with raw guttapercha, are worked in groups of three, to which number the schematic drawing is confined. Petroleum spirit from a large store vessel overhead, T_2, is admitted to the first tank of each group—A, for instance—and flows over into the next tank, B, and from this into the third, C, filling all three in succession. The circulation of the "spirit" is carried on until it is found to be quite clean as it leaves the first tank; this tank is then disconnected from the two others, and a tank with fresh raw material connected to the former No. 3, the second one in its turn now becoming the first, and so on.

The solution which comes from the third tank of a group is pretty thick, containing a large amount of resin. It is run into tank, T_3, and from there in a continuous stream into a large still, S, provided with a steam coil at the bottom. The contents of the still are heated, the "spirit" distilled off and condensed in a suitable cooling arrangement, C_2, which delivers it into the main store tank in the cellar, T_1, whence it is pumped up again into tank, T_2.

The "spirit" from tank A is run off into tank T_1, the material further washed with clean spirit and then allowed to drain, whilst communication still exists with the tank. The inner tank, *a*, is now lifted out and brought to the front of the large masticator, M. It is laid on its side, pushed into the mouth of the masticator, and the contents discharged by withdrawing the side of the tank, which now forms the bottom, the masticator having previously been filled with cold water. After removing the tank the large swing-door of the masticator is closed, steam is turned on, and the rollers set in motion so as to knead the guttapercha whilst the solvent is being distilled off. When the distillation ceases the remaining vapours are blown over into the condenser by means of steam, the masticator is then opened, the guttapercha taken out and washed in the usual way with water, or, if necessary, with an alkaline solution.

The distillation of the resinous solution is carried on until the contents of the still, S, have become very thick, and the solvent, in consequence, distils over only tardily. The supply of fresh solution is then interrupted, the valve between still and condenser closed, but the heating continued until a certain pressure has been produced by the vapours, which is then utilised to force the contents of the vessel into another still, situated at a safe distance outside the building, where the heavier parts of the solvent are distilled off by heating directly over a fire. This done, the contents of the still are discharged through a kind of treacle-valve, and run into barrels or other suitable receptacles for further use or sale.

I ought to mention that all the different tanks are mutually connected by means of a system of air-pipes, provision being made that flames cannot spread from one to the other in case of fire. The main pipe of this system is finally carried to the vessel V (of which there are two, used alternately), containing coarse pieces of dried raw guttapercha, as already mentioned. The air in passing through the guttapercha before being discharged into the open is thus deprived of all vapours, which is very desirable for safety as well as economy.

I will now show you some of the actual machinery employed for this hardening process, on the screen. (Views were then shown of the interior of the works, in which the treatment with petroleum spirit is carried out.)

Before leaving this subject I should like to demonstrate to you by a simple experiment the efficiency of the hardening process. Here are two portions of raw guttapercha from the same block cut up into small cubical pieces; one portion is still in its original condition, but the other has been treated with petroleum spirit to extract the resin as completely as possible, and was then freed from the solvent in vacuo at a slightly elevated temperature. This large glass vessel containing water is being heated on a sand bath, and the water has now reached a temperature slightly above 50deg. C. A smaller glass beaker, also containing water, is immersed in the outer vessel, and its contents, therefore, have practically the same temperature, or, if it should be different, a slightly lower one. I now throw the original material into the inner vessel, and the hardened one into the outer, and leave them there for a short time until they have acquired the temperature of the water. I try to squeeze the pieces of treated guttapercha between my fingers, but they resist the pressure, as they are still quite hard. I do the same with the original material inside

* Cantor Lectures delivered before the Society of Arts.

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the beaker, and you observe that it is quite soft and plastic. I shall recur to the great difference in the softening temperature of materials, with different percentages of resin, in my next lecture.

Extraction from Raw Materials.

Instead of removing the impurities from raw guttapercha by washing it either with water or an alkaline solution, as described in the first part of this lecture, this can also be done by dissolving the guttapercha in a suitable liquid, straining or filtering the solution, and then evaporating the solvent. This method has repeatedly been employed and had, as we have seen, already been suggested by Charles Hancock in 1846 (Patent Specification, No. 11,032*, O.L.). I myself tried this mode of purification on a rather large scale some 20 years ago, using carbon disulphide as the solvent; but I soon abandoned it again, as it was found that the cleaned guttapercha thus obtained, although apparently of excellent quality, shortly after it had been produced, nevertheless quickly perished; and this appears to be the fate of most materials obtained by evaporation of the solvent, probably because the molecular structure of the gutta is thereby affected. But there is yet another method of reclaiming a dissolved substance—viz., by precipitation, and this also is frequently employed for guttapercha.

Here is a solution prepared from raw guttapercha by means of carbon disulphide, and you observe that the dirt has settled down at the bottom. Part of the clear solution has been decanted off and the solvent evaporated, the residual guttapercha being pressed into this plate. Another portion of the solution is in this tall test mixer, and I will now add an excess of alcohol and shake it up. You see a whitish precipitate is being formed, which could be separated from the liquid by filtration and made into a plate like the one I have just shown you. There would, however, be this difference in the composition of the two plates, that the one obtained by evaporation of the solvent contains all the resin originally present in the raw material, whereas the other, obtained by precipitation, consists practically of pure gutta; and such is the case with all processes in which precipitation is employed.

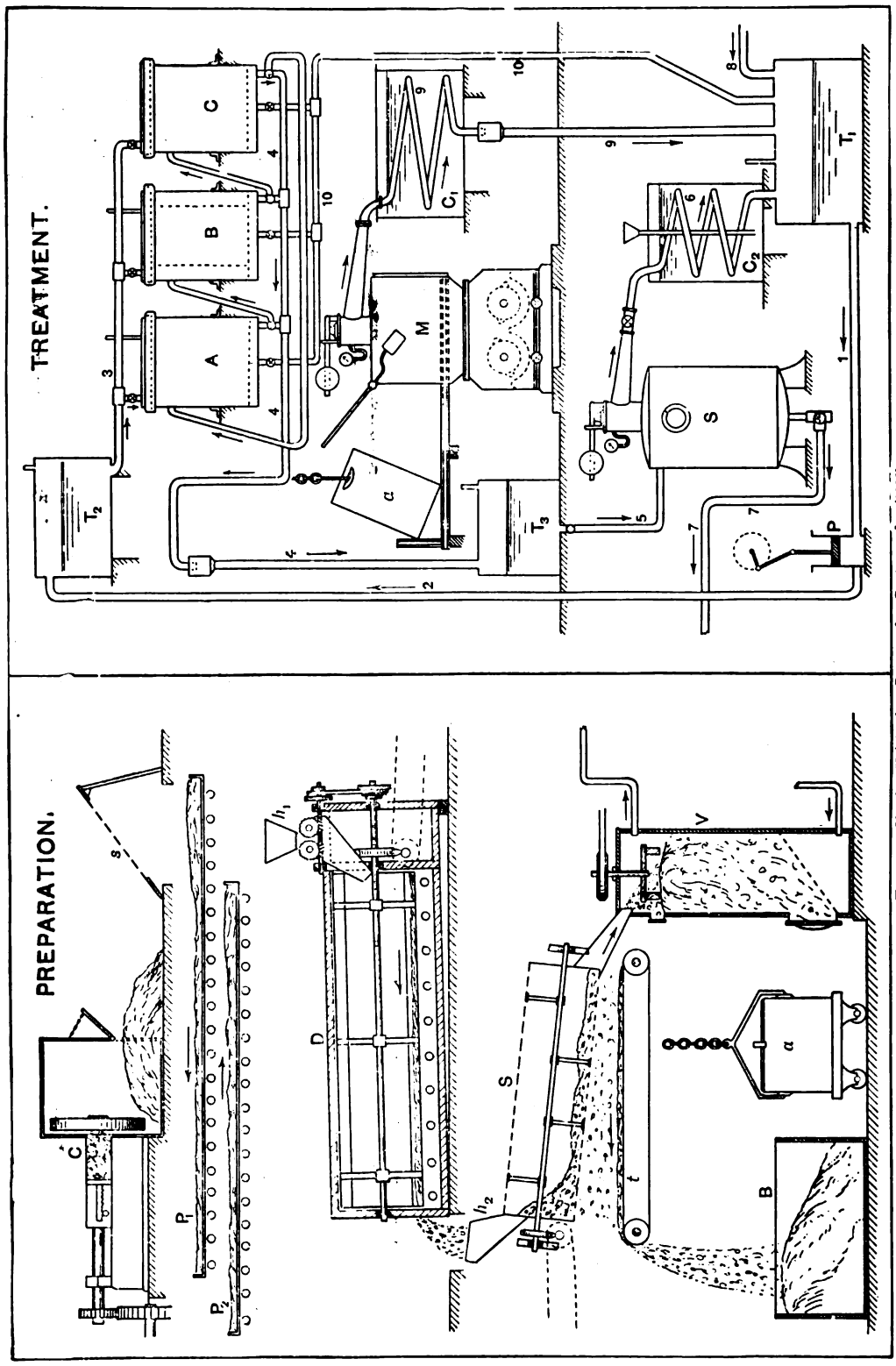

Fig. 31.—Obach's Hardening Process for Guttapercha (1880).

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Extraction from Leaves.

The present method of obtaining guttapercha from the latex in the bark of the trunk after felling the tree is, no doubt, a very crude and wasteful one, and consequently any feasible suggestion to remedy this state of affairs deserves our most serious consideration. It is now about six years since a proposal

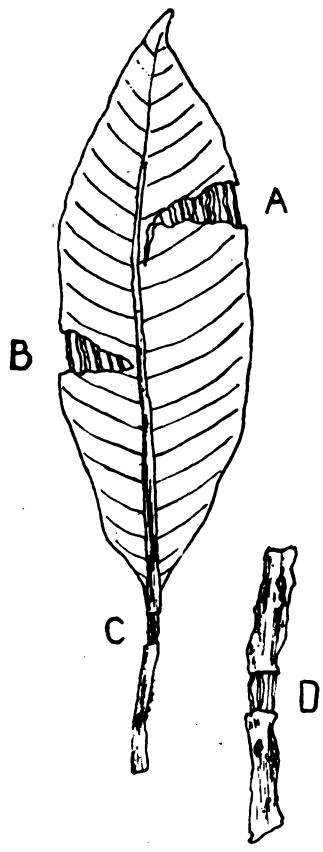

Fig. 35.—Leaf and Stem of Palaquium Gutta, showing Threads of Latex.

was made to extract guttapercha from the removable parts of the tree—such as small branches, twigs, and leaves—which can be plucked without injury to the tree, instead of from the trunk. In this way, besides saving the life of these valuable trees, other advantages would accrue, one of them being that adulteration could less easily be practised, the leaves of the gutta tree being easily recognisable, and not very difficult to distinguish from those of other trees, even of kindred species.

Examining a small branch and several leaves of Palaquium (Dichopsis) gutta, you observe the characteristic projection or beak at the upper end of the leaves, and their pronounced reddish-brown tinge and silky lustre. If you were to examine the leaves closely, you would see that each of them has at least 22 lateral veins branching out on both sides of the mid-rib, mostly at an angle of about 70deg. or 80deg. Compare these with the leaves of the branches of Dichopsis polyantha and Dichopsis pustulata, and you cannot fail to be struck by the great difference between them, not only with regard to the size and shape, but particularly in the number and prominence of the secondary veins, which are only 12 to 15 on each side of the mid-rib, instead of 22 and more. Some time ago I examined numerous specimens of sapotaceous plants in the Berlin Herbarium, measuring the leaves and counting the lateral veins, and I arrived at the conclusion that none of them could be confounded with those of the true gutta trees. I may add that in the case of the two inferior species of Dichopsis, which I have just shown you, the angle between the lateral veins and the mid-rib is also a more acute one—*i.e.*, generally less than 70deg.

If a leaf or leafstalk from Palaquium gutta is torn or broken asunder, it is found that a number of tiny white threads, like a spider's web, stretch across the gap (Fig. 35, A, B, and C). They are formed by the coagulated latex contained in the sacs, of which I showed you a microscopic section in the first lecture. In the case of a somewhat larger stem (Fig. 35 D), it requires some little force to overcome the resistance of these threads and to pull them asunder. On the other hand, if the leaf of an inferior gutta tree is similarly broken, very few, if any, such threads are visible, and accordingly very little gutta is found in them.

A tree 10 years old yields about 15lb. of dry leaves; one 30 years old, about 25lb.—*i.e.*, 1lb. more for every two years it advances in age. If, therefore, the leaves of a tree were regularly plucked every year from the age of 10 till it reaches maturity at 30, it would have produced 420lb. of them; and, as I have found that the dry leaves contain between 9 and 10 per cent. of guttapercha, this would correspond to about 40lb., that is, at least 20 times as much as would be obtained from a tree of the same age, when felled and bled in the customary way. This result, even if only partly realisable, would, in practice, be of enormous value to the gutta-planter.

Here is a large basket of leaves of palaquium gutta, which formed part of a delivery of 20 baskets sent to us from Singapore for experiments in 1894. The contents of this basket weighs about 56lb., and would therefore yield about 5lb. of guttapercha. A similar basket filled with ordinary raw guttapercha would weigh about 1½cwt., and yield about 1cwt. of cleaned guttapercha, taking the waste as 33⅓ per cent. If the material is of 3ª quality it would, on extraction from the resin, give 75lb. of gutta comparable with that from leaves, which is nearly free from resin, or 15 times the amount bulk for bulk.

The large glass jar on the table is completely filled with leaves, and on the top you observe the comparatively small piece of raw guttapercha, which contains the same quantity of clean gutta as the leaves. The difference in bulk between the two kinds of raw material is striking.

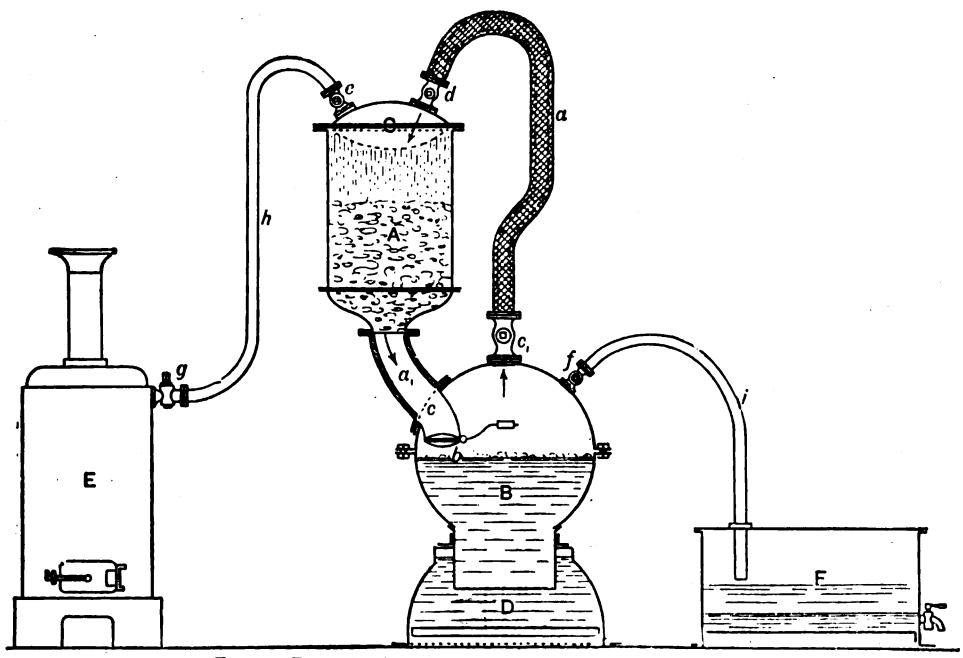

Fig. 36.—Extraction from Leaves by Rigole's Process (March, 1892).

We shall now consider the various processes recommended for extracting the gutta from leaves, and I will first describe that proposed by Mons. Dieudonné Rigole in March, 1892.

This inventor uses carbon disulphide for the treatment of the leaves; his apparatus is illustrated in Fig. 36; it somewhat resembles the Payen's percolator in the form given to it by Drechsel, and which you see here on the table. The pounded

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leaves are put into the vessel, A, the boiler, B, contains the carbon disulphide, which is heated and vapourised by means of the hot-water bath, D. The vapours which pass through *a* are condensed in C, and the liquid percolates through the leaves and flows back charged with gutta through a_1 into the boiler. After exhaustion of the leaves steam is admitted through *e*, and the disulphide from the leaves in A and the solution in B distilled off into the condenser, F. The guttapercha remains in the boiler, floating on the water condensed from the steam.

The next process is one proposed by M. Hippolyte Eugène Sérullas in June, 1892. The solvent used by this inventor is hot toluene. Fig. 37 is an illustration of the apparatus used for this process, copied from the patent specification, the apparatus I saw in actual use at Suresne-sur-Seine two years ago differing somewhat from the one here described. It was of rather large size, holding 500 kg. of pulverised leaves, and M. Sérullas stated that over eight charges could be treated in it every 24 hours. Referring to Fig. 37, the leaves are put in a

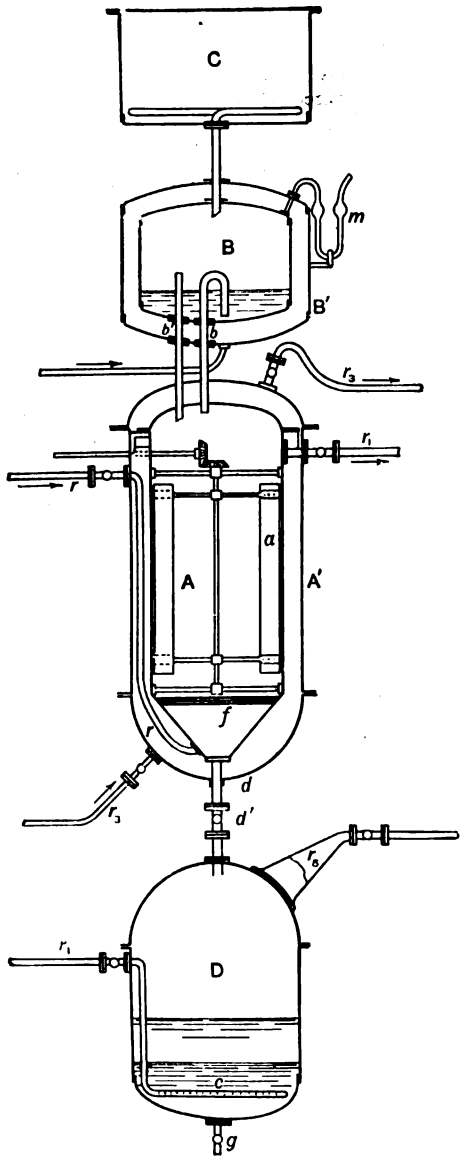

FIG. 37.—Extraction from Leaves by Serullas' Process (June, 1892).

jacketed digester, A, provided with an agitator, *a*. The toluene is filled into B, heated by means of external steam, and then abruptly discharged on to the leaves by means of the siphon, *b*. After allowing sufficient time to elapse for the toluene to act on the leaves, the solution is drawn off into the retort, D, where the solvent is removed by distillation. Later on, Sérullas introduced various improvements, and instead of distilling off the solvent, he now precipitates the gutta by means of acetone, and claims that in this way guttapercha is obtained having exactly the same composition as that produced from the latex of the Isonandra gutta in the usual way, and no doubt the precipitated material is preferable to that obtained by evaporation of the solvent.

Prof. Ramsay quite recently proposed resin oil as a substitute for toluene for extracting the gutta from leaves, precipitating it with acetone like Sérullas; I have not tried this method myself, and cannot therefore express an opinion on its suitability for this purpose.

As you are no doubt aware, a company was floated only two days ago (Dec. 4), with the object of working M. Sérullas's process, on a commercial scale, and we will certainly wish it every success. The name of the company is the Guttapercha Corporation, Limited, Lord Kelvin and Dr. Bottomley being consulting electricians, and Prof. Ramsay consulting chemist.

The next process is one which I devised myself about two years ago. It is based on an observation made in 1881—viz., that gutta is readily soluble in light petroleum spirit at the boiling temperature, but is completely reprecipitated from this solution on cooling it below 60deg. F. The process is very simple, as only one liquid is required, whereas Sérullas uses two different liquids, which have afterwards to be separated again. Instead of pulverising the leaves, which produces a large amount of fine dust, I crush them, with the stems, between closely-set steel rollers, and thus render them very permeable to the solvent.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

92. Three transformers are working in parallel in a sub-station. Describe, with sketches, the connection you would use so that with one ammeter the distribution of load between the three can be ascertained without in any way interrupting the circuits.—W. T.

93. How would you ascertain the mean spherical candle-power of an arc lamp? Is this mean spherical candle-power, when ascertained, of practical use?—J. C. R.

ANSWERS.

Question No. 86.—What are the great essentials of an arc lamp for series working?

Best Answer to No. 86 (*awarded* 10*s.*).—The essential point in an arc lamp for series working is the shunt coil. It is obvious, since the current in a series lamp remains practically constant, that the series coil does nothing after the lamp has once started up, and that it is used for this one purpose—namely, for separating the carbons on switching on. The shunt coil, on the other hand, has all the work to do, as the volts across the arc are continuously varying, and hence the arc depends upon the shunt coil entirely for keeping it at its normal length. The dash pot, again, in a series lamp is never as stiff as it is in a lamp for parallel working, the reason for this being also obvious—namely, that there is not the same tendency to pump with a number of lamps burning in series as there is with a single lamp burning across the mains. In the case of alternating lamps for series burning, the shunt coil takes the form in some cases of a choking coil, usually called a compensating coil, and which for convenience is usually fixed outside the lamps and coupled across each individual lamp as a shunt. Not only does the compensating coil, as already pointed out, take the place of the shunt coil, but it also acts as an automatic cut-out to the lamp, and as a substitutional resistance. This system has been in use for some years in America and on the Continent, but has comparatively recently been introduced into this country.

All lamps burning in series must be fitted with some form of automatic cut-out, so that should one lamp go out, the remaining lamps burning in series with it are not extinguished. In the case of short-series burning—namely, 15 or less lamps burning in series with one another—a substitutional resistance (equivalent to the resistance of each lamp) must be provided for each lamp, and so arranged that should the cut-out short-circuit a lamp its equivalent resistance is put into circuit with the remaining lamps. In the case of long-series burning—any number of lamps above

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15 burning in series with one another—a compensating resistance is not necessary, as the extinction of one lamp will not affect the remaining lamps, due to the volts formerly consumed by this lamp being divided over the remaining lamps without appreciably increasing the volts across each.

Automatic cut-outs take the following forms in practice, which are each of them suitable for special purposes, depending upon local conditions: (*a*) An auto-cut-out which entirely cuts the lamp out; (*b*) an auto-cut-out which entirely cuts the lamp out, but which substitutes a resistance equivalent to that of the lamp; (*c*) an auto-cut-out which cuts the lamp out, but which will reset itself if the carbons should come together again; (*d*) an auto-cut-out which cuts the lamp out, and which substitutes a resistance equivalent to that of the lamp, but which will reset the lamp should the carbons come together again.

In the case of the substitutional resistances being used a third terminal is necessary to each lamp.—MAIDENHEAD.

Answer to No. 86 (*awarded* 5*s.*).—The great essentials of an arc lamp for series working are: instantaneous striking gear for forming the arc, efficient and smooth feeding gear for maintaining the arc at the correct size, reliable and instantaneous short-circuiting device or cut-out for automatically closing the circuit, other than through the carbons, should the lamp through some reason become wedged or extinguished.

The striking gear must be of such a description as will not prevent the carbons from always coming in contact when the lamp is not working. In series lamps it invariably consists of a coil of thick wire surrounding a movable iron core. As the current on passing from the terminals to the carbons traverses this wire coil, it is called the series coil. When the coil is energised the iron core is drawn up further into the interior of the coil, and as it is connected directly or indirectly by means of levers to the upper carbon, this action causes the two carbons to be parted and thus an arc formed. The arc will continue to burn until the distance between the two points becomes too great for its maintenance. To avoid the undue lengthening of the arc, a second coil is introduced, whose function it is to automatically maintain the arc at its correct dimensions. This coil consists of a long length of fine wire which surrounds a second iron core, and, being connected across the lamp terminals, is called a shunt coil. It is connected in such a way as to act against the pull of the series coil. As the arc begins to lengthen less current passes across the arc due to its increased resistance, but a greater current flows round the shunt coil, which causes the carbons to approach towards each other. Then, as the resistance of the arc decreases, a larger current passes, the shunt coil becomes weaker as the series coil becomes stronger, until the two are presently in equilibrium and the arc is at its proper size. Hence the whole arrangement constitutes a *differential* device, and this differential device is essential to the smooth and proper working of series arc lamps. In its simple form as described above, it would, however, not be quite satisfactory, and it is usually modified by introducing certain devices for controlling the differential mechanism, and so ensuring a constant and unvarying light. As one faulty lamp tends to cause the remainder on the circuit to be unsatisfactory, it is desirable that this differential and controlling gear should be as simple as possible, and all complicated clockwork, etc., eliminated as far as can be arranged. It is desirable also that the striking and feeding of the arc should be done by means of the electromagnets which constitute the series and shunt coils.

Every series arc lamp must be fitted with an automatic cut-out or short-circuiting device for preventing the supply of current to a number of lamps being interfered with should one of the lamps fail through any reason. There are several devices for attaining such an end, but an excellent one is that which forms part of the Brush lamps, and which is shown diagrammatically at Fig. 1. The diagram shows a simple differential lamp in which S is the series coil and Sh the shunt coil, whilst M stands for the iron cores. The automatic cut-out is shown at C O. It consists of an electromagnet wound with fine and thick wire, a resistance, R, and a movable iron arm having two contacts at B and D. The fine-wire winding is in series with the shunt coil. The resistance, R, should be about equal to the resistance of the lamp.

Under normal conditions the current flowing through the fine winding of C O is not great enough to cause the electromagnet to pull up the arm, but should the lamp stick or fail through any cause, then, owing to the much larger current which flows through the shunt coil, and therefore also through the fine winding of C O, the latter becomes sufficiently energised to draw the arm up, and so make contact at B and D with the contact blocks immediately above them. With the arm in this position a new low-resistance circuit is opened for the current, since by passing along R, then by the movable arm to B, it reaches the negative terminal of the lamp through the thick wire surrounding C O. The two windings are necessary on C O to prevent the arm from dropping back as it would otherwise do through the short-circuiting of the fine winding when the new path for the current was formed. Should the lamp have been extinguished through a carbon having become broken off for a short length, when the pencils once again come in contact, the series coil robs C O of part of its current, and the arm falls back and out of effect.

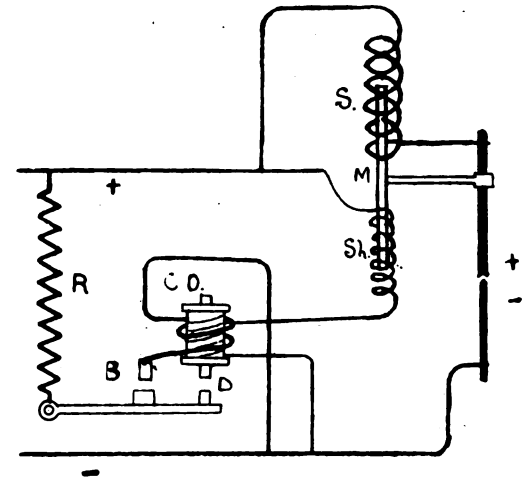

FIG 1.

Besides the above essentials there must be perfect insulation, durability of parts, and ease of inspection.—F. STOTT.

[N.B.—In this answer Mr. F. Stott has fallen into a rather common error of assuming that the current in an individual lamp varies appreciably before the lamp feeds. This is not the case, and the shunt coil is solely responsible for the feeding operation in series lamps.—ED. *E. E.*]

Question No. 87.—Discuss the advantages and disadvantages of a common return in a two-phase system for supplying power and light.

[No answer displaying a practical knowledge of the above has been received, and we do not care to award a prize to an incorrect answer. The facts of the case are as follows. Students are always told that with a two-phase system copper is saved by bunching two conductors together. If the section of each of the four conductors is unity, then the common conductor need only have a section of 1·41. In this way the copper required is reduced in the ratio of 4 to 3·41. The reasoning is sound, but it neglects entirely the question of insulation. In the four-wire system the strain on the insulation will be that due to the E.M.F. in one of the circuits. With the common return, however, this strain is increased 1·41 times. This is not much, and the casual observer would say that the cables would not be affected. But if the cables or overhead lines are to be capable of withstanding this higher pressure, then why not work them at it on the four-wire system? Each individual wire needs then only $\frac{1}{1\cdot41}$ of its previous section, and the total weight of copper is then represented by $\frac{4}{1\cdot41} = 2\cdot84$, as against 3·41 with the common return wire. Hence there is no advantage in the common return.—ED. *E. E.*]

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COMPANIES' MEETINGS AND REPORTS.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on the 19th inst. at Winchester House to consider the present position of the Company and to pass such resolutions as to the continuance or closing of the Company's business, or otherwise, as the meeting might determine, and, if the meeting should so decide, to pass the following resolutions: "(1) That the Company be wound up voluntarily; (2) that Mr. C. L. W. FitzGerald, Sir Alexander Armstrong, Mr. Arthur Henry Baker, and Mr. Henry Grëwing, the present directors, be the liquidators; and (3) that the remuneration of the liquidators be at the rate of £52. 10s. per annum each, so long as the liquidation shall continue."

Mr. FitzGerald, who presided, said what had really decided the directors to recommend this course was the very unsatisfactory trading account for the past year and the lack of orders to keep their factory at Coventry going. In 1897 the trading profit was £2,021; this year it was £92; but they had in that period increased their stock from £7,912 to £9,260. That increase represented a loss, being cash turned into unsaleable stock. Their cash balance, which on March 31, 1897, was £8,905, was now £2,100. As an alternative to liquidation, it had been proposed by Sir Alexander Armstrong to consult an expert on the subject of whether the factory could or could not be made to pay. Of course, it could be made to pay if they could get orders as they used to do, but he failed to see where their manufacturing business was to come from. In view, however, of the report of the committee which had been enquiring into the telephone question, and which recommended that licenses should be granted to municipalities to compete with the National Telephone Company, there was just the possibility of further business.

A discussion followed, in the course of which **Mr. Woolley** and other shareholders opposed the proposal to wind up the Company, and it was eventually resolved, with the approval of the Board, that an enquiry should be made by a committee, consisting of Sir Alexander Armstrong, Mr. Grëwing, Mr. Stoope, Mr. Lawson, and Mr. Woolley, with the assistance of an expert, as to the Company's business and the prospect of carrying it on profitably, and as to the present expenses of management, the meeting standing adjourned to a date to be hereafter fixed by the chairman.

RUBBER ESTATES OF PARA, LIMITED.

The first ordinary general or statutory meeting of this Company was held at Winchester House on the 23rd inst.

The **Hon. J. A. de Gray**, who presided, said this was the first English company formed to work rubber estates in Para. All legal formalities had not yet been concluded and the property transferred to the Company, but no obstacles stood in the way of everything being settled. The total cash resources of the Company amounted to £62,066 at the present time, out of which £46,500 had to be paid in cash towards the purchase of the property, leaving a balance of about £16,000 for immediate purposes as working capital. Guarantees were given for the provision of a further sum of £34,000 odd, so as to make up the working capital to £50,000. Judging by the reports received from the estates, the Board thought that the prospects of success were very satisfactory. No consignments of rubber had yet been received, and could not be before the property was transferred to the Company. The principal shipping season for rubber did not begin until October.

No resolution was passed, except a vote of thanks to the chairman.

CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED.

The ordinary annual general meeting of this Company was held at Clifton Junction, Manchester, on the 19th inst., F. H. Bowman, Esq., D.Sc., F.R.S., in the chair.

The directors' report and statements of accounts for year ending June 30, 1898, were received and adopted. A dividend at the rate of 7 per cent. per annum was declared on the "A" shares for the year. The retiring director and auditors were re-elected, and a vote of thanks passed to the chairman and directors.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Buxton.—The Urban District Council invite tenders for various works in connection with their electric light station. Tenders by Sept. 5.

Bury St. Edmunds.—The Corporation invite tenders for the erection of buildings for their electric lighting station. Tenders by Sept. 10.

Wimbledon.—The Urban District Council are prepared to receive tenders for the supply, delivery, and erection of pipework. Tenders by 5 p.m. on Aug. 29.

King's Lynn.—The Corporation invite tenders for various works in connection with the electric lighting of the borough. Further particulars appear in our advertising columns. Tenders by Sept. 7.

Bexhill.—The Urban District Council are prepared to receive tenders for various works in connection with their electric light station. Further particulars appear in our advertising columns. Tenders by Sept. 28.

Southport.—Tenders are invited for the construction of an electric railway from Southport to Lytham. Two guineas for quantities, which will be returned if not accepted. Apply to Mr. Stewart Speddy, 7, Post Office-avenue, or 118, Hampton-road, Southport.

Brussels.—Tenders are invited for the supply of electricity for the lines Liège Vottem and Liège-Beileur. The deposit required is £1,000. Conditions, etc. (10d.). are to be obtained from Société Nationale des chemins de fer Vicinaux, rue de la Science 26, Brussels. Tenders by Sept. 7, at 11 a.m.

Llandrindod Wells.—Tenders are invited for the erection of a boiler-house and short chimney stack for an electric light station. Applications for specifications and plans to be made to the Secretary of the Llandrindod Wells Electric Light Company, Limited, and to be accompanied by a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders to be delivered by first post on Sept. 1.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Kingston-upon-Thames.—Tenders are invited by the Committee for the fitting-up of an installation of electric light at the Kingston Victoria Hospital, Coombe-lane, Kingston-upon-Thames. Specification, form of tender, and further particulars can be obtained at the office of the Hon. Consulting Engineer, Central Electric Station, Down Hall-road, Kingston-upon-Thames, between 10 a.m. and 5 p.m. Tenders, endorsed "Tender for Electric Light Installation, Kingston Victoria Hospital," to be sent to Mr. J. E. Edgcome, hon. consulting engineer, Central Electric Station, Kingston-upon-Thames, by noon on Sept. 5.

Watford.—The Urban District Council invite tenders for the supply and delivery of (1) electricity meters and (2) main cut-outs, for 12 months from Nov. 1. Specifications may be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer to the Urban District Council, Mansion House-chambers, 20, Bucklersbury, E.C., on payment of £1. 1s. for each specification, which sum will only be returned on receipt of a bona fide tender. Tenders, sealed and marked "Electricity Meters" or "Cut-Outs," must be addressed to Mr. H. Morten Turner, clerk, Council Offices, Watford, and delivered by 12 noon on Aug. 31.

Potteries (Staffs).—The British Electric Traction Company, Limited, invite tenders for the provision of materials and construction of the track and permanent way of about 13 miles of tramways (in sections) in the Potteries district of North Staffordshire. Drawings may be seen, and specifications, stipulations, bills of quantities, forms of tender, and particulars obtained, on payment of a deposit of £3. 3s., which will be refunded on receipt of a bona fide tender and the return of the documents, at the Company's Permanent-Way Engineer's Office, Donnington House, Norfolk-street, Strand, W.C. Tenders before 10 a.m. on Sept. 5.

Rochdale.—The Corporation invite tenders for the following plant: Specification No. 2: (Section A) boilers, fittings, etc.; (B) economisers; (C) condensing plant; (D) feed pumps, tanks, etc.; (E) steam and exhaust pipes; (F) travelling cranes; (Specification No. 3) switchboards; (4) accumulators; (5) cables. Specifications, forms of tender, and conditions of contract may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 12, Delahay-street, Westminster, on payment of £3. 3s. for each specification, which sum will be returned on receipt of a bona fide tender. Tenders (endorsed "Electricity Works") must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by noon on Sept. 6.

Patras (Greece).—On Sunday, Aug. 16-28, from 9-11 a.m, will be given out in submission, in the Town Hall of Patras, in presence of the Municipal Council, and in public session, the concession of the lighting of Patras and its suburbs. In case the lighting will be executed by gas, the period of the concession will be for 35 years, or in case the lighting will be executed by electric light or another light, the duration of the concession will be left to the discretion of the competitor, according to the conditions of advice No. 2,222 of this year and according to the register of Feb. 7, 1898, modified by the above advice No. 2,222. Offers are to be submitted under sealed cover. A copy of above-named documents, in Greek or French, to be had on application to the President of the Municipality.

Bangor.—The Corporation invite tenders for the supply and erection of the following plant: (Contract No. I.) two water-tube boilers, economiser, brickwork, and flues; (II.) steam, exhaust, and other pipes, steam pumps, and feed-water heater; (III.) two 60 kw. steam dynamos, balancer, boosters, and 5-ton overhead travelling crane; (IV.) switchboard and instruments; (V.) accumulators; (VI) mains. General conditions, specifications, forms of tender, etc., may be obtained from Mr. F. Hastings Medhurst, B.Sc., M.I.E.E, the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., on payment of a deposit of £3. 3s. for each section, which will be returned on

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receipt of a bona fide tender. Sealed tenders, endorsed "Electricity Works, Contract No. —," must be delivered to Mr. R. Hughes Pritchard, town clerk, Bangor, North Wales, by Sept. 10.

Hull.—The Electric Lighting Committee invite tenders for the supply of the following cars, etc.—viz, 45 electric motorcars, 20 trail cars, 2 sprinkler cars, 2 traversing platforms. Specifications and forms of tender may be obtained of Mr. A. E White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Rolling Stock," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 30.

RESULTS OF TENDERS.

Bath.—The City Council have accepted the tender of Messrs. Singer and Co., Frome, at £100, for the erection of a bronze 100-light electrolier in the Grand Pump Room.

London.—The following tenders have been received for wiring for electrical installation, and for gas services at the Cranbourne Hotel, Cranbourne-street:

Warburg, Diamond, and Co.	£365
Buckley and Beach	314
Wynn	273
South	240
Electric Glow Company	238
Allan	220
Smeaton and Page	218
Christie	190
Sharp, O'Brien, and Co.	174
Strode and Co. (accepted)	139

BUSINESS NOTES.

Horsham.—The Council have decided to apply for a provisional electric lighting order.

Whitechapel.—The District Board have determined to instal their own electric lighting plant.

Mauritius.—An electric tramway scheme is being prepared by Mr. F. J. Warden-Stevens for Port Louis.

Halifax.—The Corporation are taking steps for starting the work of laying additional tramlines as early as possible.

Dreghoda.—An effort is at present being made to induce the Post Office authorities to extend the telegraph service to Termonfeckin, county Louth.

Lanchester.—The Guardians have appointed a committee to consider the question of installing the electric light throughout the workhouse and infirmaries.

West India and Panama Telegraph Company.—The receipts for the half-month ended August 15 were £9,133, as against £1,465 for the corresponding period.

Hertford.—The electric sub-committee of the Town Council are negotiating with the Municipal Electric Supply Company to take over their provisional order as to electric lighting.

South Shields.—The Council intend to apply to the Local Government Board for sanction to the borrowing of £20,000 for the purpose of providing the additional electric lighting plant.

Coventry.—The Town Council have received the sanction of the Local Government Board for the loan for electric light purposes, a balance of £3 150 having to stand over for further information.

Margate.—The construction of an electric light railway on the overhead system between Margate and Ramsgate, by way of Broadstairs, has finally been sanctioned by the Board of Trade.

Watford.—The Urban District Council have instructed the clerk to make application to the Public Works Loan Commissioners for a loan of £21,000 in connection with the electric lighting works.

Llandudno.—It appears that the opening of the electric light station has been much delayed by the late bad weather, the chimney having reached such a height that the men can only work on very calm days.

Barrow.—The General Purposes Committee of the County Council have appointed a committee to investigate the whole question of valuation, etc., of the property belonging to the tramway company.

Worksop.—The Sanitary Committee having advised the Urban District Council that an electric lighting provisional order should be applied for, a special meeting of the Council will be convened to consider the whole question.

Liverpool.—The Tramways Committee are asking the Corporation for authority to take steps to have plans, sections, and estimates prepared for the continuation of the two experimental electric lines as authorised by the tramways provisional order of this session.

Glasgow.—The Special Telephone Committee of the Corporation have decided, as anticipated by us in a previous note, to renew the application to the Postmaster-General for a telephone license for the municipality. A deputation is to press the application at the earliest convenient date.

Crewe.—The provisional order applied for by the Town Council to provide a generating station and supply the borough with electric light has been granted. The cost of the scheme is estimated at about £25,000. Prof. Hopkinson has advised the Corporation of a suitable site for the electric lighting plant in the South Ward.

Ryde.—The Town Council have decided to apply for a provisional order for the introduction of the electric light into the town, and to oppose the application by the Ryde Electric Light and Power Company, Limited. We learn that Messrs. Kincaid, Waller, and Manville have been appointed to report on the matter.

Farnworth.—At a recent meeting of the General Purposes Committee of the District Council the following resolution was passed: "That the Streets Committee be requested to appoint four of their members to join with the four gentlemen appointed by the Finance Committee to form an electricity committee, and that they be empowered to seek the advice of an electrical engineer."

Barnsley.—The Town Council have received the approval by the Board of Trade to the system for the supply of electrical energy for the purposes of the Barnsley Electric Lighting Order, 1890, subject to certain regulations therein mentioned, and also the formal approval by the Board, given with the concurrence of the Postmaster-General, of the connection by the Corporation of certain parts of their electrical circuits with earth.

Stoke Newington.—The Vestry have received notices from several electric lighting companies intimating their intention to apply to the Board of Trade for provisional orders for the supply of electric energy within the parish. The Vestry have notified the companies to the effect that they are in possession of a provisional order, and that they are taking steps to exercise their powers, and will oppose the application of the companies.

Kingston.—The Guardians have decided that enquiries should be made of the Kingston Town Council as to the terms upon which they would be prepared to supply electric current to the whole workhouse buildings, and that the architect be instructed to prepare a scheme providing the necessary power for generating the supply in order that a comparison might be made between the Corporation charges and the maintenance and expenses of an independent installation.

Broadstairs and St. Peter's.—The Urban District Council have replied to the Isle of Thanet Light Railway Company that the Council are favourably disposed to the introduction of electric lighting under certain conditions, but that they would be glad before further considering the matter to receive a copy of the proposed draft order authorising the supply of electricity. The application of the County of London and Brush Provincial Electric Lighting Company was refused.

Weston-super-Mare.—The idea of abandoning the site offered by the Great Western Railway Company in favour of the town yard, for a generating station, appears to increase in popularity. According to the *Western Mercury and Somersetshire Herald*, it is a question of freehold *versus* leasehold, and the advantages associated with the former rapidly increase on calm reflection. It appears that there is a strong majority in the Council in favour of the town utilising the provisional electric order.

Brighton.—The electric lighting here is still rapidly increasing. The report of the Lighting Committee adopted last week states that the committee had resolved that an electricity main be laid in Harrington-road at an estimated cost of £150; also that an electricity main be laid in Elm-grove, from the west end to Bonchurch-road, and a main laid in Bonchurch road, at an estimated cost of £275, and that the 14 street lamps on the route of the mains be lighted by electricity instead of gas.

Leeds.—The need for cross-communication between the Holbeck and Beeston part of the city of Leeds and the Spen Valley district is being ventilated in the local Press, and it is advocated to establish a system of electric tramways on the Leeds and Elland and Huddersfield main roads, with stages, so as to serve the population of Holbeck and Beeston, Churwell, Morley, Bruntcliffe, Howden Clough, Birstall, White Lee, and Little Gomersal, and the Spen Valley towns. This no doubt would prove a valuable means of inter communication between these populous districts.

Bradford.—The receipts on the Bolton-road line of electric tramways during the 23 days it has been open amount to £466. A trial trip on the new electric tramway between the Bradford Town Hall and Great Horton took place in the early hours of the 22nd inst., when the working of the car proved eminently satisfactory. The Board of Trade electrical engineer, Major Cardew, was expected in Bradford yesterday, in order to inspect the trams as far as the electrical outfit is concerned, whilst Sir Francis Marindin will probably inspect the permanent way in a few days.

Huddersfield.—The Council have passed a resolution authorising the town clerk to make an application to the Board of Trade for sanction to the borrowing of £7,454. 0s. 4d. for the construction and extension of the tramway at Outlane, etc. The engineer's report for the last month shows that the number of consumers had increased from 698 in June to 707 in July, and the lamps connected from 47,348 to 47,857. During July 24,289 units were metered, as compared with 19,087 last year. The latter represents an increase of 5,202 units, which is equal to 27 per cent.

Haslingden.—The town's yard has been accepted as the site for the electrical works, and the Electric Lighting Sub-Committee has been empowered to engage an electrical engineer to advise upon the several matters appertaining to the proposed application for a provisional order for electric lighting. In the event of the resolution to make the application being carried, the Electric Lighting Committee will be instructed to take the necessary measures for procuring a provisional order for the borough, and to supply electric energy themselves, and not by the Electrical Power Distribution Company, Limited.

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Outings.—Mr. W. P. Butterfield, of the Shipley Galvanising Tank and Cistern Works, gave his employés an outing to Southport on Saturday last. Dinner was partaken of at the Hoghton Arms Hotel, after which the various places of interest were visited.—The annual outing of the employés of the "Robertson" Lamp Factory, Hammersmith, also took place recently. The party, numbering considerably over 200, proceeded to Hastings, where a very pleasant day was spent.—The adult employés of the Electric Construction Company's armature shop held their annual outing on Saturday. The place chosen was Kinver Edge.

The "James" Arc Lamp.—We have received from Messrs. H. V. James, Mills, and Co., of Croft-street, Pendleton, Salford, a neat little list of their arc lamps. Lamps of many various types are illustrated in it, including closed arcs both for alternating and direct currents. In every case the overall lengths of the lamps are given, which adds to the value of the illustrations. We notice that the cases of the lamps are well ventilated. Inverted arc lamps for interior lighting are also made by the firm. We also learn that each of the enclosed arc lamps bears a license-paid ticket for the use of the inner globe, thus insuring the customers against any liability.

Appointments Vacant.—The Board of Police of Greenock invite applications for the position of resident electrical engineer. Salary £300 per annum, with office accommodation and stationery. Applications, accompanied with testimonials, endorsed "Electrical Engineer," to be lodged with Mr. Colin MacCulloch, town clerk, Greenock, Municipal Buildings, Greenock, before 31st inst. at 12 noon.—The Corporation of Dewsbury are prepared to receive applications for the appointment of an improver in their electricity supply station —The Electric Lighting Committee of Portsmouth are prepared to take pupils on payment of a premium of £50 per annum. Further particulars of these and other vacancies will be found in our advertising columns.

Morecambe.—A deputation from Barrow intends to visit Morecambe to see the system of promenade lighting. An overhead traveller has been ordered for the Victoria-street sub-station, also 50 electricity meters. The Public Works Loan Board have resolved to grant the loan of £8,821, the said loan to be repaid with interest at 2¾ per cent. per annum at the same dates and within the same period as the sum of £22,180 (part of the loan of £26,000 granted Nov. 25, 1897). The Electrical Engineer has reported upon his tests of the high-pressure concentric and single-conductor cable at the works of the Callender Cable Construction Company at Erith on July 28. He said that the tests were very satisfactory. Twenty-five additional arc lamps are to be erected upon the Victoria-esplanade.

Hornsey.—At the last meeting of the Urban District Council the Engineer reported having received from the chief engineer of the London County Council the estimate of the contractor for supplying and fixing stoneware conduits and inspection boxes across the new bridge (Highgate Archway), which amounted to £65. Instructions were given for the necessary work to be done. It was also resolved to require the National Telephone Company to remove all wires that contravene the Council's by-laws in connection with a telephone wire between Stroud Green and Hornsey. Ten spans exceed 115 yards, one being no less than 172 yards. The arrangement for a conference between the Highways Committee and the Finchley District Council with reference to the Highgate and Finchley tramway was deferred until after the vacation.

King's College.—The Michaelmas term commences Tuesday, October 4. The full curriculum for the college associateship in mechanical, civil, or electrical engineering, architecture, chemical manufactures, and metallurgy, extends over a period of three years. A shorter course of two years qualifies for the certificate of engineering. The Siemens electrical laboratory (founded by Lady Siemens) and the mechanical engineering laboratory and workshops, the metallurgical laboratory, and others are fitted with all the necessary appliances for the most advanced practical and research work. Non-matriculated students, or those who, not wishing to attend the whole course, are desirous of studying any particular subject, may attend any of the classes held on payment of the specified fees. Fuller particulars appear in our advertisement column.

Buxton.—The Electric Lighting Committee reported to the Urban District Council last week recommending that enquiry be made of the owner of the land adjoining the proposed central station if he would sell a strip of land 20ft. or 30ft. wide, in order that if the building were placed on the east side of the river, the railway siding for coal could be brought alongside. The Midland Railway Company's engineer is to be approached with reference to siding accommodation. The committee directed that application be made to the Local Government Board for sanction to borrow the sum of £20,000. Proofs of the general conditions and regulations relating to contracts for machinery, plant, apparatus, mains, and of the specifications Nos. 1 to 5, were submitted. Tenders are to be advertised for in such papers at the engineer may think desirable. The report was agreed to.

Rawtenstall.—At the meeting of the Town Council on the 19th inst. the town clerk reported the receipt of notices from Edmundsons' Electricity Corporation, Limited, and the Electrical Power Distribution Company, Limited, respectively, stating that it was their intention to apply to the Board of Trade in the ensuing session for a provisional order under the Electric Lighting Acts in respect of the area comprised within the borough, and asking for the consent of the Corporation thereto. It was resolved that the matter be referred to the existing Parliamentary Sub-Committee to consider and report upon. A local paper says: "We think it would be well if Rawtenstall and Bacup could combine in the matter, and especially if they could succeed in taking over the tramways on advantageous terms, and then drive the trams by electricity instead of by steam."

Newton Abbot.—The report of the Lighting Committee, which has been adopted by the District Council, contains a paragraph to the effect that having considered the letters with reference to the intention of Edmundsons' Electricity Corporation, Limited, to apply for a provisional order for electrically lighting the urban district, it was resolved that the clerk be asked to obtain a copy of the Bill promoted by the General Power Distributing Company now before Parliament, and of the provisional order for electric lighting the district and of any Act bearing on the same that the clerk may think desirable for the use of the committee in further considering these matters, and that the meeting be adjourned to a date to be decided by the chairman of the Lighting Committee. They had also received a letter from Mr. F. J. Warden-Stevens, A.M.I.E.E, offering to prepare a preliminary report on electric lighting.

Waterford.—The annual meeting of the proprietors of the City of Waterford Gas Company was held on the 20th inst. In the report, which was adopted, it was stated that the draft of a Bill had been prepared and submitted to the Corporation of Waterford. Among the clauses in the Bill had been one seeking permission to apply the funds of the company at any time for making application for provisional order or license to supply electricity, and another clause to enable the company to issue new capital to the consumers at par. Against both these clauses the Corporation petitioned, and they were withdrawn. At the request of the Corporation, a clause similar to that in the company's Act of 1877 has been inserted, empowering the Corporation to purchase the concerns of the company within three years from May 16 last—*i.e*, on or before May 16, 1901. Should this clause be acted upon, the shareholders' interests will be fully protected.

Coatbridge.—At a recent meeting of the Tramways Committees of the Town Councils of Coatbridge and Airdrie, a circular from the Light Railway Commissioners was read, stating that with reference to the application made by the British Electric Traction Company, Limited, for an order to authorise the construction of a light railway, they propose, subject to their consideration of any representations which may be made to them, to make an order in the terms of the draft order which they sent, and adding that the Commissioners before finally settling the order would be glad to receive and consider any observations which the Councils desire to submit in the matter, provided they were made on or before Friday, 29th inst. The joint committees went over the order, and they were of opinion that certain alterations should be made therein. For instance, Clause 53 should be altered to read as follows: "Subject to the provisions of this order, the company may demand and take for every passenger travelling upon the railways or any portion thereof, including every expense incidental to such conveyance, any rates or charges not exceeding ½d. per half-mile, and in computing the said rates and charges, the several railways herein authorised to be constructed shall be treated as one railway, and a fraction of half a mile shall be deemed half a mile, etc." It was agreed that the town clerks should submit these observations to the Light Railway Commissioners, and endeavour to have them given effect to.

Leamington.—With regard to the coming electric tramways, the *Leamington News and Warwick Herald* states that "the company has now disposed of its business, and presently an application will be made by the purchasers to the Town Council at Warwick and our own Town Council for leave to erect along the streets the iron columns which are indispensable to the electric system it is proposed to adopt. What may be the feeling entertained at Warwick with regard to this proposal we are not aware, but at Leamington one constantly hears objections, particularly with regard to the Parade. The placing of a row of iron posts on either side will, it is contended, be a disfigurement which in the interest of the town ought to be resisted." The paper continues: "For ourselves we must hesitate to express an opinion until the details are fully before the Council. The present tramway, now valued by all, was vehemently opposed before it was started, and in the case of the electric tramway we may have a repetition of a page of our local history; antagonism before it is introduced, followed by unanimous praise. On reference to the report of the annual meeting of the shareholders on Monday, it will be seen that Mr. J. Ash thought the Leamington people would not allow overhead wires, and he advised the company to stick to what they had at present. There are many other people who believe with him that the Corporation will refuse the application, and more than a few hope such will prove the case."

Newbury.—The *Newbury Weekly News* says: "A proposal to introduce electric lighting into Newbury occupied the attention of the Corporation at their monthly meeting on Tuesday. The committee had recommended that the offer of the company making the proposals be not entertained, and this course was, after considerable discussion, adopted by the Council. On behalf of the proposed electric lighting it appeared that the offer of the company was in effect to supply light at a price equivalent to 2s. per 1,000ft. of gas, a reduction on the present cost, to which the Mayor specially drew attention. On the other hand it was urged that the Corporation being already the owner of the gas undertaking it was not to the interest of the borough that a competitor such as the electric light would prove should be introduced, with a consequent probable reduction of the gas revenue. It was also pointed out that although for eight years the Corporation had been legally bound to supply electric lighting if required, no demand to that effect had hitherto been made—an

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argument which we regard as more conclusive than the allegation that the electric light could not possibly be produced by the company at the rates quoted. This may or may not be the case, but in the event of their proposals having been accepted, it would have simply been the duty of the Corporation to insist that the proposed terms should be adhered to. Presuming, however, that the rates offered would actually be charged, it would be then a question whether the probable deficiency in revenue through diminished gas consumption might not almost counterbalance, in increased rates, the saving to the ratepayers' pockets in respect of cheaper lighting. Broadly speaking, it was this consideration, amongst others, which induced the Council to decline the offer. Should it lead to some reduction in the present price of gas, the application of the electrical company will not have been altogether without result."

Grimsby.—Prof. Kennedy's report on the proposed electric lighting of the borough has been adopted by the Electric Light Committee. The site suggested for the power station is north of the old cemetery, and the estimated cost was set down at £35,000, but, in view of contingencies of slight alterations and extensions, it was advised that £40,000 should be applied for as probable capital expenditure. The report recommends the use of a continuous-current three-wire system, with lamp running at about 230 volts. It was assumed that within a year or two of the opening of the station there would be a total of about 9,000 lamps of 8 c.p. or their equivalent, requiring 135,000 units per annum, connected to the mains, but as not more than 5,000 would be alight at once, the estimate provided for plant sufficient for the smaller number. The total power of the plant to be put down in the station, including reserves, would be about 750 h.p. Separate mains would be required for the tramlines. A route was mapped out in the report for public lighting by electricity by 50 lamps of ordinary power, nominally 1,000 c p. each. In view of the erection in the future of a refuse destructor near the electric lighting station, there would be no difficulty in making the electric lighting chimney large enough to serve also as the chimney for the destructor when the latter was at work. On the question of dock lighting, Prof. Kennedy stated that he roughly estimated that the offices and sheds would require from 150,000 to 200,000 units per annum, supposing that in most cases the sheds were used all night. He considered it would be worth the while of the Corporation to supply the electricity. The report of the sub-committee respecting the supplying of electrical power to the tramway company suggested that the company on making their line for electric traction should purchase the power from the Corporation at the rate of 1½d. per Board of Trade unit for the 360,000 units used, and guarantee to take a minimum of 360,000 units per annum; above 360,000 and up to 460,000 units the charge to be at the rate of 1⅜d. per unit, and all above 460,000 units to be charged at the rate of 1¼d. per unit. The tramway company are to reconstruct the present lines, to double them from the depôt to The Old King's Head in Victoria-street, and to construct an additional loop line from the latter place, *vid* George-street and Osborne-street, to the White Hart Hotel. The company are to run a 7½ minutes' service from April 1 to Oct. 31, and a 10 minutes' service during the remainder of the year, and to institute a system of universal penny fare within he borough.

Newcastle.—At a meeting of the New Tramways Committee of the Corporation, on the 23rd inst., the reports of Dr. Hopkinson and Mr. Colam were considered. Dr. J. Hopkinson, in reporting on a scheme of electrical tramways, recommends the overhead trolley wire system. In Newcastle, on the lines likely to bear the most holiday traffic, the gradients were not difficult, and to these lines he would restrict the use of trailing cars. The steeper inclines worked without trailers would present no difficulty. The width of half the streets to be traversed by the trams would allow of central poles with brackets on each side to carry the trolley wires; in the remainder he suggests the erection of poles on either side of the road, or attachments to the houses from which span wires could be stretched. He propounds as the simplest plan for working those sections where the trolley wires would be inadvisable, the provision of small cars fitted with accumulators, which would pick up the passenger cars at one terminus of the trolley wire, and draw them to the other terminus. The generating station Dr. Hopkinson thinks would be most conveniently situated on the piece of vacant land belonging to the Corporation near to the Manors Station, and fronting on to Melbourne-street. The power station might also be utilised for supplying current to drive the cranes on the quayside, but this, of course, would require the addition of motors. Again, arc lighting could be provided by means of current from the generating station, the lamps being placed upon the poles carrying the trolley wires. Dr. Hopkinson appends to his report four schedules. The first is an estimate of the capital outlay required for the 40 miles of single track proposed. This totals £358,877, exclusive of anything for land, and allows for 132 passenger cars carrying 51 persons (22 inside and 29 outside). If a 42-passenger car were used the price would be slightly lower. The estimated area of the car-sheds is 5,554 square yards, and of the engine and boiler houses, etc., 1,603 square yards. The second schedule gives an estimate of the cost of working per car mile, which is totalled at 4·706d. on the basis of 112,320 car miles run per week. The third schedule gives the actual cost in pounds sterling of the various items set forth in Schedule 2, and on the basis of 5,840,640 car miles being run per annum sets forth the total working cost at £114,559. Schedule 4 shows the estimated cost of maintenance per car mile of track, machinery, and rolling-stock, this being put at 0·845d. for track, 0·110d. for machinery, and 0·382d. for rolling-stock per car mile—a total of 1·337d. The above estimates presuppose that the car mileage run per week is 112,320, running 18 hours a day for six days and half-day on Sundays. Mr. W. N. Colam's report on a scheme of cable traction is framed on the basis of 40 miles of single track (the whole of the track being double throughout) with a service of cars averaging 2½ minutes throughout a working day of 17 hours, and a total annual car mileage of 5,956,800 (as against 5,840,640 car miles run by the proposed electrical system, the difference being, presumably, that the cable trams would run all day on Sundays). Mr. Colam does not estimate for the cost of permanent way, but accepts a fixed sum of £5,000 per mile of single track. The estimated cost of construction and equipment of a cable tramway system for 40 miles of single track in Newcastle running 132 cars amounts to £452,080. The estimated annual cost of operating the system—*i.e.*, maintenance and motive power—is stated at £23,668, or ·953d. per car mile. Working expenses under the head of traffic and management amount to £34,957, or 1·408d. per car mile. These estimates and allowances for depreciation, interest, etc., bring the total working cost per annum to £83,017, or 3·344d. per car mile. A sub-committee has been appointed to go into particulars and report to the general committee.

PROVISIONAL PATENTS, 1898.

AUGUST 15.

17539. Improvements in and relating to brushes and brush-holders for constant-current dynamo-electric generators and motors. Anthony Patterson, William Henry Davies, and Henry White, Lloyds' Bank-buildings, Bristol.

17566. Improvements in and relating to perforators for use in connection with automatic telegraph transmitters. Angus Fraser, Walter Judd, and George Draper, 323, High Holborn, London.

17580. Improvements in the manufacture of filaments for incandescent electric lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Carl Auer von Welsbach, Austria.)

17583. Improvements in electric batteries. Owen Thomas Bugg, jun., and David Henry Darling, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17588. Improvements in or relating to primary electric batteries. Alfred Julius Boult, 111, Hatton-garden, London. (Victor Busson, France.) (Complete specification.)

17591. Improvements in arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Compagnie de L'Industrie Electrique, Switzerland.)

17592. Improvements in portable electric lamps. Owen Thomas Bugg, jun., and David Henry Darling, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17601. Improvements in electric arc lamps. Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

AUGUST 16.

17622. Method of manufacturing incandescent lamps. Charles Arthur Allison, 52, Chancery-lane, London. (John Thomas Lister and William Selar Chamberlain, United States.) (Complete specification.)

17626. Improvements in cord-grips for electric lampholders. Alfred Watson, 24, Temple-row, Birmingham.

17647. Improvements in or relating to electrical switches, plugs, and the like. Francis Gibson Baily, 111, Hatton-garden, London.

17659. Improvements in and relating to electric meters. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Emanuel Bergmann, Germany.) (Complete specification.)

17692. A system of reflectors for double-globe electric arc lamps. Otto von Mülmann, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 17.

17705. Improvements in the method of and means for electrically extracting poisons from the human body. John Bunyan Campbell, 20, Bucklersbury, London.

17710. Improvements in electric lamps and other bulbs, globes, or transparencies. Joseph Barton Scammell, 56, Leadenhall-street, London.

17727. Motor power produced by magnet or magnets. Sidney Johnson, 28, Barclay-road, Fulham, London.

17741. Improvements in electric batteries. Thomas Machin and Edwin Cake, 77, Colmore-row, Birmingham.

17764. Improvements in or connected with electric meters. Henry Reason and the Mutual Electric Trust, Limited, Norfolk House, Norfolk-street, Strand, London.

17769. Improvements in electric accumulators. Marcel Dubrot, 321, High Holborn, London.

AUGUST 18.

17773. Improvements in reversible electric tramcars. John Eadee and the Manchester Carriage and Tramways Company, 70, Market-street, Manchester.

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17786. Improvements in or relating to electric storage batteries. Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, London.

17823. Improvements in electrolytic cells. Sherard Osborn Cowper-Coles, 45, Southampton-buildings, Chancery-lane, London.

AUGUST 19.

17841. Improvements in electricity railways or tramways. James Booth and Albert Ernest Woodhouse, Penny Bank-chambers, Halifax.

17861. Improvements in generators for electricity. John William Bernard Wright and Evan Evans, 18, Southampton-buildings, Chancery-lane, London.

17880. Improvements in pushes and like contacts for electrical circuits. Walter Reginald Lambert, 73, St. Stephen's-road, Upton Park, London.

17881. Improvements in telephone exchange instruments. Frank A. Lundquist and John Anderson, 1, Church-court, Old Jewry, London.

17883 Improvements in arc lamps. Frederick Booker, 70, Chancery-lane, London.

17896. The production of incandescent materials suitable for use in electric lighting. Sydney Pitt, 24, Southampton-buildings, Chancery lane, London. (The Pharmaceutisches Institut, Ludwig Wilhelm Ganz, Germany.)

17914. Automatic electric lighting apparatus for vehicles of all kinds. Sigmund Bauer, 18, Southampton-buildings, Chancery-lane, London.

AUGUST 20.

17950. Improvements in locks for doors of dwelling-houses, shops, banks, safes, and other places of security, and in the method of connecting them by electrical appliances so as to cause, in the event of them being tampered with by burglars or other felonious persons, immediate communication to be made to the nearest or to any police station. James Aitken-head Wilson, 142, West Nile-street, Glasgow.

17959. Improvements in or relating to electrodes for electric batteries. Jean Claude Chorlier, 111, Hatton-garden, London.

17973. Improvements in induction coils or transformers. Charles Edmund Stanley Phillips, Birkbeck Bank-chambers, Southampton - buildings, Chancery - lane, London.

17974. Improved appliances for cooling dynamos. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton - buildings, Chancery - lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

17979. Improvements in dynamo-electrical generators, motors, or transformers. Courtenay William Thompson, 47, Lincoln's-inn-fields, London.

17984. Improvements in and connected with electric railways and tramways. Elizabeth Warwick, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

17523. Coin-freed electrical meters. Beaumont.

18120. Manufacture and production of electric cables. Edmunds.

19794. Electric arc lamps. Davy and Thomas-Davies.

20501. Electric railways. British Thomson-Houston Company. (Potter.) (Amended.)

22339. Electric motorcar switch Immisch.

22627. Alternating arc lamps. Drake and Gorham.

23332. Secondary battery plates or electrodes. Paris.

24591. Galvanic cells. Heil.

25941. Construction of electrical transformers. Boritschewsky.

1898.

5550. Dynamo-electric machinery. Pickstone, Portheim, and Peebles.

6032. Electrical or electromagnetic therapeutic apparatus. Wacatka and Sachs.

8848. Method of and means for the electrical propulsion of railway, tramway, and other similar vehicles. Heys. (Heilmann.)

10477. Quick-break switches for electric lines. Jaeger, Jaeger, and Bender.

10606. Electric signal bell for cycles. Kraus.

10652. Electric condensers. Bradley.

12349. Microphones. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft).

12699. Electric transformers. Bellman and Rittenhouse.

13113. Protectors and holders for electric incandescent lamps, thermometers, and other articles. Hughes.

13960. Electrode for accumulators. Dämm.

14101. Surface-contact railway systems. The British Thomson-Houston Company, Limited. (Potter.)

14112. Primary batteries. Peters.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns week ending.			Increase or decrease.	Total receip's since July 1.	
		1898.	1897.		1898.	1897.
		£	£	£	£	£
Birmingham Tramway Company, Limited	Aug. 20	3,897	3,546	+ 350	—	—
Bristol Tramways and Carriage Company, Limited	,, 19	3,941	2,691	+1 250	—	—
City and South London Railway	,, 21	1,044	1,021	+ 23	7,829	7,314
Dover Tramways	,, 20	273	—	—	4,794	—
Dublin S.D. Electric Tramways Company	,, 19	1,250	722	+ 528	7,938	6,068
Liverpool Overhead Railway Company	,, 21	1,664	1,518	+ 146	—	—
South Staffordshire Tramways Company	,, 19	735	681	+ 54	20,589*	20,831*
* Receipts since	Jan. 1.					

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	13-14
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9¾-10¼
—— 4½ per cent. Cum. Pref	10	10¾-11⅛ xd
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	16⅛-17
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	10	13-14 xd
Brush Company, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9¾-10¼
——	6	5⅞ 6⅛
—— Pref. Half-Shares	1	1⅛-1⅜
—— ,, ,,	5	4¼-4½
Charing Cross and Strand	5	12-13 xd
—— 4½ per cent. Cum. Pref.	5	6 6¼ xd
Chelsea Electricity Company	5	8¼-9¼
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	25-26
—— 90,001-100,000	10	25-26
—— 6 per cent. Cumulative Pref.	10	16¼ 17¼
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	2⅞-3⅛
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½ 15½
—— ,, ,, '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— ,, ,, ,,	6	8¼-9¼
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞ 2⅛
—— 5 per cent. Debentures	—	89 94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130 xd
—— Preference 5 per cent. Stock	100	142-145 xd
Edison and Swan United Ordinary	5	2⅛-2⅜ xd
—— 5 per cent. Debentures	5	4-5 xd
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5⅛
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	3-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅛ ¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	21-22
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	112-117
House-to-House Company, Ordinary	5	3¼-3½
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4⅛
Metropolitan Electric Supply, Limited, Ordinary	10	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 5½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7⅛
—— £4½ shares	4	6-6⅛
Oriental Telephone and Electric Company	1⅛	⅝-¾
Royal Electrical Company of Montreal	—	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-106
South London Electric Supply, Ordinary	3	3-3⅛
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	126-131
Westminster Electric Supply, Ordinary	5	15½-16½ xd
Yorkshire House-to-House	5	8¼-8½

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NOTES.

The Central London Railway.—It is announced that this line will be completed early next summer. We trust the prophecy will be fulfilled, but railways as a rule do not come up to date in the matter of time of completion. Without a doubt the line cannot be opened too soon from the public's point of view, as the present means of communication along the route of the new railway are totally inadequate.

Switch Pillars in Traction Work.—With reference to the American Press commendation of the English practice of using switch pillars for cutting up the trolley wire into sections we have looked up the history of the design. We find that they were first used on the Bristol electric tramways, which were designed by Messrs. Kincaid, Waller, and Manville. The work on these lines was commenced in 1894.

The Value of the Telephone System.—Our contemporary the *Statist* has made elaborate calculations to find what it would cost the State to purchase the National Telephone Company's system outright and immediately. The amount arrived at is £6,566,442. It is further calculated that in the 13 years to elapse before the rights of the company expire in 1911 the Government would make a profit of £4,732,000.

Municipalising London Tramways. — A step further in this direction has been made by the London Tramways Company's recent decision at an extraordinary general meeting. By it, as will be seen by a report elsewhere in this issue, the County Council will purchase practically all the company's lines. As the terms of compulsory purchase had been fixed by arbitration, the company could not do otherwise than to instruct their directors to sell.

Presentation. — On Thursday, the 25th ult., the engineering staff of the British Thomson-Houston Company presented Mr. Frederick Samuelson, the firm's chief draughtsman, with a marble timepiece and a pair of bronze figures as a token of their esteem and regard on the occasion of his marriage. A portfolio containing the signatures of the contributors to the testimonial was also handed to the recipient, who in reply thanked his colleagues for their handsome present.

Lighthouse Arcs.—A gigantic electric light beacon is now being tested at the United States lighthouse depôt at Tompkinsville, Staten Island. In consists of two great lenses, each 9ft. in diameter, between which, in their focus, is placed a 9,000-c.p. arc light. The theoretical luminous range of this great beacon in clear weather is said to be 147 nautical miles, and if the light were placed on a sufficiently lofty eminence to compensate for the curvature of the globe it would be possible under favourable conditions to see it at that distance.

The Lighting of Madras.—The municipal authorities of Madras have just received a report of their Special Committee on Street Lights. Oil is used in the present lamps. The committee report that gas would be more expensive than oil, and that electricity would cost 15 times more than gas. The committee must have among them some experts in the art of calculating, but surely they might have secured some technical advice in the matter. Nothing definite has been done as yet, the question of lighting by gas or electricity having been deferred to some future occasion.

The Decimal System in Difficulties.—In England the proposed introduction of the decimal system for engineering work, with the metre as the standard of length, is not being very favourably received in many places, but the opposition to it is hardly so strong as in Bombay. There, we understand from *Indian Engineering*, the water engineer of the Municipality lately received a letter, ostensibly written by a Mahommedan, stating that if the metric system is adopted he will be cut to pieces, and that the system is being forced on the city so that the water engineer may obtain a big commission from some firm of manufacturers in England.

Bradford Electric Trams.—The opening of the lines between the Town Hall at Bradford and Horton Bank Top was celebrated last Friday by a luncheon in the Town Hall. The company first ran a trial trip over the line in two gaily decorated cars. The full details of the lines were given in our last issue. After the luncheon, at which the mayor presided, several speeches were made. In reply to certain toasts, Mr. J. H. Cox and Mr. A. H. Gibbings gave some interesting particulars of the tramways in the city, showing that, with the lines proposed to be constructed, there would be a grand total, including Shelf, Wyke, Tong, and Shipley, of 80 miles. At present they were able to supply 40 electric cars, and had facilities for increasing that number to 120. The line was opened to the public on Saturday, when, in spite of wet weather, the receipts amounted to £30.

The All-British Pacific Cable.—We notice that Mr. Charles Bright has contributed an article on the above subject to the current number of the *Fortnightly Review*, in which he also considers the possibilities of an Anglo-American Pacific cable. The argument in favour of the "All-British" line is well put, but the author is a little behind in his final sub-head, which deals with the question of who shall pay the cost. He quotes the old resolution of the Australian premiers by which England and Canada were asked to guarantee two-thirds of the total cost. As stated in our last issue, this has now been reduced to five-ninths by a resolution passed at the last conference of the premiers of Queensland, New South Wales, and Victoria. Mr. Bright has most rosy ideas of the advantages of an Anglo-American cable, and describes the way it would draw the two countries together by many expressions in inverted commas.

The Hanover System.—The last report of the late Dr. John Hopkinson on electric tramways was prepared for the Corporation of Newcastle-on-Tyne. The Council decided to call in two experts—one for a cable system and one for electric traction. Dr. Hopkinson, while recommending the overhead trolley system, explained that in certain streets if the overhead wire was strongly objected to, that part of the line could be worked by a battery of accumulators on the cars as at Hanover. A correspondent of the *Newcastle Daily Chronicle*, who has just returned from Hagen, in Westphalia, writes to point out that in that town of 40,000 inhabitants, the system recommended by Dr. Hopkinson is successfully worked. There is an overhead wire, but in the centre of the town the cars run without a wire, being propelled by accumulators which are charged on the end sections of the line.

A Proposed St. Bernard Electric Railway.—A scheme has just been submitted to the Italian Government asking for a concession to construct an electric railway of a total length of 43½ miles over the Great St. Bernard. The project, which is being promoted by an English company called the Great St. Bernard Railway Concessionary Company, has been placed before the Italian and Swiss Governments by a Mr. John B. Fell, engineer, of Turin. A concession is sought for the building of the line from the Italian frontier to Martigny, in the Canton of Millais. It

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is proposed to overcome the heavy gradients by the adoption of a third rail on the rack system, as used on the Mont Cenis line. The promoters of the railway intend to ensure safety in working during the winter months by the adoption of precautions against the danger of snowfall and avalanches. The cost of construction and equipment of the railway, for which no subsidies are asked by the promoters, is estimated at £120,000.

Electricity from Whisky.—The power of whisky to increase the apparent candle-power of a lamp is a matter of history, but we gather from the *Sheffield Daily Telegraph* that in a village in Scotland even better results have been obtained. It seems that a little village near Dunfermline, named Hill of Beath, has municipalised its public-house, and installed the electric light out of the profits. This success has raised envy in the soul of another village close by, called Kelty. Kelty does not see why it should not municipalise its whisky drinking, so a public meeting has been held, with a real live county councillor in the chair, to propound a scheme. This scheme provides that all profits over 5 per cent. go to the County Council, but it is not proposed to limit the application of this money to electric lighting. Notice may be expected in the bar to the effect that if a certain quantity of whisky is consumed by, say, Jan. 2 of a certain year, the Council will proceed to repave the High-street, etc.

Electric Light in Boston.—The annual report of the Boston Electric Light Company would not be interesting to our readers if given in detail, but the bare facts as a comparison with our London companies may be. Thus the Boston Company last year had a gross income of about £162,000, while the gross expenses came to £102,700. This showed a gross profit of £59,300, or 36·5 per cent. of the revenue. The City of London Company, with a smaller area than the Boston Company, earned about £188,000 in the same time. It showed a gross profit of £81,685, or 43·5 per cent. on the revenue. The Westminster Company, with a revenue of £107,300, earned a gross profit of £49,580, or 46·3 per cent., while the St. James's and Pall Mall Company, with the smaller revenue of £68,270, showed a profit of £40,200, or at the rate of nearly 59 per cent. From these it will be seen that the London companies are well up to the Boston people as regards earning capacity, and that the undertakings are even more remunerative on this side.

The Gas that Failed.—The sooner the electric light is introduced in Tonbridge the better, as we learn that a considerable amount of consternation was caused in this town one evening lately by the sudden plunging of the town into darkness just before eight o'clock. The extinction of the gas occurred just when the streets were most busily thronged and the business of the town in full swing. For about six minutes the business portion of the town was in absolute darkness, and much inconvenience was caused at the railway station in connection with the working of the signals. The sudden defection of the gas was due either to an accident to a pipe in the gasholder or to negligence in allowing a water syphon to become filled, thus shutting off the supply. With great promptitude the manager of the gasworks caused a fresh holder to be turned on, and in a short time the town was again in its normal condition. Mishaps of this kind are now not so common as they once were, but editors of gas journals who jeer at the regularity of electricity supply when an electric light conduit is blown up by a gas leakage should remember such failures of gas supply.

Submarine Mines in the States.—The removal of the mines laid in the principal harbours of the United States during the recent war seems to have caused n inconsiderable excitement. From what we read from various sources we gather that these mines were most rapidly constructed and laid, and that little forethought was paid in the hurry to provide for dismantling them. Hence, in several cases, it has been deemed safer to blow the mines up than to attempt to extract their explosive charges. Thus, the *New York Sun* relates that a number of the submarine mines recently taken up in New York harbour were found to have rusted around the caps. These mines were put aside until some means of unscrewing the caps, so as to get out the guncotton, could be devised. The danger of doing this work lay in the possibility of sparks flying when the rusty caps were turned. One of the mines was placed in a sort of cradle that had been built on a raft and lashed down tight. Then the cap was connected with a flywheel so that when the wheel went around it would unscrew it. An electric motor attached to the wheel was connected by wires with a source of electricity on shore, and the raft was then sent out into the Narrows about 150ft. A couple of seconds after the wheel had started there was a terrific explosion. The mine disappeared in fragments, the wheel with it, and the raft was sent flying. Just what caused the explosion will never be known. The force of the explosion broke the windows in several houses at Fort Wadsworth, but nobody was hurt.

Electricity in French Mines.—A lengthy letter in *Eastern Engineering* on the above subject traverses nearly all the aspects of electrical devices in mines which have to do with lighting and power. The author, who signs as "C.E.," does not give any startling facts, and his knowledge of English rather distorts some information he does give. Thus, speaking of electric lamps, he tells us that "the present electric lamps as used in French mines are not considered adequate, though they are a great improvement on those formerly employed, and which were fed from accumulators: they were defectuous in this sense, that they were only intended to last a certain number of hours; at the expiration of which time they had to be recharged, thus incurring delay. The lamps now in use are still accepted as being much too heavy, for they actually weigh 4lb. 6oz.; this weight when attached to the miner's hat is very exhaustive. The latest amelioration adopted is, the establishing of currents which charge the incandescent—not arc—lamps, that are affixed to the roof not to the hat as formerly—of the galleries, thus spreading a plentiful supply of light; there is no difficulty experienced in the working of the wires, and it is equally as simple to affix other lamps along the route of operations, as the perforations may require. Great care must, however, be observed in the laying down of the insulated wires, the better to prevent the possibility of friction or sparks, which could well provoke either an explosion in fire-damp mines especially, or ignite the surrounding wood-work." The writer advocates trolley traction in mines, but does not say how the sparking difficulty is to be overcome.

Electric Belts.—The exact incidence of some of the new war revenue taxes in the United States is, says our New York namesake, still uncertain. We have made note of the struggle over the one-cent tax on all telegrams, and the success thus far of the telegraph companies in leaving it for the customer to pay. But there are some unexpected points in regard to other items, and we note that "electric belts" are held to be mechanical appliances, and not taxable under Schedule B as medicinal preparations. Electricians will hardly find fault with the dictum that an electric belt is not a "medicinal preparation," but they will be at a loss to understand why it passes muster as a "mechanical appliance." It does not hold up the trousers of its wearer,

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neither does it pull down his shirt or vest. It is true that it is not held on magnetically, but that is also true of collars and socks, and they are not looked upon as in any sense mechanical appliances. If an "electric belt" were held capable of hitching a steam-engine to a dynamo, and thus helping to generate current, the propriety of the term would commend itself, but we have never seen an "electric belt" used in that way. Perhaps our readers have, and will be better able than ourselves to penetrate the mental mysteries of the fiscal expert who looks on electric belts in the light of suspenders. We accept the dictum that "the first absolute pre-requisite to the imposition of the tax is that the article should be medicinal in its character," for that is certainly what the "electric belt" is not. But why should mechanical be the alternative or antithesis to medicinal? Why not say outright that the belts are fakes? So far we have quoted our contemporary, but we wonder if this solution is feasible from the taxgatherer's point of view. Having declared that electric belts are fakes, would he find a special war tax for fakes, which would save further trouble.

Motors in Bleach and Dye Works.—In such works the atmosphere usually contains corrosive particles, which are most destructive to all exposed metal work. Hence, when using electric motors in such works, trouble often occurs, due to oxidation of the exposed contact. The multiphase induction motors have a great advantage over the direct-current types for such places. We understand, from the *Electrical Engineer* of New York, that the installation of these motors by the Silver Springs Bleaching and Dyeing Company, of Providence, has shown their fitness for this peculiar line of service in which the use of direct-current motors would be almost impossible. When extending the electrical plant at these works in 1895, Mr. E. C. Myrick, the company's engineer, recommended the adoption of the Westinghouse three-phase system, with 50 ⌣⌢, for both lighting and power. This decision was at the time severely criticised by several mill engineers, but the results of two years of active service under the worst imaginable conditions have fully demonstrated the soundness of engineering judgment manifested. In addition to lighting the entire plant, some 30 Westinghouse induction motors of from 3 h.p. to 75 h.p. have been installed. These motors are employed for driving washing machines, ironing machines, tentering frames, triplex pumps, elevators, ventilating fans, etc. Some of the motors operate constantly in a cloud of steam where a direct-current motor could not run for five minutes. Many of them are subjected constantly to the action of chloride fumes, and all the copper parts of the motors and switches are green with corrosion. In many of the operations enormous starting torque is required, the initial torque in some cases being four times the normal torque of the motor. The plant has proved so satisfactory that it has recently been extended by an installation of 10 more of the Tesla "Type C" motors.

Electromagnets in Eye Surgery.—Dr. J. Jameson, M.R.C.S., contributes a most interesting article to the current number of the *Lancet* on "The Electromagnetic Extraction of Foreign Bodies from the Eye." He points out that while it is fully established by the record of successful cases that the electromagnet is of value in ophthalmic surgery, there is still a considerable amount of doubt and divergence of opinion as to its exact *rôle* as a strictly conservative agent. For example, Hirschberg gave his favourable results as 10 per cent., while Mayweg's were 31 per cent.; Knapp's results were even less favourable that those of Hirschberg. This is a point which can only be established by the record of series of cases preferably drawn from the practice of one individual or institution. As such, the author gives a series of detailed cases which represent the electromagnetic extractions at the Birmingham and Midland Eye Hospital during a period of about two years. He also details some of the dangers and complications, both immediate and remote, of electromagnetic extractions. The series includes four cases in which pieces of iron or steel were extracted from the interior of the eye, and in which the eye was subsequently lost by after symptoms; 14 cases in which the foreign bodies were removed and the eye saved (in these cases the effect on the sight is noted), and also 16 cases in which the electromagnet was inserted in the eye without discovering any magnetic substance. The instrument used was that of Snell, and the current was supplied from a secondary battery. In a certain number of the unsuccessful cases the foreign body was undoubtedly firmly embedded in the coats of the eye. Dr. Jameson thinks in these cases a powerful magnet, such as Haab's, might have been more successful than the small magnet, or, having carefully localised the object by the means above mentioned, an incision could be made directly over its site and the foreign body extracted by magnet or forceps.

Our Profession: A Retrospect.—

We have wrestled, we have fought, our success is dearly bought,
We have wobbled, perhaps, at moments when a wobble means a fall;
But the world is in our hands, we are numbered like the sands,
And our foemen may with clearness read the writing on the wall.

But a twin decade ago, when the buzzing dynamo
Was partly built of gingerbread and partly built of jam,
We oft put our simple trusts in a "10-to-one-it-busts,"
While attendants put expression in the good old English "Damn!"

Now our years of youth are past, yet the first is like the last
In the plentitude of striving for efficiency and dibs;
But we give our word *to-day* that the goods will work O.K.,
And we do not pray for miracles to save us from our fibs.

Paced by Glory, spurred by Need, we have come since then full speed,
And our octopods of copper change burnt carbon into gold.
We have changed in a decade what long centuries had made,
And the change is—like "Aladdin"—new and better lamps for old.

We have changed the mind of man in a quarter-hundred span,
We have made a once-time luxury an article of need,
We have yoked the mighty force that will soon replace the horse,
O! the end of things is coming for the gas-man and his breed.

* * * * * *

Lest we suffer from swelled head, we to whom E.C. is bread,
And lest envious, thirsty laymen haste to join our happy band:
It is well to bear in mind that it's never hard to find
An electricious Johnny who would rather take than "stand."

J. H. C. B.

The Detroit Municipal Plant.—The street-lighting by arc lamps at Detroit is carried out by the municipal authorities, and a report of cost of working for 1897-8 has just been issued. From extracts of this report published in the American Press we gather that it is the first complete year that the whole plant has been working, and that the cost per arc lamp comes out at £16. 14s. per annum. The lamps are burned all night and the above figures include 4 per cent. interest and 3 per cent. for depreciation. The detailed cost per lamp is as follows: labour, £6. 13s.; material (coal, oil, and stores, we presume), £3. 14s.; and

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establishment charges, £6. 7s. The lamps are said to be of 2,000 c.p. As the offer of the Detroit Electric Light and Power Company, given in 1893, was to supply the lamps at £20. 8s. per lamp per annum on a 10 years' contract, the municipality claim to have saved money by laying down their own plant. Some of our contemporaries take a different view. Thus our New York namesake declaims against the 3 per cent. depreciation as utterly insufficient, and says that the saving is purely fictitious. This time will show; but we cannot see that the report gives occasion for the following tirade: "We are very tired of such municipal plant humbuggery and of the idea that the man in buttons can run things better than a private citizen as soon as he gets the buttons on. The last huge scandals in New York State canal administration would seem enough to warn against further attempts to administer commercial enterprises by public officials with public money. If the service is honest it costs above the market value. If the service is dishonest, there is no end to the leakage of funds which have to be met or raised by taxation. But we suppose the process of creating new departments for Tammanies to run will go on indefinitely, the delusion and deception being far too deeply seated to vanish because of any exposure." Our contemporary's logic also suffers, as it argues that it is not fair to compare the present cost with that offered by the company in 1893, as the cost of street-lighting has come down since then. It seems to us, however, that the saving through reduced cost would, under the proposed 10 years' contract, have gone to the company and not to the municipality.

Electric Traction in New South Wales.—We have just received the full report of the Public Works Department of New South Wales for the year ending June, 1897. The information is thus at least a year old, and yet some details contained in it as to electric traction may be of value, as showing how far the department is satisfied with such works. Thus we read that during the year the extension from Spit-road to Mosman's Bay of the Military Road Electric Tramway, a length of 1 mile 37 chains, has been completed and handed over to the Railway Commissioners. The heavy gradients on this extension afford a severe test of the suitability of electric traction to the more rugged and uneven districts met with in this portion of the metropolitan area, and although these have demanded the supply of extra power, the working of the line has so far proved satisfactory. The Willoughby electric tramway is also referred to as being in progress. This further extension in the North Sydney district of electric traction on the overhead-wire system was authorised in December, 1896. In connection with this line it is interesting to note that the section of the existing cable tramway between Ridge-street and the terminus in Falcon-street will be converted into an electric line, the motive power for the whole distance from Ridge-street to Chatswood being supplied from generators placed in the Ridge-street engine-house. After mentioning one or two smaller lines, the report draws attention to the George-street and Harris-street electric tramway. This tramway, the construction of which at an estimated cost of £130,500 was authorised by Parliament in September, 1896, will be the most prominent instance of electric traction in the colony. It will consist of a double track throughout its whole length of 3 miles 20 chains. Including cross-over roads and junctions, this is equal to a length of single track of about seven miles. The overhead-wire system has been adopted for this tramway after a very careful examination into the merits of the various methods of electric traction in use throughout the world. It was found that the overhead-wire system was being almost everywhere adopted in preference to all others, inasmuch as it possesses the advantages of comparative lowness in initial cost with a proved efficiency and cheapness in working. Contracts for most of the materials required for the construction and equipment of the line are now in course of execution. This shows that good contracts for electrical plant are to be had from the department.

Fire-Alarms in Chicago.—The fire-alarms at Chicago have for some time been worked from accumulators, as the primary batteries were found to be so troublesome to maintain. Now, as we gather from the *Electrical Engineer* of New York, motor generators driven from the town mains have been installed to replace the accumulators when they are being recharged. The fire-alarm system of Chicago, as in all the large cities in the States, is a closed-circuit system—that is, a small amount of current is kept flowing constantly through the circuit—the alarm boxes are placed in series on the circuit, and the fire-alarm signals are made by the momentary opening of the circuit by a signal street box. Absolute reliability and constancy are, of course, essential features of any current supply for this class of work. The storage batteries recently purchased by the department afforded both reliability and a reserve that can be depended on. It is necessary, however, to provide for supplying the fire-alarm circuits when the batteries are being charged, and for this motor generators have been adopted. Each motor generator consists of a 110-volt motor for direct current, directly connected through a flexible coupling to a direct-current dynamo of a voltage suited to the particular fire-alarm circuit it is desired to supply. The motor is shunt wound, as is also the generator, so that the fields of both machines are connected directly across the mains of the 110-volt supply circuit. The speed of the motor is varied by an adjustable resistance in its field circuit. The field circuit of the generator is also provided with a variable resistance. From the armature of the generator, to which the fire-alarm circuit is connected, the circuit runs out through the various street-alarm boxes and back through a relay in the central office to the motor generator. The duty of the motor generator when in use is to maintain on an alarm circuit a current of ·04 ampere. The current in the fire-alarm circuit can be adjusted in a number of ways by the arrangement adopted. Thus the current around the fields of the generator can be varied, the speed of the motor can be changed by varying the motor-field resistance, or finally an adjustable resistance in the fire-alarm circuit itself can be used to regulate the amount of current flowing in the fire-alarm circuit. Six motor generators have been put in. One of these gives 100 volts for the alarm circuit, two give 70 volts, and three give 40 volts. They have been in continuous operation since they were put in, and, except when the storage battery is being "exercised," will probably be used most of the time.

Sulphating of Negative Accumulator Plates.—Mr. Jumau contributes to a recent number of *L'Eclairage Electrique* an interesting discussion with the results of numerous experiments concerning the objectionable sulphating due to local action on the negative plates. This local action is shown by the evolution of hydrogen, and is due to two causes—the chemical action of spongy lead and sulphuric acid, and the electro-chemical action of the couple formed by the lead and the alloy of the grid; the former action increases with the concentration of the acid, and is very rapid at a density above 1·45; the E.M.F. between the lead and the grid at a density of 1·27 varied from 0·49 to 0·54 volts, according as the grid is made of soft lead or antimony lead; the spongy lead is electro-positive, and the sulphating therefore

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means a loss of the charge of that plate. To determine the extent of this action he made some tests, the results of which are given; the plate was formed of pastilles originally obtained from chloride of lead, and these were analysed after various periods of rest, and at two different densities of solution; the results are also given in curves; they show clearly the great effect of the density of the acid on this local action; also that densities not exceeding 1·32 can still be used, provided the cell does not remain inactive too long. Sometimes the sulphating is much greater, and it is then due to particles of peroxide detached from the positive plate or to copper, antimony, or iron, even though the antimony is only very slightly soluble in the acid; researches were made with antimony as the impurity, and the results are given in tables and curves, showing its enormous influence in this local action for high densities of about 1·31; the action of iron is less energetic at first, but after longer periods of rest it becomes more active; the antimony is the material which is to be feared most; the tests showed that it is found mostly on or near the surface, 40 per cent. of it being in the outside layer of 0·1 mm. The E.M.F. of lead and antimony in sulphuric acid is about 0·5 volts, the lead being positive. His conclusions are that to avoid this local action the positive plate should be made of soft lead, as pure as possible; when the positive plates are made of a lead antimony grid the local actions are reduced by avoiding as much as possible the peroxidation of the antimony, and by using an electrolyte of low density; to put the negatives in the best condition they ought to be taken out often and have their outer layer rubbed off mechanically, notwithstanding the resulting slight reduction of the capacity. The above abstract is taken from Mr. Carl Hering's well-known digest.

The British Association.—We must remind our readers that this gathering of scientific men and their lady friends commences next week at Bristol. The reception-room will be opened on Monday, the 5th inst., in the Victoria Rooms, where Post Office facilities will be provided. The offices of the presidents, the secretaries of sections and of councils, will be arranged in the building lately occupied by the Salisbury Club. The first general meeting will be held at the Colston Hall on Wednesday, Sept. 7, at 8 p.m., when Sir William Crookes, F.R.S, V.P.C.S., president elect, will assume the presidency, and will deliver an address; on Thursday evening, Sept. 8, at 8.30 p.m., there will be a soirée in Clifton College; on Friday evening, Sept. 9, at 8 30 p.m. a discourse will be delivered by Prof. W. J. Sollas, R.R.S., on "Funafuti: the Study of a Coral Island;" on Monday evening, Sept. 12, at 8.30 p.m., a discourse will be delivered by Mr. Herbert Jackson, on "Phosphorescence"; on Tuesday evening, Sept. 13, at 8.30 p.m., there will be a soirée in the Colston Hall; and on Wednesday, Sept. 14, the concluding general meeting will be held at 2.30 p.m. The various sections will open their meetings by presidential addresses on Thursday, the 8th, and many interesting papers are to be read in Sections A and G, with which the engineering profession is specially concerned. Thus Prof. Oliver Lodge will read a paper on telephony; Lord Kelvin has many communications to make in Section A, but the subjects are not to hand at present; Prof. W. E. Ayrton and Mrs. Ayrton have also a number of papers in Section A, of which section Prof. Ayrton is president this year. In Section G Sir John Wolfe Barry, K.C.B., is the new president, and a valuable presidential address is expected. In this section Mr. A. H. Gibbings is to read a paper on "The Application of the Electric Motor to Small Industrial Purposes, and its Effects on Trade and on the Community Generally." A larger number of foreign scientists than usual are attending the meeting this year on account of the international conference on terrestrial magnetism and atmospheric electricity, which will be associated with Section A as a department under the presidency of Prof. A. W. Rücker, M.A., D Sc. In this sub-section numerous papers by such men as Prof. Selém Lenström, of the Helsingfors University of Finland; Prof. Bauer, of Berlin; Prof. E. E W. Mascart, of Paris; Prof. Schuster, of Manchester; will be read, while Prof. Rücker's presidential address will be of special interest from the great amount of research he has conducted in terrestrial magnetism. Prof. Lenström will also read a paper on "The Influence of Electricity on Plant Life," which will, we believe, come on in Section A. The usual social functions will be quite up to the average in number, and a great variety of excursions have been arranged to places near Bristol.

Mr. Tesla's Circuit Interrupter.—When a charged condenser is discharged through a circuit possessing high induction and low resistance electrical oscillations are produced, the frequency of these being given by $2\pi\sqrt{KL}$, where K and L respectively represent the capacity of the condenser and the coefficient of self-induction in the charging circuit. Under the most favourable conditions which can be realised experimentally the train of waves produced by a single discharge is quickly damped, owing to the dissipation of energy due to the resistance of the circuit. Thus with oscillations possessing a frequency of several hundred thousand per second, if after 200 oscillations the electric waves have been so far damped as to be negligible, there will be a current flowing through the circuit for only an inappreciable fraction of the whole time, unless the condenser be charged and discharged many times per second. The primary object of several recent patents due to Mr. Tesla is to obtain an arrangement which is capable of doing this in an efficient manner. The actual arrangement of the electrical apparatus is somewhat as follows: The terminals of a condenser of suitable capacity are connected with the electric mains, one terminal through a coil of wire possessing an iron core, the other terminal through a few turns of wire of small resistance, forming the primary of a trans former with an air core. The condenser is also capable of being short-circuited through the above-mentioned low-resistance coil by a mechanical contact-maker effecting as many as 1,000 contacts per second. As a consequence, electric oscillations will be produced in the condenser circuit, and these will be transformed to an exceedingly high voltage by means of the transformer. The general principles of the circuit interrupter employed may be understood from an example. An arm hangs vertically from a stationary horizontal spindle, a star wheel being attached to the end of the arm so as to be capable of free rotation. The spindle passes through the centre of an airtight case, which can be rotated at a high speed by means of a motor. Mercury is placed in this case, and will be driven, by centrifugal force, to form a ring around that part of the case furthest from the axis of rotation; a non-conducting liquid, less dense than mercury, forms an interior ring owing to the same cause. The quantity of mercury is so adjusted that the points of the star wheel alternately dip into it, and are withdrawn from it as the wheel revolves. The methods of using this arrangement to make and break a circuit are obvious. A number of other ingenious contrivances are also described, in some of which mercury jets are used to make contacts, whilst high-pressure gases are employed to diminish sparking. Important applications of the high-tension currents of great frequencies may be anticipated, both in regard to lighting and the formation of chemical substances, such as ozone.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXXVI.

The mean specific gravity of several masses of different specific gravity, or, in other words, the specific gravity of a mass compounded of substances of various specific gravities has frequently to be calculated. Or, conversely, the specific gravity of a body entering, in known proportions, into the composition of a given mass, of which the volume is known, has to be determined.

The distinction between mass and weight may, in ordinary calculations, be neglected; but, strictly speaking, the *weight* of a mass is dependent upon its distance from the centre of the earth; and, when we speak of a given *weight*, we usually mean a given *mass*, without any reference to the value of g or the pull of gravity upon it.

In any absolute system of measurement (and, practically, also in the metric system) the unit mass is unit volume of the substance (water at the temperature of 4deg. C.) of which the density or specific gravity is taken as the unit. In this case we have the following simple relations:

Mass or weight at a given latitude and altitude = volume multiplied into specific gravity. Or

$$W = v \times \text{sp. g.}$$

Whence $$v = \frac{W}{\text{sp. g.}}, \text{ and sp. g.} = \frac{W}{v}.$$

If we have two masses of the same weight but of different specific gravities, the volumes will differ; the smaller volume will have the greater specific gravity, and *vice versâ*. This is expressed by the equation

$$W = v \times \text{Sp. G.} = V \times \text{sp. g.} \quad \text{And} \quad v = V\frac{\text{sp. g.}}{\text{Sp. G.}}. \quad V = v\frac{\text{Sp. G.}}{\text{sp. g.}}.$$

If we have two different masses of the same volume, then the greater mass (weight) will have the greater specific gravity, or sp. g. will vary directly as weight. Thus:

$$v = \frac{W}{\text{Sp. G.}} = \frac{w}{\text{sp. g.}}. \quad W = w\frac{\text{Sp. G.}}{\text{sp. g.}}, \text{ and } w = W\frac{\text{sp. g.}}{\text{Sp. G.}}.$$

The mean specific gravity of several masses will be the sum of the weights divided by the sum of the volumes.

$$\text{Mean sp. g.} = \frac{W + w + w_1, \text{ etc.}}{v + V + V_1, \text{ etc.}} \quad . \quad . \quad . \quad (a)$$

Or, substituting for W its value according to the equation given above,

$$\text{Mean sp. g.} = \frac{V \times \text{sp. g.} + v \times \text{Sp. G.} + v_1 \times \text{Sp. G.}_1, \text{ etc.}}{V + v + v_1, \text{ etc.}} \quad (b)$$

In the case, however, of our unscientific and anachronistic units of measure, these simple relations are necessarily complicated by numerical constants, excepting when these happen to cancel out from the numerator and denominator of a fraction. The constants of course vary according to the unit adopted. Thus when the cubic inch and the ounce avoirdupois are used, the weight of any body (CXXV.) is $W = v \times \text{sp. g.} \times \cdot577$; the constant being here the weight of a cubic inch of water expressed as the fraction of an ounce. If the pound, instead of the ounce, avoirdupois be taken as the unit of mass, the volume being still in cubic inches, the expression becomes: $W = v \times \text{sp. g.} \times \cdot03617$. In the case of the French measures, we have simply:

$$W = v \text{ . sp. g. (grammes)};$$

the volume being given in cubic centimetres.

As an example of the cancelling out of a constant, we may take the above equations (a) and (b). The former, with any of our units of measurement, is numerically incorrect; the denomenator requiring to be multiplied by the constant ·577 if the weights be given in ounces, or by ·036 if the weights be given in pounds—the volumes in both cases being in cubic inches. But the equation (b) is numerically correct for any units; the constant giving the correct numerical value for volume cancelling out in the numerator and in the denomenator. This equation may therefore be found useful; as will be the general rule that "the specific gravity of a compound mass is its weight divided by that of an equal bulk of water."

If the weight, volume, or specific gravity of one component of a mechanically compounded mass be unknown, it can be calculated by the following formulæ:

$$w_1 = \text{mean sp. g.} \times (v + V + V_1) \times \cdot577 - (W + w)\,(\text{oz.}) \text{ (from } a)$$

$$V_1 = \frac{W + w + w_1\,(\text{oz.})}{\text{mean sp. g.} \times \cdot577} - (v + V)\,(\text{c. in.}); \text{ and}$$

$$\text{Sp. G}_1 = \text{mean sp. g.} \times \left(\frac{v_1}{V + v} + 1\right) - (V \times \text{sp.g.} + v \times \text{Sp.g.})v_1$$

These apply to a mass compounded of three substances of different specific gravity. The formulæ can be simplified in the case of a mass compounded of only two substances, or extended in the case of one compounded of more than three constituents.

CXXVII.

In designing traction accumulators, a case which may be of frequent occurrence—as, for instance, when a certain number of cells, giving the required E.M.F., have to be stowed away within a given space—is that in which one of the *data* (a) is a containing box of given size. In this case the questions to be solved are generally:

(1) How many plates will the given receptacle contain?
(2) What will be the capacity of the cell?
(3) What will be its rate of discharge?
(4) What will be the weight and volume of the electrolyte?
(4) What will be the total weight of the cell?

Before these questions can be answered, the designer will usually require as further *data*:

(b) The density of the current.
(c) The time within which the cell is to be discharged.
(d) The initial and the final density of the acid electrolyte.
(e) The weight per square inch of the grid or other support.

The responsibility of *assuming* certain of these data cannot always be undertaken by the electrician whose duty it is to solve the above questions and to carry into effect the details of construction in accordance with the solutions worked out. His opinion may be required in regard to (b) and (d); but these two data are of such importance that they would usually be derived from high authority or extended experience.

Example.—The receptacle is an ebonite box, 6¼in. wide, 7¾in. long (L), and 9in. deep (inside measurement). The maximum density of current allowed is $\Delta = \cdot08$ (ampere per square inch). (It should be pointed out that this is a high value—just double the maximum density allowed by the E.P.S. Company for the T-type cell.) The time of discharge is to be θ = three hours. The grid or aperture support is $t = \cdot07$ (in.) thick, and one square inch weighs ·2oz. (w). The mean specific gravity of the active material is given as 8·5.* (This is supposed to be the specific gravity of either of the two kinds of active material.) The weights of the two kinds of active material are to be equal. The initial and final densities of the electrolyte are $N = 35$ and $n = 20$.

Before we can calculate the number (n) of plates the given receptacle will contain, we must ascertain the thickness (supposed to be the same) of the plates, and also the thickness (l) of the layers of electrolyte separating them.

The thickness of each plate—if the number of plates be taken as $(n - 1)$ instead of n—will be the thickness of the metallic supports—viz., 70 mils—*plus* twice the thickness (τ) of the layer of active material. The equation for this is:

$$\tau = \frac{p_1}{\cdot577 \times \text{sp. g.}} \quad \text{(CXII. formula IV.)}$$

But before we can apply this, we must obtain the value of p_1 (the weight per square inch of active material outside the support):

* According to F. Loppé, the usual density of the electrolytic peroxide of lead is 9·4, and that of spongy lead 8·2. The mean specific gravity for equal volumes would thus be 8·8; for equal weights, 9·1. The above is, therefore, a low value.

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$$p_1 = P - (6{\cdot}56\,t - w)\,\frac{\text{sp. g.}}{22{\cdot}8} \qquad \text{(CXII., formula VA.)}$$

And again, before we can apply this, we must have the value of $P = p_1 + \frac{p}{2}$, the total weight of active material per square inch of surface. When the time of discharge is three hours, we allow ·7oz. of lead in the form of peroxide, or $·7 \times 1·153 = 8$oz. of peroxide (III.) per ampere-hour. The weight (P) of active material per square inch will thus be $·8\text{oz.} \times \Delta\theta = ·8 \times ·08 \times 3 = ·192$oz.

Now we can obtain the value of p_1—viz.:

$$·192 - (6{\cdot}56 \times ·07'' - ·2(\text{oz.}))\,\frac{\text{sp. g.}}{22\,8} = ·1\,(\text{oz.})$$

and also that of τ, viz.:

$$\frac{·1}{·577 \times 8·5} = ·02''\ (\text{or } 20 \text{ mils}).$$

And the thickness of each plate will be

$$t = ·07'' + ·02 \times 2 = ·11''\ (\text{or } 110 \text{ mils}).$$

The thickness (l) of each layer of electrolyte is calculated from the weight of acid per ampere-hour, which, for the present initial and final densities, is ·74oz. avoirdupois. The bulk of this weight of electrolyte is almost exactly one cubic inch. The capacity per square inch of surface being $\Delta\theta = ·24$ ampere-hour, it will be seen that the distance between the plates will be $l = ·24$ (in.)

Now the number (n) of plates can be calculated from formula II. (Section 1). In this case $t = t_1$, or the plates of different sizes are supposed to be equal in thickness. Then

$$n = \frac{2L + 2l}{2t + 2l} = \frac{15·5 + ·48}{·22 + ·48} = 22·8.$$

But, as the fraction of a plate is out of the question, we call this 23 plates; thus slightly diminishing the value l. (*Ans.* 23 plates).

The size of the plates may conveniently be $8 \times 5\frac{3}{4}''$, and the area (a) of each side will be 46 square inches. (*Ans.*)

The capacity of the cell will be

$$\Delta\theta\, a\,(n-1) = ·24 \times 46 \times 22 = 202 \text{ amp.-h.} \qquad (\textit{Ans.})$$

Rate of discharge will be

$$\Delta a\,(n-1) = ·08 \times 46 \times 22 = 81 \text{ amp.} \qquad (\textit{Ans.})$$

Weight of electrolyte will be

$$202 \text{ amp.-hours} \times ·74\text{oz.} = 149\text{oz.} = 9\text{lb. } 5\text{oz.} \qquad (\textit{Ans.})$$

Taking 1 cubic inch per amp.-h., the volume of the electrolyte will be 202 cubic inch. (*Ans.*)

And the total weight of the contents of the receptacle will be

$$\mathfrak{W} = [·2 + (2 \times ·192) \times 1·6] \times 46 \times 22 \quad \text{(CXVI.)}$$
$$= ·814 \times 1{,}012 = 824\text{oz.} = 51\text{lb. } 8\text{oz.} \qquad (\textit{Ans.})$$

ELECTROLYTIC THEORIES AND THEIR RELATION TO COMMERCIAL ELECTRO-CHEMISTRY.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

(Continued from page 200.)

We have already seen that in some galvanic cells the electric energy obtainable, under certain conditions, is only partially accounted for by the chemical energy corresponding to the reactions which take place whilst the current is flowing. There are, however, some forms of cells, possessing definite E.M.F.s and capable of producing limited currents, in which no chemical reactions, as generally understood, take place. As the production of current in these cells has most important theoretical bearings, and may be put in evidence concerning views leading to valuable practical applications, a short description may not be out of place here.

Suppose that a cell is constructed from two pure copper electrodes, placed horizontally one above the other, the intervening space being occupied by two layers of copper-sulphate solution, the lower layer being the denser. We thus have the lower electrode bathed in a solution of its own salt stronger than that which surrounds the upper electrode. No chemical reaction can take place, and yet the two electrodes will be found, by experiment, to be at different potentials.

Another similar cell may be constructed by placing layers of zinc amalgam of different concentrations at the bottom of two vessels filled with an aqueous solution of a zinc salt, and connecting these vessels by means of an inverted U-tube filled with the same solution. A current will flow from the stronger to the weaker amalgam through the solution when the two are connected by means of a metallic wire. Further, this flow of current gradually leads to an equalisation in the concentrations of the amalgams, the more concentrated one becoming weaker whilst the weaker gains in strength. The explanation which has been proposed to account for these phenomena will be given later. At present it is only necessary to point out that chemical reactions are not the only source of energy in electrolytic cells.

Descriptive Theories.—Faraday showed that the passage of any quantity of electricity through an electrolyte was always accompanied by a corresponding transfer of matter. This generalisation has since been confirmed by the work of Kohlrausch, Lord Rayleigh, and others, most amply with regard to the passage of electricity through salts of silver and copper; and though the evidence is less conclusive in cases where other salts have been employed, it is such as to leave little doubt as to the substantial truth of Faraday's law, any apparent variations being probably due to secondary reactions and unavoidable experimental errors. When, therefore, an electric current passes through a solution of copper sulphate, copper is transported from the anode to the cathode of the voltameter. As to the exact way in which this transfer is effected, there is, however, much less unanimity of opinion.

In 1805 Grotthus proposed his now well-known theory of the preliminary formation of a chain of polarised molecules, followed subsequently by a molecular splitting up all along the line, the ions thus freed immediately reuniting—the positive ion of one molecule with the negative ion of the neighbouring one—except at the ends of the chain, where the ions may combine with the electrodes, or give up their charges and combine one with another, or enter into secondary reactions with the solvent.

It will be noticed that Grotthus assumed the ions to possess definite charges even whilst forming part of a complex molecule; further, that the algebraic sum of the charges comprised in a molecule was equal to zero.

Faraday's acceptance of this theory has doubtless had much to do with its popularity in this country, where it is the only explanation of the mechanism of electrolysis given in most of the text-books. On the other hand, it must be noticed that Maxwell tacitly recognised the necessity of a most important modification in this theory. Prof. J. J. Thomson has, however, in his "Recent Researches in Electricity and Magnetism," practically returned to the theory of Grotthus.

Before proceeding to the consideration of more recent theories, it may be as well to consider to what extent, if at all, Grotthus's original conceptions are inadequate for our present needs.

An objection immediately suggests itself in connection with the fact, experimentally demonstrated, that any E.M.F., however small, is capable of producing an electric current in an electrolyte, whilst the above theory would appear to require an E.M.F. greater than a certain minimum value, before any decomposition could take place. Details of the experiments just referred to will be given later; at present it will suffice to state the facts of the case.

Ohm's law has been found to apply accurately to the case of a current in an electrolyte, thus leading us, from another point of view, to the conclusion that an E.M.F., however small, is capable of producing a definite electrolytic current.

This objection has sometimes been evaded, rather than answered, by such statements as that, for an E.M.F. smaller than that corresponding to the chemical affinity of the ions a feeble current may begin, but no ions will be liberated, the current completely ceasing after a time. In answer to this, it has recently been shown by Glaser that whereas the chemical affinity of hydrogen for oxygen corresponds to an E.M.F. of about 1·45 volts, as previously

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calculated, yet a continuous electrolysis of acidulated water, accompanied by the evolution of oxygen and hydrogen, can be effected at 108 volts.

Enough has perhaps for the present been said to show that the above objection represents a serious difficulty to be faced by those accepting Grotthus's explanation of electrolysis.

Grotthus originally supposed that the electrodes exerted a definite force (varying according to the inverse square law) on the molecules throughout the medium. This supposition was conclusively disproved by Faraday, and needs no further consideration here.

An objection which has led to some important theoretical developments has been founded on the well-known fact that when, for example, an aqueous solution of copper sulphate is electrolysed between copper electrodes, its concentration increases noticeably near the anode, whilst a corresponding decrease in concentration takes place near the cathode. Now it is quite obvious that, supposing the whole of the current to be carried by means of the interchange of the ions composing the copper sulphate molecules in the manner supposed by Grotthus, no alteration in concentration should anywhere occur. The fact of its occurrence has consequently been urged as a disproof of Grotthus's theory.

It may,* however, easily be seen that if the current be carried partly by the agency of Grotthus's chains composed of copper sulphate molecules and partly by chains composed of water molecules, the occurrence of concentration differences near the electrodes would follow as a matter of course. In this case also no concentration differences will occur from the actions taking place in the copper sulphate chains. To examine the effects produced by the simultaneous electrolysis of the water, let us first turn our attention to what takes place at the cathode. Here for every interchange taking place along a "water chain" two atoms of nascent hydrogen will be liberated. These, acting chemically on a copper sulphate molecule, will form a molecule of sulphuric acid, whilst an atom of copper will be set free and deposited on the cathode. Thus

$$2H + CuSO_4 = H_2SO_4 + Cu.$$

The consequence will be that the solution near the cathode will be gradually impoverished in copper sulphate, at the same time becoming acid.

Turning now to the anode, the liberated atom of oxygen forming the other end of the "water chain" may be supposed first to oxidise an atom of the anode copper to cupric oxide. If now there be a molecule of sulphuric acid in the immediate neighbourhood, this will react with the cupric oxide forming water and copper sulphate. Thus

$$CuO + H_2SO_4 = CuSO_4 + H_2O.$$

Thus corresponding to one molecule of water, together with one of sulphuric acid present near the cathode the instant preceding the interchange along the "water chain," we shall have a molecule of water together with one of copper sulphate the instant after the interchange has been effected.

As a consequence the solution near the anode will gain in concentration as far as the copper sulphate is concerned, whilst that near the cathode will lose in concentration, at the same time becoming acid. This, as a matter of fact, represents very well the phenomena observed in practice. The fact that the bath used for the deposition of copper from a sulphate solution gradually becomes acid, even when a copper anode is used, is well known to the trade.

In accordance with the views just developed, the reason why an advantage is gained by the addition of a few drops of sulphuric acid to the sulphate solution in a copper voltameter, becomes fairly obvious. The oxidation of the anode when no acid is present has been often observed.

Of course, the reasoning employed above can in no sense be said to prove the truth of Grotthus's theory. It is well, however, to carefully discriminate between valid objections to a theory, and specious arguments which, when carefully considered, are found not to tell against it.

As to the assumption that part of the current is carried by the water ions in an aqueous solution of a salt, it seems to present no inherent improbability. The fact that brass may be deposited from a mixed solution of the cyanides of zinc and copper lends to it some sort of support. We shall see later that there is considerable evidence that the water ions do, under certain conditions, take an important part in the transmission of an electric current through a salt solution.

(To be continued.)

* The reasoning here employed is similar to a line of argument employed by Dr. Lodge in a slightly different connection (see "Report on Electrolysis," B.A. report, 1885.)

MAGNETIC SURVEYING FOR IRON ORES.

BY PROF. G. NORDENSTRÖM.

At the meeting of the Iron and Steel Institute, held at Stockholm last week, Prof. G. Nordenström, of the Stockholm School of Mines, read a paper on "The Most Prominent and Characteristic Features of Swedish Iron Ore Mining." The paper gives a most interesting survey of the chief geological characters of Sweden, and also of the geographical distribution of the Swedish iron ores, as well as particulars of their occurrence, nature, and composition.

As regards the prospecting for iron ores the professor states that, in no country have magnetic instruments been employed so long and on such a large scale for discovering iron ores, nor have the instruments used for this purpose in any other country reached such perfection as in Sweden. Some have thought that this depends upon the fact that all Swedish iron ores generally more or less attact the needle, while such ores are less common in other countries. It is also true that not only the most commonly occurring iron ores in this country, the magnetite ores, but also the next commonest, the hematites, are magnetic, although in a lesser degree, since they are always more or less mixed with magnetite. But such iron ores also occur, as is well known, in large quantities in many other countries, notably in the United States of America, also in Canada, Mexico, Russia (Ural Mountains and South Russia), Asia Minor, and British India. In several places in these countries there are very large and numerous iron ore deposits, partly composed of magnetite and partly of hematite mixed with magnetite. Furthermore, such iron ores occur (although not in such great quantities) in Spain (in the provinces of Malaga, Seville, and in the Pyrenees mountains), in Portugal (at San Thiago, in the province of Alemtejo), in France (in the Eastern Pyrenees mountains at Carrigon, at Segré, in the Department of Maine-et-Loire, at Dièlette, in the Department of La Manche, and in Italy (on the island Elba, in Piedmont, and in Sardinia).

Sweden is, therefore, far from being alone in the possession of such ore deposits. Thus the fact that magnetic instruments have long been employed on a large scale does not at all depend upon these suppositions, but can doubtless be ascribed to the interest for the exploring of ore which has made itself manifest for centuries, not only among our mining men, but also among the inhabitants of the mining districts in general. Among the latter class, this interest was aforetime constantly encouraged by the rulers of the country, who granted mining charters and rewards to such as discovered new ore deposits. A law was made to this effect more than 300 years ago.

Magnetic instruments have, in Sweden, been employed for exploring ore for more than 200 years, and perhaps longer. To begin with, only declination compasses were probably used for this purposes. In 1770 inclination compasses, or what are now called miners' dip compasses, were also brought into use. This miners' dip compass was constructed in the following manner: In a round brass box a magnetic needle is suspended in such a way that it can move freely on a horizontal plane and on a vertical plane to an angle of about 70deg. from the horizon. It is compensated for the earth's magnetism, so that it takes a horizontal position in districts void of ore, or where there are no magnetic ores. By the help of this simple instrument, which by far excels the dip compass "invented" a 100 years later (1866) in the United States, all our iron ores have been explored, and even a large number of other ore deposits, such as copper, zinc, cobalt, and nickel, has been discovered by its aid, since these ores contain a greater or lesser proportion of magnetite or magnetic

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pyrites. As a rule, miners' compasses without graduation are used. The horizontal plane of the needle is only indicated by a ring inside the compass. The dip of the needle is estimated only by the eye, and is not actually measured. The miners' compass is still used, and with success, for exploring for ores, but more particularly for the preliminary exploring work in ore fields.

In later times, however, the demand for more accurate results has grown, and during the past 30 years there have been introduced magnetic instruments, by means of which a still more exact knowledge of the magnetic conditions of our iron ore fields can be obtained. These instruments are Thalén's magnetometer and Tiberg's inclinator, or inclination-balance. Thalén's magnetometer, constructed by Mr. Thalén, professor at the Upsala University, is a modification of Lamont's theodolite. It consists of a declination-compass (A), Figs. 1 and 2, of about 80mm. in

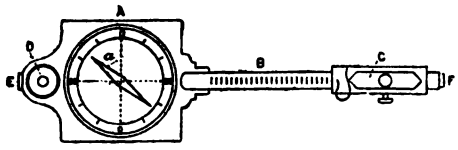

FIG. 1.

diameter, which is provided with a scale graduated to degrees and half-degrees from 0deg. to 90deg. At right angles to the diameter which passes through the zero point of the scale, there is attached an arm (B) from 200mm. to 220mm. long. On this arm, which is graduated in millimetres, is placed the bar-magnet (C) for the deviation measurements, which can at the will of the operator be given a certain fixed distance from the centre of the needle. The instrument is rotated on a vertical axis, whose central line passes through the centre of the magnetic needle. It is provided with a spirit-level (D), sights (E and F) and levelling screws, and is placed on a tripod. Thalén's magnetometer, which has been in use for more than 25 years, is now used principally for measuring horizontal intensity. In so doing, two methods may be used: the

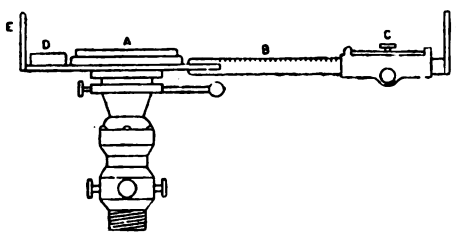

FIG. 2.

tangent method and the sine method. In using the tangent method, the magnetic needle is first placed at zero after the instrument has been levelled and the bar-magnet has been removed from its place. Then the bar-magnet is put in its proper place on the arm and the angle of deviation (a) is read. In using the sine method, the bar-magnet is first put in place on the arm. Then the magnetic needle is placed at zero, and, after the bar-magnet has then been removed, the angle of deviation (a) is read. This latter method gives more exact results, and it is always used for theoretical calculation or when absolutely exact results are desired. In practice, however, the tangent method is generally used, partly because it is more convenient and partly because it is everywhere applicable, which is not the case with the sine method in certain points of the ore field north of the ore. In these points the free needle has an indifferent equilibrium, and they are therefore called indifferent points. If in measurements of a field where magnetic ores are found R stands for the resultant of the horizontal component of the earth's magnetism and other magnetic forces present, the following formulæ for the two methods of observation are easily obtained:

$$R \tan a = K, \text{ and } R \sin a = K_2,$$

in which K and K_2 are constants as long as the size and position of the magnet remain unaltered.

In regard to the use of the magnetometer in ore fields, the author refers to a more detailed account given in his book, "L'Industrie Minière de la Suède," published last year. The main points of the method commonly used are as follows: Before the measurements are begun, the instrument is adjusted at a place where there are no magnetic ores, and consequently no other magnetic force than the earth's magnetism. The angle of deviation found here is noted a_0, and is generally so arranged that it is equal to 25deg. or 30deg. Then begins the measurement of the ore field, which for this purpose is divided into squares with sides 10m. in length. By the aid of the tangent method the angle of deviation (a) is afterwards obtained in each corner of every square. These a-values are noted on a map (see ideal map, Fig. 3), and the points for which equal angles have been obtained are joined. This gives two systems of isodynamic curves, which in a more or less regular manner are grouped around their foci or centres. One of these is situated north of the ore and where the a-value is greatest, and is therefore noted with a-maximum; the other is situated either directly above the greatest mass of ore or somewhat to the south of it, and represents the smallest a-value, being therefore noted with a-minimum. Between these two groups of curves there is an open curved line, whose angle of deviation is the same as obtained in dead regions, and it is noted with a_0. This curved line is called a neutral line after the angle a_0, which is called a neutral angle. The line which unites the maximum point and the minimum point indicates

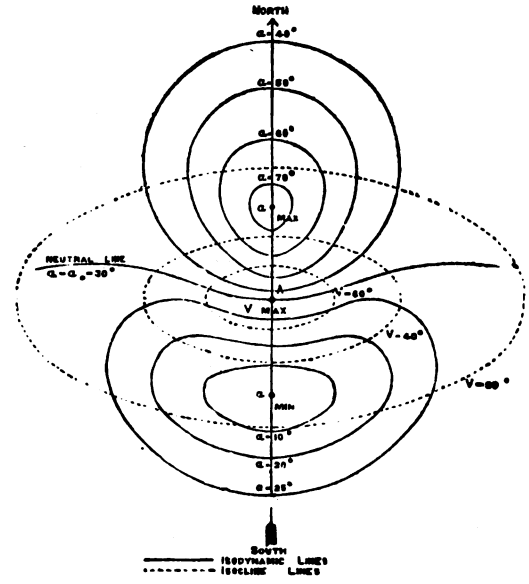

FIG. 3.

the direction of the magnetic meridian of the ore field. The centre of the great mass of ore is situated in the point of intersection of the magnetic meridian and the neutral line as often as

$$\sin a_0 < 3 \sin a_{\text{min.}}$$

In this case the outcrop of the ore is also covered with more or less thick beds of sand, gravel, or other younger deposits. If, on the other hand, we have $\sin a_0 \leqq 3 \sin a_{\text{min.}}$, the centre of the ore is situated either under the point representing a min., or somewhere on the magnetic meridian between this point and the aforesaid point of intersection. In this case the ore either crops out at the surface or its outcrop is covered with younger deposits, whose thickness is least when the nearest the centre of the ore lies to the minimum point. Finally, in should be noticed that, in order to get correct results, the levelling of the ore field which is being measured should be known.

Tiberg's inclinator, or inclination balance, as it is also called, has been in use since 1880, when it was invented by E. Tiberg. It consists of a dip compass, 80mm. in diameter, graduated from 0deg.-90deg., and a magnetic needle so hung that it cannot move except on the plane of the graduated circular scale. The instrument furthermore differs from other dip compasses in that the centre of gravity of the magnetic needle is a little below its horizontal axis when the compass is in a vertical position. The

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needle is compensated for the vertical force of the earth's magnetism by a piece of wax, or by a counterbalance of aluminium fixed to it. For some years this instrument has been generally used in combination with Thalén's magneto-meter, partly to avoid the necessity of taking more than one instrument on surveying expeditions, and partly because that by such a combination of the two instruments, measurements, according to both Thalén's and Tiberg's methods, could be more quickly made, especially if the tangent method was to be used.

The combined instrument is illustrated in Figs. 4 and 5. Fig. 4 shows the instrument furnished with Tiberg's compass, but in Fig. 5 it is substituted by Thalén's compass. In order to make it possible to use first the one and then the other of these compasses, they are provided with axle-pins fitting into the bearings in the standards (*a*). The centre lines of the axle-pins in the Tiberg compass run through the zero-points, but in the Thalén compass through the 90deg. point. The instrument is furnished with a spirit-level (*b*), a transverse arm (*c*), and sights (*d*). The arm (*c*), secured on one of the standards, serves to receive the bar-magnet for the deviation measurements, when measurements according to the Thalén method are to be made. The method of using the instrument in making such measurements has already been sufficiently explained. Tiberg's method is described in detail in the author's work: "L'Industrie Minière de la Suède en 1897," pp. 26-29. Consequently I need here only give the following hints: To begin with, the instrument is adjusted on perfectly

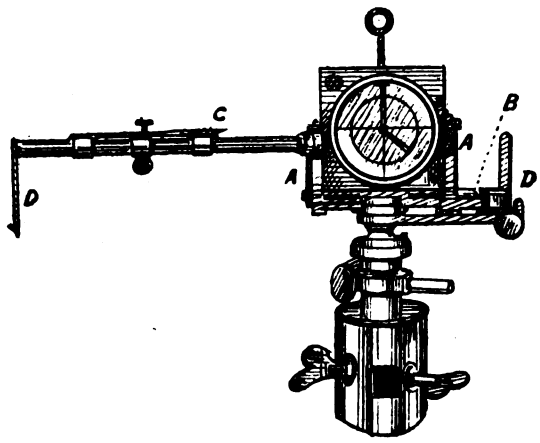

Fig. 4.

neutral ground, as above described. After the ore field to be explored has been divided into squares, with sides 10m. long at the most, observations are made with the inclinator in each corner of every square in the following manner: The compass is placed horizontally, and is turned on the horizontal plane till the central line through the axle-pins of the compass is at right angles to the direction of the needle, or, in other words, so that the needle is placed at 90deg. Then the compass is turned on its axle-pins, so that it has a vertical position. In this position the needle is only affected by the vertical component of the ore, and this causes a greater or lesser inclination of the needle. If the magnetic force of the ore is P, and the angle of the inclination is V, then we have

$$P = K \tan K.$$

If we mark the value of V on a map, and the points for which the same V-values were obtained are united, we get a system of curves, isoclinic curves, which are more or less regularly grouped around a certain centre whose V-value is greater than that of all the others (see Fig. 6). Immediately under this centre where V = V max., the greatest mass of ore always occurs. Besides for surveys at the surface, both the magneto-meter and the inclinator are also used for surveys underground, in galleries and in other places, for exploring the ore. For this purpose the sine method is generally used. If H (Fig. 6) is the horizontal component of the earth's magnetism, and F that of the ore, and R is the resultant of both, we obtain for each point of observation R_1, R_2, R_3, etc., according to the formula:

$$R = H \frac{\sin a_0}{\sin a}.$$

If we give an arbitrary value to H, which is considered to be a constant, we get the lengths R_1, R_2, R_3, etc., as well as their direction. The length and direction of the component of the ore (F) is then obtained by construction. The position of the centre of the ore sought for (C) is indicated by the direction of F_1, F_2, F_3, etc., all of which converge more or less towards this centre. The magnetic plans made by means of this graphic method are called "kraftpilkartor" (magnetic force-arrow plans).

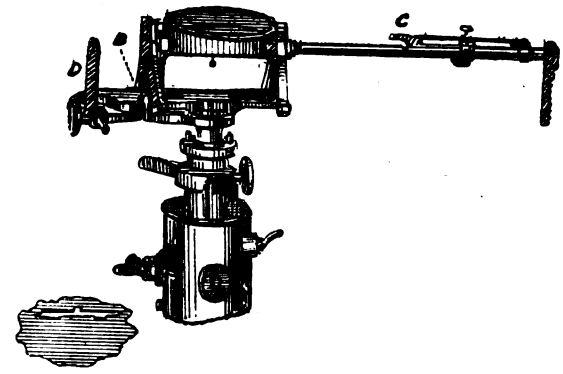

Fig. 5.

Everywhere in the Swedish mining districts the above-described Thalén and Tiberg instruments have been employed with the best results, both in measuring on the surface and down in the mine. There is probably not a single mine in the country where these instruments are not used in one way or another, and magnetic maps based on one or the other of the aforesaid methods have been made of nearly all of the magnetic mines. This greatly facilitates prospecting. Guided by the results of the magnetic measurements, it has been possible to conduct this work far more accurately than would otherwise have been possible, and thus a great saving in shafts, levels, and other exploratory work has been accomplished. Even for estimating the value of smaller mines, measurements are taken with these instruments, and magnetic maps are made.

It has been doubted whether these methods of measurement could be used in more southern degrees of latitude; but I have several times had an opportunity of proving that they are really just as useful there. I had a specially good opportunity of this kind in 1895, when paying a

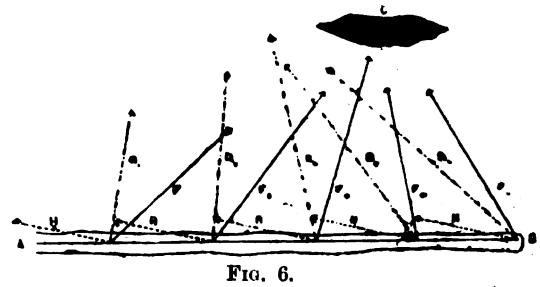

Fig. 6.

visit to some mines in Southern Spain, at Marbella, Estepona, and Pedroso, and the measurements I then made completely proved the practicability of these methods at that southern latitude. During the following year a Swedish engineer, Mr. K. Johansson, guided by the results reached by the aforesaid experiments, and by my suggestions, made complete magnetic measurements and maps of the Iberian Iron Ore Company's mines near Pedroso (Spain).

These were the first complete magnetic measurements which have been made of iron-ore fields in Europe outside of Sweden, except, perhaps, some few in Finland. By means of these measurements, which were made both according to Thalén's and Tiberg's methods, much has been learnt in regard to the site, etc., of these mines, and they have, on the whole, been of the same use at Pedroso on 38deg. latitude as in Sweden on 60deg. latitude. The benefit of magnetic measurements in ore fields has also been proved

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in the United States, and there is no doubt that such measurements would be of great use in all countries which have been above mentioned as possessing magnetic iron ores. It is astonishing that people in these countries have not already learned to appreciate the great advantages which are offered to the practical miner by the use of the magnetic instruments described above.

In the latter part of his paper the author gives details as to the methods of working iron mines in Sweden, and states that electric rock drills have been tried of recent years to replace the more tedious hand drills for preparing blasting holes.

ELECTRIC UTILISATION OF WATER POWERS.*

BY L. D. W. MAGIE.

The harnessing of water powers is not an easy task, but requires a great deal of thought, scheming, trying, and fitting by the engineer. The records of the stream have to be looked up and studied into, with reference to high and low water, during a period covering many years, and due provision made for getting rid of the maximum flood of every season.

Probably one of the most important things to study, especially in localities subject to severe winters, is the question of frazile or anchor ice. This is a condition which has caused hundreds of thousands of dollars to be spent, either from the lack of knowledge or want of forethought; in some cases the conditions have been such as to make it almost impossible to successfully cope with them, without expending such sums of money as to practically ruin the enterprise. To overcome it successfully the only way seems to be to provide a large pond of still water extending to as great a distance as possible, even several miles if attainable.

The pioneer work in electrical transmission was done with direct-current system, and too much credit cannot be given for achievements attained. However, although in a few instances the distance transmitted by the direct-current system has been up to 12 miles, yet, on the whole, for commercial reasons it has not been desirable to transmit power by direct current to a distance of over two miles, and even the advisability of this is looked upon to-day doubtfully.

The amount of copper required for the transmission of power is directly proportionate to the amount of power to be transmitted, and also directly proportionate to the square of the distance for a given efficiency. This may be stated commercially by the amount of copper required for transmitting, say, 100 h.p. for both one and 10 miles, the loss in transmission to be 8 per cent., and the voltage to be 500 volts.

For each leg of a one-mile circuit there would be required two No. 0000 wires, or four No. 0000 wires, each one mile long, weighing 15,312lb., which, at 15 cents per pound, would cost £460. For each leg of the 10-mile line there would be required 20 No. 0000 wires or 40 No. 0000 wires, each 10 miles long, weighing 1,531,200lb., which, at 15 cents per pound, would cost £46,000; or the power would cost, at 10 per cent. interest and depreciation on copper alone, 9s. 7d. per horse-power annum in the first instance, and £46 per horse-power annum in the second case.

If, however, the voltage be raised to 5,000 volts, and be used for transmitting 100 h.p for 10 miles, the condition would be entirely different, for instead of 40 No. 0000 wires, each 10 miles long, there would be required for each leg but one No. 4 or two No. 4 wires each 10 miles long, weighing 15,300lb., which, at 15 cents per pound, would cost £460, or the same as transmitting the same amount of energy only one mile at 500 volts.

The primary or fundamental question is to ascertain the point at which transmission of water powers will be a source of profit to the investor. The cost of electrically transmitted power is represented by the interest on the capital invested, the depreciation, the maintenance, the operating expenses, and numerous other small contingencies, and besides, in some cases, the amount of money that has to be expended for water and land privileges. The sum of these accounts per year, divided by the amount of horse-power actually sold, will be the actual cost per horse-power for the case in question.

Probably the greatest competitor to electric power is steam power. In a few instances power derived from gas or petroleum engines may also compete. The cost of producing steam power in any given locality is a fair criterion by which to determine how much electric power should cost. The cost of power produced from other sources can usually be disregarded.

The cost at which steam power can be produced in a given locality being ascertained, it can be determined what cost per horse-power may be expended on the construction of an electrical transmission plant to make it profitable to the investor, provided, again, a sufficient market can be obtained for power.

When electrically transmitted power does not cost more than £20 to £28 per horse-power installed, the investment is apt to be a profitable one, providing, of course, it is properly managed.

The first item of expense is amount required for water privileges. In some cases this is rather an unimportant consideration, while in others it is the chief expenditure, for it may involve the buying of thousands of acres of land surrounding the stream, because the necessary dams may cause to be submerged a great deal of valuable land, or large tracts have to be bought for building storage reservoirs, or the right of way for pipe lines, etc., have to be secured. When land is cheap these considerations are often not objectionable, but where good farming land, or land valuable for other reasons, has to be thrown to waste, the question is often a perplexing one.

The cost of the dam, power-house, and hydraulic machinery is, as a rule, dependent almost entirely on the characteristics of the stream being utilised. Entering into the question is the amount of water in the stream, both under normal as well as abnormal conditions at various seasons of the year; also the head or fall, and whether it is dependent on natural conditions or requires the building of large dams. Generally speaking, other things remaining equal, generating plants, comprising the power-house, hydraulic and electric machinery, as a whole cost less as the head increases, until certain limits have been reached. When the head is low, as ranging from 4ft. to 10ft., it requires a comparatively large wheel for a relatively small amount of power, and then slow speeds can only be attained. Where large units are desirable a number of these wheels must be coupled together in order to get the required power. The speed required can be raised or lowered to a certain extent, depending on the size of the wheel. If higher speeds at low heads be desired for large units, many wheels must be operated together, requiring not only a great deal of room, and consequently larger power-house, but considerable line shafting, gears, couplings, etc., which not only increase the initial cost, but increase expenditure of operation and maintenance of the plant as well as introducing another source of inefficiency. With higher heads a larger amount of power can be obtained from fewer and smaller wheels, with higher speeds, and, therefore, cheaper generating apparatus.

The cost of generating apparatus for a given capacity, other things remaining equal, is almost directly proportional to the speed at which it runs, and for this reason it is always desirable to refrain from too low speeds wherever possible. A good engineer will hardly warrant the expenditure of, say, £3,000 for a 300-kw. generator to run at a speed of, say, 75 to 100 revolutions per minute, when a machine just as good in every respect, and sometimes better (because it is a standard size), can be bought in belted units for £1,000.

The next item of considerable expense is the transmission line. The poles, with their appurtenances, exclusive of wire, will cost between £50 to £100 per mile, varying according to circumstances. Rights of way for the placing of poles may often be expensive. The transmission wire must be considered separately.

The cost of the transmission wire is often the most

* A paper read before the Canadian Electrical Association, Montreal, June 28, 1898.

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important part, but is always different with each case, dependent as it is upon the amount of power to be transmitted, the transmitting voltage, distance, and the allowable loss. As a whole it is always best to keep the transmitting voltage as low as possible, and still keep within commercial conditions. Many people are carried away with the idea that if they could only use high voltages the cost of transmitting would be reduced to a minimum. It must be borne in mind that with the use of the higher voltages the cost of insulators increases, the electrical apparatus necessarily costs more, and, moreover, the risks are greater throughout the system, and consequently necessitate more skilled attendants to look after the plant. All of these items have to be carefully considered before looking into the possible saving of copper on the line. For mechanical reasons a wire smaller than No. 6 B. & S. should not be used for line work. More cautious engineers will say it should not be smaller than No. 4 B. & S. It is foolish to attempt to use voltages which allow the use of smaller than No. 6 wire. Where a shut-down would mean heavy damages it might be even advisable to use a wire not smaller than a No. 2 B. & S. If these facts are always borne in mind, the question of voltage will oftentimes adjust itself, and the use of very high voltages will not be found necessary, unless the transmission be for especially long distances, and the amount of power particularly large.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE II.

(Concluded from page 282.)

The principle of the process is illustrated in Fig. 38, copied from the patent specification. The crushed and dried leaves are put into a basket made of perforated metal or wire gauze. This basket is lowered into one of the jacketed digesters, D_1 and D_2, which is then filled with petroleum spirit from tank T_1 or T_3. The spirit is heated to boiling temperature by passing steam through the jacket of the digester, and the vapours are condensed in C, which acts as a reflux condenser. After a certain time the solution in the digester is allowed to cool a little, and is then drawn off into tank T_2; fresh spirit being then admitted and the operation repeated. After draining the remaining solvent is distilled off from the leaves through C into tank T_4 by means of direct steam, whereupon the exhausted leaves are removed. The gutta solution, which is kept slightly warm, is pumped up into tank T_3, whence it flows either through a fresh charge of leaves, or, when sufficiently thick, is cooled down in one of the digesters by passing water through the jacket to precipitate the gutta. The mother liquor is then drawn off into tank T_2, the precipitate washed with clean spirit from tank T_1, and allowed to drain. Steam is now admitted into the digester to distil off the remaining spirit, and the gutta which is found floating on the condensed water is removed and washed. The two digesters are worked alternately.

Here are specimens of guttapercha extracted from leaves by Rigole's, Sérullas's, and my own process respectively. This specimen, which is in the form of a brick, was obtained by my process. As you observe, it is of a very light colour, but still shows a slightly greenish tinge due to the presence of chlorophyll; however, some which we washed with particular care before the spirit was distilled off from the precipitate looked decidedly better, and at the next lecture I will show you some of it rolled out into a thin sheet.

I am able to carry out the precipitation of gutta from solutions in your presence. This large vessel contains a solution prepared from leaves by means of hot toluene, and I will now pour twice its volume of acetone into it in the form of a spray, whilst I briskly stir the solution. After the lapse of a little time you will observe the precipitation of the gutta in the form of a white flocculent mass.

In this bottle is a solution of gutta, prepared by heating crushed leaves with petroleum spirit and straining the solution, which was then placed in ice. You notice the gutta has separated out in the form of a white powder. The solution in the other bottle is still clear, having been kept at a temperature above 60deg. F. I now put it in ice, and we shall examine it again at the end of the lecture.—[The gutta had then been precipitated voluminously. In the case of the solution in toluene, precipitation did not take place immediately after the addition of the acetone, but it occurred before the lecture was over, as was shown.]

* Cantor Lectures delivered before the Society of Arts.

Advantages and Disadvantages of the Different Processes.

On reviewing the various processes used or recommended for extracting, purifying, and hardening guttapercha, one is struck by the fact that in almost every instance there are some disadvantages besides the advantages. The guttapercha extracted in a conscientious manner from the trunk of the right kind of tree possesses all the good qualities of this material, particularly that of durability, which is most valuable, but there is a risk of adulteration by admixture with juices from other plants which are worthless or even detrimental; and, moreover, the destruction of the trees is, as has been repeatedly said, a most extravagant and wasteful proceeding. In that respect the extraction from detachable parts of the tree is certainly preferable; but, as hitherto no satisfactory mechanical process has been proposed for that purpose, chemical methods have to be resorted to, as we have seen. This I consider to be a disadvantage, inasmuch as the durability of the guttapercha, particularly on exposure to air and light, is thereby imperilled.

The chemical hardening process differs from the chemical extraction process in so far that the salient constituent—*i.e.*, the gutta—is not affected by it, the solvent acting exclusively upon the resinous components. One point, however, must be taken into consideration—namely, that whatever the properties of the gutta itself may originally have been, they remain practically the same after the hardening process. By far the most (though not all) of the commoner sorts of raw materials, containing a large amount of resin, which would recommend themselves for the hardening process, contain also a gutta of inferior description. Hence, in spite of the low percentage of resin which the hardened materials may contain, they cannot be considered fully equal to the superior kinds of guttapercha obtained directly from the tree. I shall, however, have something more to say about this subject in my next lecture.

Natural Substitutes.

I designate as natural substitutes those materials proposed as a substitute for guttapercha which are direct natural products, and which have been aptly termed pseudo guttas by Mr. James Collins. I can only consider a few of them to-night, and I shall more especially refer to those which have either been submitted to the Society of Arts or with which I have become personally acquainted. The first material proposed as a substitute is the product of the common Indian Mudar-plant (Calotropis gigantea Robert Brown), which belongs to the Asclepiadeæ; it was proposed in 1852 by Dr. Riddell, a surgeon in the Nizam's army. Sir Richard Shakespeare, the Resident of Gwalior, had the electrical properties of this gum tested, and found it to insulate badly; but he recommended the juice of the Mudar-plant for impregnating fibrous materials to render them elastic and waterproof. Mr. T. T. Henley and Captain G. E. Hollings, deputy-commissioner in the Punjab, proposed another substance, called "Garancine," obtained from the juice of the "Munjeet" or Indian madder (Rubia munjista Roxburgh), and also the product of the "Alk" (Calotropis Hamiltonii Wight).

I have not hitherto had an opportunity of testing either of these substances, but of those which I am now going to mention I have had specimens for examination from the Kew Museum.

The first of these is the gum from Dichopsis obovata Teijsmann, found in the province of Mergui. Sir Archibald Boyle, the commissioner of Tenasserim, submitted a specimen of this "new kind of guttapercha" to Dr. Falconer, the superintendent of the Honourable East India Company's botanic garden at Calcutta. It was handed for chemical analysis to Dr. Macnamara, who states in his report "that he does not hesitate to express his confident opinion that this new variety of guttapercha will be found to have all the useful qualities of that generally known and to be equally valuable." I have examined a specimen of this substance sent to Kew from the Indian Museum, but found it quite useless as a substitute, as it had neither strength nor tenacity. It is almost completely soluble in cold ether, and does not contain any appreciable amount of true gutta.

The next specimen I examined was a gum known under the name of "Pauchontee," which had been submitted to the Guttapercha Committee of the Society of Arts by the Secretary of State for India in 1859, with a request for their opinion as to its quality and commercial value. Dr. Dugald Campbell, to whom the specimen was handed for testing, found it hard and brittle at ordinary temperatures, and of little use for admixture with ordinary guttapercha. My own experience confirms this unfavourable report. The gum is the product of Isonandra acuminata Miquel or Bassia elliptica Dalzell, a tree which appears to be common on the Malabar coast, the forests of Coorg, at Travancore, etc.

In 1849, Mr. Richard Spruce sent a sample of gum called "Massaranduba" to the Kew Museum from Para. This gum, which is derived from the cow-tree (Mimusops elata Allemao), I have recently examined, but found it resinous and brittle, and, therefore, of no practical use as a substitute for guttapercha.

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We have next to consider the "gutta shea," the product of the shea butter-tree, or Karité (Butyrospermum Parkii Kotschy), which has been recommended as a substitute, and was very favourably reported upon by Dr. Edward Heckel, professor of botany at the Faculty of Sciences of Marseilles. The solid oil or fat of the shea butter-tree, which is largely used for soapmaking, contains from 0·5 to 0·7 per cent. of a hydrocarbon said to be similar to gutta, and which has been termed "gutta shea." I have examined a specimen of the concrete milk from the trunk of the tree, also some of the gutta from a perfectly fresh and intact state. MM. Sérullas and Hourant propose to extract the "gutta shea" from the raw material with toluene, and to precipitate the hydrocarbon from the solution by means of acetone, in the same way as they obtain the ordinary gutta from leaves.

The getahs of Dichopsis maingayi and Bassia motleyana, which I mentioned in my first lecture, as well as some of those from Celebes, to which I then referred, may also be properly classed amongst the pseudo-guttas, but of those I examined several—for instance, the getah taban simpor from Dichops.

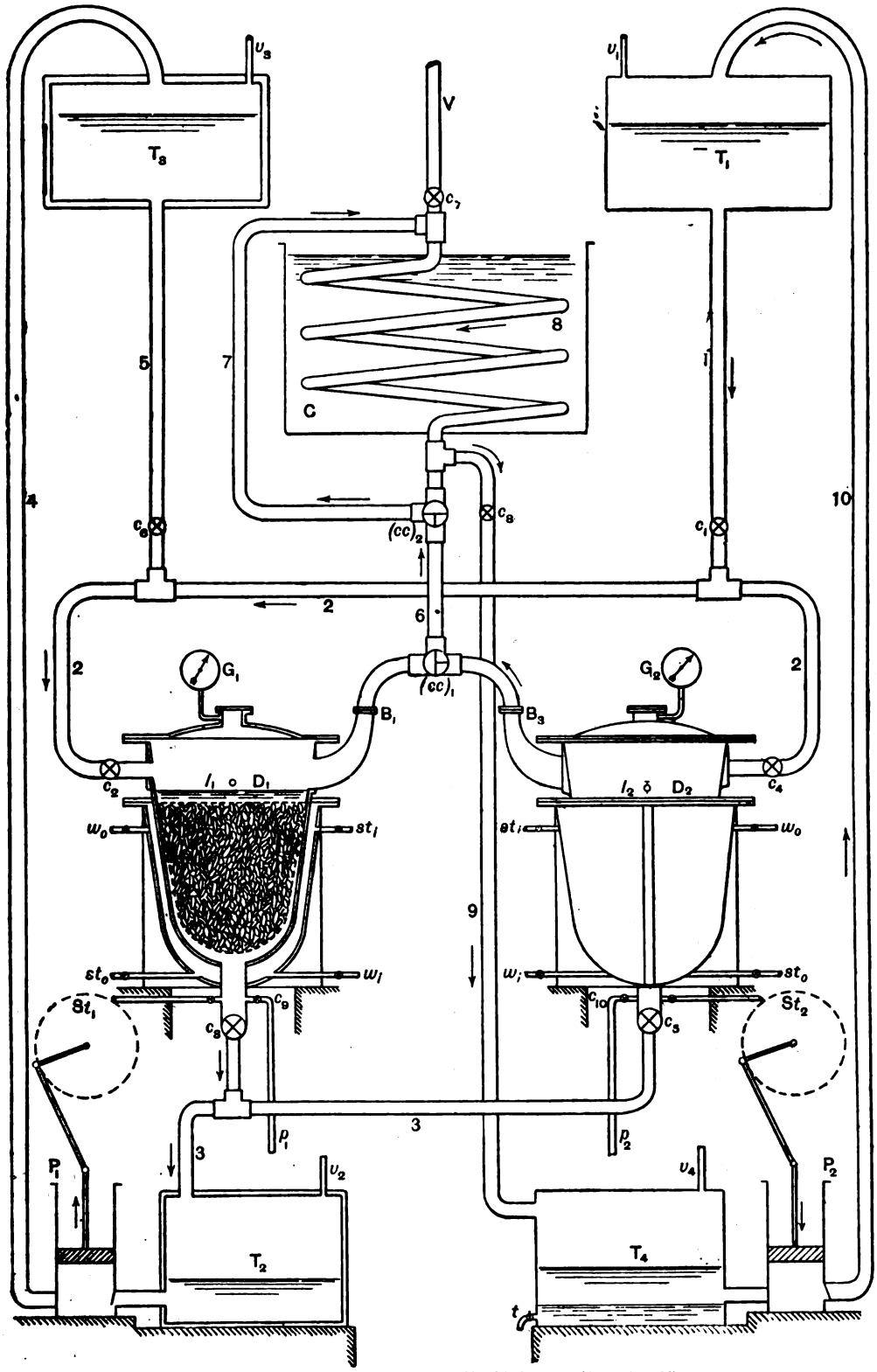

FIG. 38.—Extraction from Leaves by Obach's Process (August, 1896).

shea butter, and some slightly fermented gutta from the trunk, which I received in 1891. They were taken from samples sent to the Kew Museum from Western Africa some years ago by Sir George Goldie, of the Royal Niger Company. Two of the samples contained about 14 per cent. of a substance somewhat resembling gutta, but possessing no strength or tenacity, and partaking more of the nature of a wax. The material could, therefore, hardly replace guttapercha, except, perhaps, for some special application. However, I should not like to express a definite opinion on this substance until I have examined it in Maingayi and two of the specimens from Celebes—contained an appreciable amount of real gutta, and might therefore be used for certain purposes in combination with a better class guttapercha, or they could be freed from resinous matter by treatment with petroleum spirit, as described to-night, and then used.

BALATA.

The only natural substitute for guttapercha with which I am acquainted, and which really deserves that name, is Balata. It is the coagulated latex of a large forest tree belonging to the

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Sapotaceæ, which is known under the name of "bullet tree," "bully tree," or "bolletrie." The botanical name is Sapota Mülleri Blume, Mimusops globosa Gaertner, or Mimusops balata Gaertner fil. The tree reaches at maturity a height of 120ft., and usually has a large spreading head. Its cylindrical trunk is 60ft. to 70ft. high and 4ft. to 5ft. in diameter. The wood is hard, dense, and has a reddish tinge, which accounts for the name of "paardenflesch" (horseflesh) given to it in the Dutch colonies. The glossy leaves are oblong-oval, 4in. to 6in. long, and 2in. to 2¾in. broad; they are acuminated, petiolate, and alternate, being crowded together towards the ends of the branches. On the table there are some leaves of the balata tree, modelled in the gum itself, and presented to Kew in 1882 by Mr. E. Im Thurn, of Demerara; perhaps they give you even a better idea of the appearance of these leaves than the drawing. Here are also dried branches with flowers and fruits, from the herbarium, and specimens of wood and bark of the tree from the museum at Kew.

The flower is six-parted (hexamerous), the corolla being white and about ½in. long. The fruit is sometimes spherical, sometimes oval; it is edible, having a sweet taste like a plum. The milky juice which exudes from the trunk on incision is also consumed by the natives, who dilute it with water.

The Mimusopeæ are distributed all over the globe, and not long ago Dr. Schweinfurth found the leaves of Mimusops Schimperi Hochstetter within the wrappings of Egyptian mummies 4,000 years old.

The bullet trees are found in Jamaica, Trinidad, Venezuela, British, Dutch, and French Guiana; they are also said to occur on the Amazon river. In the colony of British Guiana they are most plentiful between the east bank of the River Berbice and the Corentyn.

To obtain the latex, which is chiefly contained in the intermediate layer of the bark, it was formerly the custom in Jamaica to fell the trees and ring the bark, as described in the case of the true gutta trees; but this method has now been abandoned, and the trunk is simply tapped, which is quite practicable, as the balata milk is much more liquid than that of the guttapercha tree, as I stated in my first lecture.

In Surinam the trees are likewise tapped, or "bled," as it is technically called, the bark being scarified half round the tree to a height of about 20ft. from the base, and I will now show you some pictures on the screen which illustrate the method of bleeding in Surinam. The first shows the men in the act of cutting the grooves which are so arranged that the milk runs from one into the other till it reaches the lowermost.

The next picture shows the tree after all the grooves have been cut in the trunk, and you observe the vessel or calabash placed at the bottom of the system of grooves to collect the milk flowing along them. The gang of men is in the act of leaving in search of another tree. The contents of the calabash are emptied into another gourd provided with a handle, termed a gooba. Specimens of these utensils are here on the table. In the gooba the milk is taken to the settlement, and either sold as it is, fetching about 1dol. per gallon, or it is evaporated to obtain the (pinkish or greyish coloured) solid balata, for which 10d. or 11d. per pound is paid. A gallon of milk yields about 4lb. of dry balata. A "bleeder" of average skill obtains about four gallons, and a very successful one as much as 10 gallons per day, thus realising over 30s.

I had the opportunity of examining some balata milk sent to the Colonial and Indian Exhibition at South Kensington in 1886. I found its specific gravity at 60deg. F. to be 1·0063, and after evaporation on the water-bath I obtained about 60 per cent. of dry balata, which when analysed had practically the same composition as that of most commercial specimens.

The first published records of balata are to be found in Prof. Bleekrode's paper of 1857, mentioned above, and in a communication of his to the Society of Arts made in the same year. From some chemical tests he arrived at the conclusion that balata, or Surinam guttapercha, as he called it, was identical with the product of the Isonandra gutta.

The Society of Arts again plays an important part in the early history of this interesting substance. In August, 1860, the colonial secretary of British Guiana sent some balata, which had been collected in Berbice by Dr. van Holst, to the secretary, Mr. Le Neve Foster, and the specimens were afterwards forwarded to the Kew Museum. Other specimens were received by the society in February, 1864, from Sir William Holmes, in response to the offer of a premium for substitutes for guttapercha, and in his letter to the secretary, Sir William states that he had been commissioner for British Guiana at the International Exhibition of 1862, at which he exhibited about ½lb. of balata, which had been submitted to Mr. Charles Hancock, who had expressed a favourable opinion on it. This specimen also was afterwards forwarded to Kew. It is exhibited here to-night, together with the historically valuable first sample sent to this society in 1860. Other specimens of balata were afterwards sent to Kew from British Guiana by Mr. James Collins in 1868, from Trinidad by Governor Longdon in 1874, from Demerara by Mr. E. Im Thurn in 1882, and by Mr. G. S. Jenman in 1884. The latter also sent a specimen obtained by precipitation with spirits of wine, and some of the milk itself.

All these specimens, with the exception of that submitted to the Society of Arts by Sir William Holmes in 1864, were analysed by me in 1886, in the manner described in my previous lecture. [The results were shown by the author in a table.] The average composition of balata is also graphically shown in Fig. 42, and is thus easily comparable with that of the various commercial brands of guttapercha, similarly depicted in the former lecture.

The gutta contained in balata is very strong and tough, being altogether of excellent quality; but the percentage of resin is a large one, and the material can consequently only be regarded as a substitute for second, or perhaps even third-class guttapercha. Balata is somewhat more flexible than guttapercha containing an equal amount of resin, which appears to be due to the softness of the resinous constituents. (I have several times observed an oily substance exuding from balata on stretching, which, after drying up, left a whitish powder behind, resembling mildew.)* To determine the composition of the resin contained in balata, a specimen extracted with

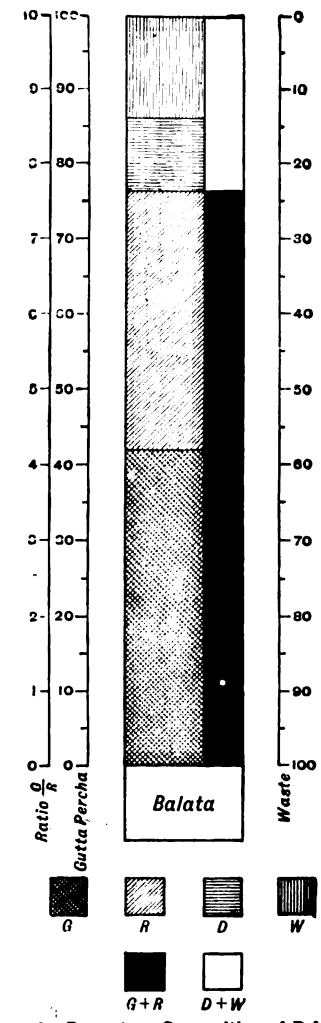

FIG. 42.—Percentage Composition of Balata.

ether was carefully heated until the weight remained constant, whereby it lost 4·6 per cent.; it was then repeatedly treated with boiling alcohol, from which the albane was precipitated on cooling as a white crystalline powder, leaving the fluavile in solution which was evaporated. It was thus found that the resin consisted of about two parts of albane and three parts of fluavile.

I will now show you, that on heating, balata behaves pretty much like ordinary guttapercha. I plunge a piece into boiling water and you see it becomes quite soft and plastic; I now immerse it in cold water, and you observe that it slowly hardens again, but remains flexible and elastic, showing no signs of brittleness.

Some of the specimens of balata sent to this country perished quickly when exposed to air and light, and this rather prejudiced the manufacturers against the material, but others retained their good qualities a long time, and I have here a sheet of balata which was manufactured in January, 1881, nearly 17 years ago, and which is still as sound as one could wish it. The sheet has been kept in a comparatively cool cellar, but

* A loss in weight observed during analysis indicates the presence of volatile constituents.

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without any special precautions. I am inclined to think that the materials which decayed so prematurely had either been carelessly prepared from the latex, or else were obtained by some special method of coagulation. I shall refer to the behaviour of balata towards atmospheric oxygen in my next lecture, and I will now conclude this subject by giving a few data about the price of balata, and the quantities exported from the two principal producing countries.

In 1884, two samples sent to the Kew Museum by Mr. G. S. Jenman were submitted to the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, for trial, by Sir Joseph Hooker, and they reported that the materials lost 25 and 38 per cent. respectively on washing and drying, and valued them at 1s. 9d. and 1s. 3d. per pound. The Silvertown firm took an interest in balata at a very early date, and obtained specimens of it through Mr. David Melville in 1859—*i.e.*, before the first samples had been sent to the Society of Arts.

The price paid in London during the last 15 years for balata in "sheets" or "blocks," varied between 1s. 1d. and 2s. 6d., being on an average about 1s. 10d. per pound.

[A table was given to show the quantities and values of balata produced and exported from British Guiana for each year from 1895 to 1896, abstracted from the Government reports on this colony.]

From 496cwt. in 1895 the annual quantity gradually rose to a maximum of 3,245cwt. in 1889, whereas it diminished again to 1,424cwt. in 1895-6. The values per pound given in the table have been worked out from the total quantities and values of each particular year. They vary between 9d. and 14d., and are therefore notably less than the prices asked for the material by the dealers. The figures only refer to the export of balata actually produced in the English colony, and not to the total amount of this material exported from it, which is considerably larger.

LECTURE III.

THE CLEANED MATERIAL.—Chemical composition and analysis—Physical and mechanical properties—Electrical properties—Application for various purposes—Home consumption—Use of hardened gutta-percha—Absorption of oxygen—Behaviour towards ozone—Deterioration and preservation—Artificial substitutes—Concluding remarks.

Last Monday I told you that it was Mr. Charles Hancock who first devised special machinery for cleansing and purifying raw guttapercha, which, more or less modified, is still in use at the present time, and we shall presently see that to him is also due the honour of having obtained the first patent for the practical application of this material. Again, it was at the Society of Arts that Mr. Hancock obtained his first specimen for experiment. It was given to him by Mr. Henry Gouger at a conversazione, probably held during the winter 1843-44, and the Rev. Thomas Hancock informs me that he well remembers his father's great delight on first becoming acquainted with the new substance, and his sanguine prediction of the many uses to which it could be applied.

It occurred to me that it might interest you to see Mr. Hancock's portrait, and I had a lantern slide made from a photograph kindly lent me by his niece, Miss Maria Hancock. Mr. Hancock was by profession an artist; he was born at Marlborough on Dec. 16, 1800, and died at Blackheath on July 30, 1877.

CHEMICAL COMPOSITION AND ANALYSIS.*

We have now to consider the composition and analysis of cleaned guttapercha. Here we find the same components as in the raw material—viz., gutta, resin, dirt, and water. The gutta and resin are unchanged and in the same relative proportion as before, but the dirt now consists chiefly of colouring matter (phlobaphenes) and finely ground bark and wood, which are uniformly disseminated in the material, and impart to it the characteristic reddish or chocolate-brown colour.†

The amount of dirt remaining in guttapercha after thorough mechanical cleaning depends essentially on the nature of the material, some kinds parting with their impurities much more readily than others. This likewise applies to the water left in guttapercha after mastication, some sorts giving it off without difficulty, whereas others tenaciously retain it.

The analysis of cleaned guttapercha may be carried out in much the same way as that of the raw material, described in the first lecture. The guttapercha, preferably in the form of thin sheet, is cut up into small pieces and divided into two portions. In one the water is determined by heating it in a current of rarefied air or hydrogen and absorbing the moisture with sulphuric acid in a weighed U-tube; in the other, the resin, gutta, and dirt are determined. The resin is extracted by means of cold ether, the solution distilled, and the residue carefully heated and weighed. The gutta and dirt remaining after the extraction of the resin are dried in vacuo and weighed so as to check the other result; the gutta in its turn is then dissolved in carbon disulphide or chloroform, the solution filtered, and the solvent distilled off. The gutta thus obtained is dried in vacuo and weighed, and is then softened and pressed into the form of a plate, which is tested for elasticity and strength. In order to facilitate the separation of the dirt from the gutta solution, the latter is either subjected to the action of a centrifugal machine or it is mixed with alcohol or water, according as the solution has been made in carbon disulphide or chloroform respectively. On standing, the two liquids separate again, and the lighter one, on rising to the top, carries the dirt with it; the clear solution can then be drawn off at

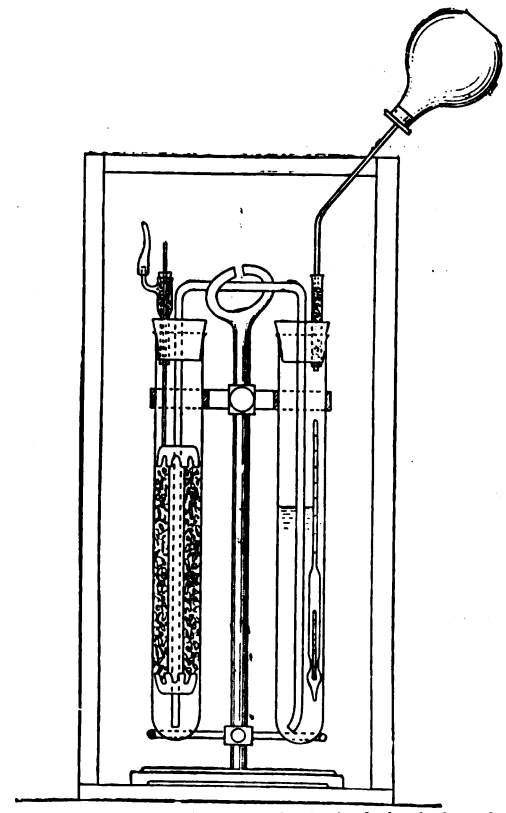

FIG. 43.—Apparatus for Approximate Analysis of Cleaned Guttapercha.

the bottom. In this way results can be obtained which are sufficiently accurate for most practical purposes; although, scientifically speaking, they are not strictly correct, inasmuch as the resin is not completely separated from the gutta, and the latter also still contains a certain amount of colouring matter. However, these disadvantages are more than balanced by the great convenience of this method for daily use in the laboratory, in comparison with the other method of precipitating the pure gutta with alcohol.

For such cases, where it suffices to ascertain approximately the percentage of resin in cleaned guttapercha, I devised some years ago a rapid method, which is based on the increase of the specific gravity of a solvent, ether for instance, through the presence of resin. The apparatus (Fig. 43) consists of two glass tubes, closed at their lower ends and provided with caoutchouc stoppers, through which the two ends of a narrow glass tube, bent in the form of a ∩, pass. A weighed quantity of guttapercha, cut up into very small pieces, is put into one of the larger tubes, and a measured quantity of ether into the other. The ether is forced over into the first tube and left for a certain time in contact with the guttapercha. It is then driven back and its specific gravity measured with a special hydrometer, which is provided with a thermometer. The apparatus stands in a wooden box, with glass windows back and front, so as to ensure uniformity of temperature, and special precautions are taken to guard against loss by evaporation, etc. Tables have been prepared for use with this apparatus, by means of which the percentage of resin can be directly read off from the increase of specific gravity.

(To be continued.)

* The lecturer, before starting on his special subject, called attention to two specimens of gutta obtained from leaves and precipitated from solutions at the last lecture. Both precipitates—viz., the one obtained from a solution in toluene by means of acetone, and the other from a solution in petroleum spirit by cooling—had since been washed, and now presented a clean appearance.

† The phlobaphenes are soluble in alkaline solutions, and are therefore extracted during the chemical washing process, described in the last lecture. They can be precipitated from the washings in the form of brown flocculi by the addition of acids.

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OUR LOSS.

The death of Dr. John Hopkinson makes the first breach in the ranks of those prominent engineers who together solved the difficulties connected with the first step of electrical engineering. The sadness caused by his sudden death in the very prime of life is intensified by the fact that three of his children perished with him in the fatal accident on the Petite Dent de Veisivi. The sincere sympathy of the electrical profession throughout the entire world will go out to Mrs. Hopkinson in her dreadful bereavement. Of the past work of Dr. John Hopkinson we do not propose to refer here in detail, but rather to call attention to the great originality of his work, in whichever direction his attention was directed. The same may be said of his amusements. Thus his chief hobby was mountaineering, and in this the results he achieved in discovering new routes showed how he avoided repetition when possible and preferred attacking new problems and difficulties. To quote his own words from his James Forrest lecture on the relation of mathematics to engineering: "After all, in any department of applied or pure science, the highest satisfaction comes from accomplishing that which no one has done before—from disclosing what no one hitherto has known. When a department of the arts or sciences ceases to advance, and becomes simply the application in known ways of known principles to obtain known ends, that department has lost its charm till the time comes for a fresh advent of change and development." These few sentences give the keynote to Dr. Hopkinson's career. He had great mathematical abilities, and above all he delighted to use his knowledge in solving practical problems. We consider Lord Kelvin and the late Dr. Hopkinson to be types of a new class of engineers, who are fully equipped by a first-class college education for their engineering profession. The practical engineer has in the past conquered many problems by sheer pluck on the trial and error method, but he is heavily handicapped in developing any new branch. For such departures deep knowledge of natural laws is required, and here the new type of engineer finds a place. Such men having the higher mathematics as their servant, are not led away to regard formulæ as a fetish to be worshipped, but are able to weigh fairly every element essential to the successful carrying out of new engineering works. The inestimable value of the work of Dr. John Hopkinson to the electrical profession can only be appreciated by reading his early publications, which were issued when little was known in practice and when the theories on dynamo construction, for instance, were often wrong in first principles. Thus it was he who showed the absurdity of the

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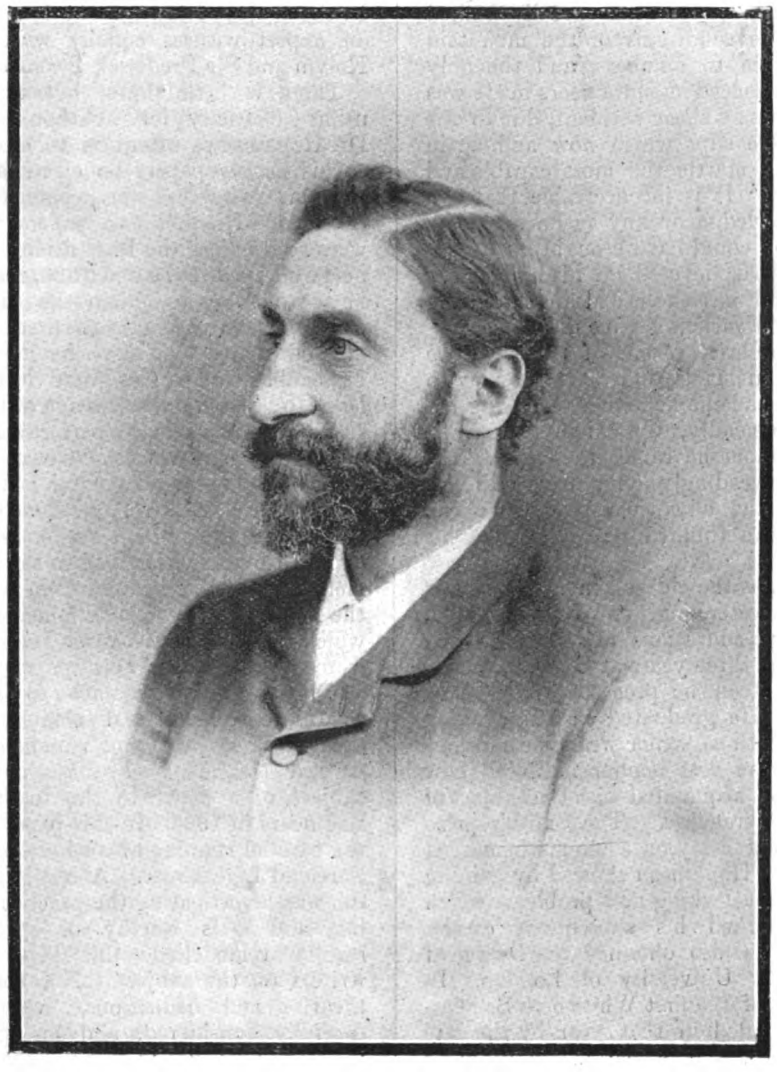
long limbs of the early Edison dynamos, which had been introduced to give a large magnetic moment to the dynamo. The work actually accomplished by the deceased is, we regret to think, only a small part of what might have been had his life been spared. One particular characteristic of Dr. Hopkinson was his marked modesty of demeanour in his various functions and his varied intercourse with the world. Tenacious of his opinions when duly matured, he never obtruded them or suffered his personal equation, so to speak, to be too largely in



evidence. This, of course, is only a proof of his worthiness to rank among the great men of science, whose quiet and unassuming behaviour has always been in proportion to the width of their knowledge and depth of their convictions.

THE LATE DR. JOHN HOPKINSON.

We very much regret to have to record the sad death of Dr. John Hopkinson, which occurred on Saturday last in Switzerland. Dr. Hopkinson, who had been spending a lengthy holiday with his wife and family in Switzerland, attempted on that day to climb the Petite Dent du Veisivi, in company with his second son, John, and two daughters. As the party did not return a search was instituted, and at length the bodies of all four were found roped together at the foot of a moraine. The most complete account of the climb in question is given by a correspondent of the *Manchester Guardian*, who obtained his information from two Englishmen who were in Arolla at the time. It seems from their account that Dr. Hopkinson for several years past had visited the Arolla Valley for climbing, and that he had established a considerable reputation among the local guides. On this occasion he had with him his entire family with the exception of his eldest son, who recently left for Colombo. His daughter Alice, 23, and his son, John Graham, 18, were also more or less expert climbers, but the second daughter, Lena Evelyn, 19, had not done any serious rock-work, and was little acquainted with the higher altitudes of the neighbourhood. It was to gratify her more particularly that the excursion on Saturday, which resulted in such a terrible disaster, was planned. The excursion was to the Petite Dent du Veisivi, probably more difficult than the Grande Dent. Dr. Hopkinson and his son had made various ascents before by the ordinary route. In view of this excursion they had discussed the practicability of descending by the couloir between the penultimate and the final ridges. Usually climbers attack the Petite Dent by the Col de Zarmine, climbing successive ridges to the summit and thence descending by the furthermost. The two gentlemen had themselves come down by the couloir before mentioned, and it was understood that the Hopkinson party would take this way.

They left the hotel at 7.30 in the morning without

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guides—not unnaturally, seeing the knowledge that Dr. Hopkinson had of the mountain. The party was so unapprehensive concerning the enterprise that they took no ice axes, contenting themselves with rope, stocks, and a supply of provisions in a knapsack. They proceeded by the Col de Zarmine for the peak, and should have returned in nine or ten hours. All appears to have gone well until the afternoon, when they began the descent of the couloir mentioned between the second peak and the summit. For this it would be necessary, in order to avoid a large rock filling the top of the couloir, to pass over the spot whence they apparently fell. Their bodies were found 600ft. or 700ft. below, roped together and terribly disfigured.

The account adds that the spot is difficult, but not dangerous. There are no loose stones or steep or slaty rock, and the party must have really walked on the solid bed. The conditions of the mountain are entirely favourable to climbers, and the only suggestion these experienced mountaineers made was that the catastrophe was a sheer accident, due to one of those unaccountable slips which now and again come to surprise and startle the most capable and daring Alpine experts. It is inconceivable that any want of skill or knowledge or any rashness on the part of Dr. Hopkinson could have brought about this terrible event, as he has devoted all his holidays to climbing for years, and has succeeded in many new ascents and descents in various Alpine districts.

The following is a brief *résumé* of the career so suddenly cut short, but it is difficult to convey to any one who has not had the honour of knowing Dr. John Hopkinson personally, the high esteem he inspired in all with whom he came in contact. His life has been an exceedingly busy one, and his personal labours in the advancement of practical science have more than fulfilled the promise of his youth.

Dr. J. Hopkinson was the eldest son of Alderman Hopkinson, of Manchester, and was born in 1847. After a preliminary education at Queen's-road College, he spent some three years at Owen's College, Manchester. At eighteen he proceeded to Trinity College, Cambridge. He graduated in 1871, taking the highest honours both as senior wrangler and first Smith's prizeman. The first honour indicated how thoroughly well he was acquainted with the subject of mathematics in all its branches. The Smith's prize is given for an original essay on some mathematical subject, and hence Dr. Hopkinson showed by gaining this that originality in attacking new problems which has so eminently marked his subsequent career. While at Cambridge he also obtained the Doctor of Science degree in the University of London. In 1869 he obtained one of the first Whitworth Scholarships which were founded in that year by the late Sir Joseph Whitworth, and which has assisted so many of our leading engineers in their early days.

Dr. John Hopkinson's success at Cambridge did not lead, as such similar successes too often do, to a career devoted to teaching, and he elected instead to turn his mathematical knowledge to commercial undertakings, so in 1872 Dr. Hopkinson joined the firm of Chance Bros. and Co., near Birmingham, as engineer and scientific adviser in their lighthouse works, in succession to Mr. James T. Chance, M.A., to whom the introduction into the United Kingdom of this most important industry is due, and he retained for many years the responsible charge of it. Dr. Hopkinson effected several improvements in the Fresnel system of lights as well as in their mechanical construction, and in conjunction with Mr. Chance he rendered valuable service to the three Lighthouse Boards of the country. To him is due the system of group-flashing lights, probably the most important characteristic ever introduced, and which has been adopted by all maritime nations. This was described by the inventor in his pamphlet of 1874. He constructed the great electric lights of Tino, near Spezzia, and of Macquarie at Sydney Heads. These are the subject of his paper read in 1886 to the Institution of Civil Engineers, and they are among the most conspicuously successful lights in the world. Of Dr. Hopkinson's mechanical improvements, the most widely known are connected with the clockwork of revolving lights, and with their carriage or turntable, on which latter he placed conical rollers and roller paths admirably adapted to diminish friction and ensure stability of movement. Dr. Hopkinson quitted Birmingham about 1878, and while still retaining in London Messrs. Chance as his clients in optical matters, entered into a wider field as an electrical engineer and referee in many branches of science involving mathematical and mechanical treatment. In the courts of law he will long be remembered as an expert witness equally with his friends, Lord Kelvin and Sir Frederick Bramwell.

There is little doubt but that the question of using electricity for lighthouse work first turned Dr. Hopkinson's attention to electrical engineering, as his earlier papers on electrical machinery show that his researches were conducted more or less to that end. His first two papers on electric lighting were read before the Institution of Mechanical Engineers in April, 1879 and 1880, respectively. In these he showed how to obtain the characteric curves of dynamos, and thus gave the first step in that graphical method of analysing the behaviour of dynamos which has enabled others less gifted in mathematical knowledge to assist in the perfecting of that machine. These early papers also show a perfect knowledge of methods of measurement which have enabled others to rightly comprehend the fundamental facts of electrical engineering. The effects of the shape of the characteristic curve of a dynamo on the stability of an arc lamp supplied by it is described in the 1880 paper. These facts were further amplified in a paper read before the Institution of Civil Engineers in April, 1883, in which more useful figures from actual experiment were given. In this paper the tendency of alternate-current dynamos to run in parallel was clearly described, and also the reason why two such dynamos will not run in series. The mathematical treatment of these problems formed the subject of a paper to the Institution of Electrical Engineers in 1884. In this paper a record is given of the parallel running of two alternators at the South Foreland Lighthouse. About this time Dr. Hopkinson was investigating the practice of dynamo designing, and it is worthy of special note that his results remodelled the ideas of all previous writers on the subject. Not content with general theories and deductions, every point was most carefully considered, and his paper on the subject, published in the *Transactions* of the Royal Society in 1886 shows how thorough his investigations were. Previously two papers on the magnetisation of iron had been contributed to the same society, in which the effects of the composition of iron and its magnetic properties were shown by a series of curves obtained from a large number of different samples of iron and steel. The results of further researches in magnetism were given at various times, and may be listed briefly as follows: "Magnetic Properties of Impure Nickel," *Proceedings* Royal Society, 1888; "Magnetic and other Physical Properties of Iron at a High Temperature," *Transactions* Royal Society, 1889; "Magnetic Properties of an Alloy of Nickel and Iron," *Transactions* Royal Society, 1890; "Magnetism," the presidential address at Institution of Electrical Engineers, 1890; "Magnetic Viscosity," *Proceedings* Royal Society, 1893; and three papers in 1895 on the "Propagation of Magnetism in Iron," communicated respectively to the Royal Society, the Royal Institution, and the Institution of

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Electrical Engineers. Dr. Hopkinson also further extended his paper on "Dynamo Design" by papers before the Royal Society in 1887, entitled respectively "Theory of Alternate-Current Dynamos" and "Induction Coils on Transformers." In 1892 a communication was also made to the same society on "Dynamo-Electric Machinery," which treated of armature reaction effects in direct-current dynamos; and in 1896 the *Transactions* of the Royal Society contained a paper on "Alternate-Current Dynamos" by the same author. From the above it will be seen that Dr. Hopkinson has contributed more than any other engineer to our literature on the design of electrical apparatus, and that his communications as a rule were published at a time at which they were specially valuable to the profession. The list we have given only contains the titles of the papers of interest from an electrical designer's point of view. There are many others—such as the presidential address to the Institution of Junior Engineers in 1892, on the cost of electricity supply—which are of great general interest. Dr. Hopkinson also published numerous papers of purely physical interest, and his "Research on the Optical Properties of Glass," show how thoroughly he investigated the physical properties of any materials which as an engineer he had to employ. Another instance of this is given by his work on the electrical conductivity of iron and steel, undertaken when he was designing a third-rail conductor for an electric railway. Such results are of inestimable value to all electrical engineers, and the knowledge that the results were obtained by such a reliable expert gives confidence in using the conclusions arrived at.

Coming now to the electrical works designed by the late Dr. John Hopkinson, we are inclined to place first the electric lighting of Manchester. In no town have the results obtained been more gratifying, and the rapid extensions of the works are a proof of the excellent results obtained by the plant laid down at first. The electric lighting of Stafford and Whitehaven was also carried out under Dr. Hopkinson's advice, and both towns possess electricity works of which they may be proud. In traction work Dr. Hopkinson had a large and growing practice. He acted as consulting engineer to the contractors for the City and South London Railway, and had much to do with the design of all the electrical plant on that line. He also advised the Southend Corporation while their electric line on the pier was being constructed. This past work is somewhat dwarfed by the large number of commissions Dr. Hopkinson had in hand at the time of his death. Thus he was advising the Liverpool Corporation on electric traction generally, and the trial line in that town, equipped to his instructions, will be running shortly. This line is only the beginning of a large system of electric traction in Liverpool. The Leeds electric tramways were equipped under his supervision, and here again large extensions requiring some 2,000 h p. are being put in hand. At St. Helens the lighting plant was being remodelled on the direct-current system, and a scheme of electric traction was also being proceeded with. In Stafford large extensions are required, and Dr. Hopkinson was responsible for their design. He has also reported recently on traction schemes to the Newcastle-on-Tyne Corporation, and on electric lighting to the Crewe municipal authorities.

The large Canadian scheme for transmission of power from Thorold to Toronto, for which Dr. Hopkinson has recently prepared plans and estimates, would have given a large amount of cheap power to Hamilton and Toronto. The works were estimated to cost some 2½ millions.

We understand that Dr. Hopkinson was expected to return to England on the very day after the lamentable accident occurred, and that he was due to start for America at the end of this month to report on another large electrical undertaking. From the above, it will be seen how large a gap is left by his untimely decease.

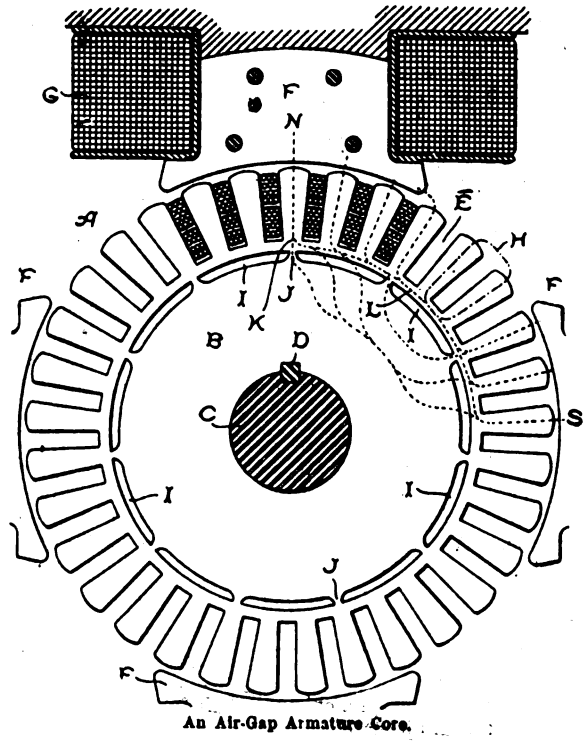
As regards degrees and learned societies, Dr. Hopkinson was a Fellow of the Royal Society, a Member of the Council of the Institution of Civil Engineers, a Member of the Council of the Institution of Mechanical Engineers. He had twice filled the presidential chair of the Institution of Electrical Engineers, and the second time, in 1896, he successfully piloted the Institution through a somewhat turbulent period of its existence. He was also a manager of the Royal Institution of Great Britain, a Member of the Council of the British Association, and a Member of the Physical Society. He also was professor of electrical engineering at King's College, and was responsible for the equipment of the Siemens laboratory at that College.

The patents taken out by Dr. Hopkinson are too numerous for individual mention, but that for the three-wire system of electrical distribution was undoubtedly the most important. This was another indication of his remarkable intuition as regards the practical requirements of electrical engineering.

When president of the Institution of Electrical Engineers in 1897 Dr. Hopkinson proposed the formation of the new Electric Engineers Volunteer Corps, which is associated with the Royal Engineers. This corps has done its first year's work this year, and will be a standing memorial to its first major.

THE REDUCTION OF THE SELF-INDUCTION OF ARMATURE COILS.*

A patent, No. 608,277, issued in the United States to E. H. Anderson and D. P. Thomson, of the General Electric Company, on Aug 2, 1898, describes an ingenious method of reducing the self-induction of armature coils and hence the tendency to spark at the brushes.



An Air-Gap Armature Core.

By the construction claimed in this patent and shown in the accompanying illustration it is proposed to increase the reluctance of the local magnetic circuit in the teeth and around the slots without proportionately increasing the reluctance of the main magnetic circuit through the armature

* The *Electrical World*, New York.

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and fields. This is accomplished by providing air-gaps, I I, in the laminated armature core separated only by bridges, J J, for mechanical strength. The effect of these air-gaps is to cause the main flux entering the armature teeth from any pole, as N, to divide between two paths to the teeth under pole S, one path being between the bottoms of the slots and these gaps, I I, and the other across the latter gaps and through the main body of the core, B. The latter path, in which the lines of force are compelled to crowd into the junctions, J, or cross two air-gaps, I I, is of comparatively high reluctance, crowding the alternative path, L, between the slots and the gaps, I I, which is of comparatively small cross-section, to a high magnetic density. On account also of the large cross-section in the core plate between the shaft and the auxiliary gaps, I I, the density in this part is comparatively low.

By this arrangement the path of the local lines of force, such as H, up one tooth across to the next tooth, down the latter and completing itself under the bottom of the slot, is already crowded, or saturated at the latter point with the lines of force from the main field, and its cross-section at that point is also considerably reduced, for both of which reasons the magnetomotive force tending to set up the local self-inductive flux around the armature coil has a comparatively small effect.

A similar principal has been used hitherto, especially in railway motor work, by reducing the radial depth of the armature core from the slots to its inside face, and thereby running up the density of the magnetic flux in this portion and reducing the self-inductive effect of the teeth by crowding out, so to speak, the local lines of force tending to complete themselves around the slots. This requires, however, the working of all the iron in the armature core at a high density and increases considerably the iron losses. By the improved construction proposed in this patent, only the narrow rim of the core immediately under the slots is run at a high density, the main body being worked at a comparatively low density.

The specification of the patent describes a comparative test of two armatures, one provided with a narrow core and the other with the improvement described in the patent, which is aptly termed "an air gap core," both armatures being of the same size and similarly wound. The tests showed that the core loss of the former amounted to 2,350 watts, and that of the improved core amounted to 1,550 watts, the maximum efficiency of the air-gap core motor being 2 per cent. greater than that of the other.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

94. Wanted, particulars of an easily-constructed form of potentiometer, suitable for grading small ammeters and voltmeters.—L.

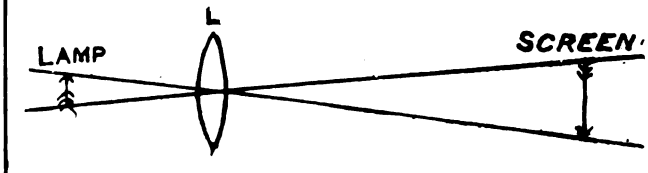
95. It is required to design a chimney shaft for a central station intended for an ultimate output of 2,000 h.p. How would you arrive at the dimensions required?—W. J. S.

ANSWERS.

Question No. 88.—Give full particulars of methods of measuring the distance (1) between the carbons of an ordinary arc lamp when running, (2) between the carbons of a Jandus arc lamp.

Best Answer to No. 88 (*awarded* 10*s.*).—The only accurate methods of measuring the distances between the carbons of arc lamps are methods which depend on optical principles. A lens is used to obtain the image of the arc on a screen, and then by measuring the distance between the images of the carbons on the screen elementary optics enables us to find accurately the distance the carbons are apart.

(1) With an ordinary arc lamp, if the globe be made of clear glass, it is unnecessary to remove it, but if it be made of ground, ribbed, or thick opal glass it must be removed. The only apparatus required for the measurement is a simple convex lens of about 30in. focal length, a 2ft. rule, and a screen, which may consist simply of a sheet of white paper pinned on to a drawing board (see diagram). Place



the drawing board about 12ft. from the lamp, and adjust the lens (L in the figure) until the image of the carbon points is clearly defined on the screen. The distance between the images of the carbons must then be measured, and the distance of the lens from the screen and the carbons respectively. If the distance of the lens from the screen be a inches, and its distance from the carbons b inches, then the distance between the carbons is magnified $\frac{a}{b}$ times, and hence if the distance between the images is l inches, the distance between the carbons is $\frac{b\,l}{a}$ inches.

Better results are obtained if a piece of coloured glass (what is known in the trade as ruby red is the best) is placed between the arc and the lens, as the light is then mono-chromatic and the image is more sharply defined. If this precaution is not taken, the image is slightly blurred and its distance uncertain, owing to rays of different colours coming to a focus at different distances from the lens.

(2) With a Jandus arc lamp the same method can be used, as when the outer globe is removed the inner globe of clear glass does not practically affect the image formed by the lens.

An error often leading to waste of time, is to have the screen nearer to the arc than four times the focal length of the lens, as in this case it is impossible to obtain an image.—J. C. R.

Answer to No. 88 (*awarded* 5*s.*).—The distance between the carbons of any arc lamp is not constant; it is continually varying during running. As the carbons burn away the arc lengthens; then when it feeds the arc becomes shorter for a time. There is no lamp that feeds exactly as the carbon burns, or there would be no flicker, which is so common to all arc lamps, in spite of what the makers say to the contrary. To get the distance between the carbons, a number of measurements will have to be made, and the mean of these taken as correct. To measure it, all that is required is the lamp, a convex lens of about 60in. focal length, a white screen, and a rule. The lamp, lens, and screen are placed on the bench in this order, and the lens will throw an image of the arc on the screen. The distance of the lamp from the screen must be between 60in. and 120in., neither more nor less, if the focal length of the lens is 60in., and then the screen moved backwards and forwards until a good sharp image of the arc and ends of carbons is formed. The distance between the carbons of the image can now be measured with the rule, and also the distances of lamp from lens, and lens from image.

Then let L_1 = lamp to screen;
L_2 = screen to image;
d_1 = distance between carbons of lamp;
d_2 = distance between carbons of image;

then by proportion $d_1 = \frac{L_1\,d_2}{L_2}$.

If L_1 is made equal to L_2, then d_1 is equal to d_2, or the image of the arc is equal in size to the arc itself.

The above is also true for the Jandus arc lamp, only it

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must be focussed so that the carbons are well defined.—J. GILHAM.

Question No. 89.—Is it advisable to run two alternators of different design in parallel, and on what does the smooth running of alternators in parallel chiefly depend?

Best Answer to No. 89 (*awarded* 10*s.*).—Although it is a common practice to run alternators of different design in parallel, it is not advisable to do so if it can be helped, as they rarely run so well together as machines of the same type. There is no extra danger of breakdown in running machines of different types in parallel, but they are liable to get out of phase with one another and require more attention in the adjustment of the fields, etc. If the use of different plant is unavoidable, then machines having iron in their armatures should be chosen in preference to those having no iron, as the self-induction of iron armatures helps to keep the alternators in parallel. Machines of the same make having no iron in their armatures will run very well in parallel, but it would hardly be safe to order a machine of this type from one maker to run in parallel with an existing machine of the same type by another maker; it would be better to get an iron armature machine. The engines also have a good deal to do with the running; they should be, if possible, of the same type and run at the same speed, and it is better not to run two-crank and three-crank engines together, as the turning moment of a two-crank engine, being different from that of a three-crank one, is liable to make the running unsteady.

With regard to the second half of the question, the smooth running of alternators in parallel depends chiefly on the governors of the engines. Of course, the machines must be made to run at the same periodicity, but this is a *sine qua non*. The governors should be sensitive, and adjusted so that all the engines will run light at the same speed when the stop valves are full open, and the greatest care must be exercised in keeping the governors clean and properly adjusted, at the same time taking care that there is no slack or play in the working parts, as this is a common cause of unsteadiness when running alternators in parallel. Where the governors work a throttle valve the latter should be cleaned at regular intervals, as it may get dirty and stick, causing the engine to "hunt." An even-turning moment in the engines has a great deal to do with smooth running. Engines with three cranks, placed 120deg. apart, have a more even turning moment than engines with two cranks, whether placed opposite or at right angles. Of course, the valves and steam distribution must be so arranged that each crank has the same pressure upon it, and the crank-shaft and moving parts of the engine and alternator should be carefully balanced.

Smooth running depends also in some measure on uniformity of plant, both in size and type, as alternators differing very much in size rarely run well together in parallel for long; a sudden rise or fall in the load generally throws them out of phase. It is rather like putting a horse and a donkey to pull a load. The donkey is more trouble than use. Uniformity in design of alternators and engines is also desirable for reasons given above. The way in which the fields of alternators are excited has a good deal to do with their running. The field current should not be supplied from an exciter driven by the alternator, but from an independently driven machine, as in this case the exciting current is not dependent on the speed of the alternator, whereas the output of an exciter driven from the alternator shaft will vary with the speed of that alternator, making it more difficult to synchronise, as the voltage of the exciter must be regulated as well as the speed of the engine, while the latter only is required if a steady current from a separate exciter is used. Then, again, the time when an alternator requires the heaviest field current, through low speed caused by overload or low steam pressure, or both, would be just the time when its own exciter could not supply its full current, and for this reason it would have to be made a good deal larger than it otherwise need be.

Separate exciters should be as large as possible, as large ones are more efficient and reliable than small ones. For medium-sized alternators one exciter will be required for every five or six alternators, with a spare exciter in case of breakdown, and there should be a separate exciter switch-board, with 'bus bars from which the current is taken for the fields. Two-pole shunt-wount dynamos are best, the voltage being regulated by a resistance in the shunt winding.

Last, but not least, of the elements upon which the smooth running of alternators in parallel depends is the human element. The engine driver and switch attendant must be intelligent men, and have had some experience with this class of work before they can be expected to run the machines properly. They will soon show whether they understand the work or not. Some men take a very long time to grasp the working of alternators in parallel, while others pick it up in a week. In order to work well together the engine driver should know something of alternators and the switch attendant something of engines. It would be a good plan to change them round at intervals; they would then become good all-round men, and could be depended upon to take charge of both engines and alternators for a short time if necessary.

To sum up, smooth running depends on: (1) engines having an even turning moment and provided with sensitive and properly adjusted governors; (2) alternators of about the same size and make and with iron in the armatures for preference; (3) care and intelligence on the part of the men in charge of the plant.—R. S.

Answer to No. 89 (*awarded* 5*s.*).—Assuming that all the alternators are run at a perfectly constant speed, and precisely in step with one another, no inter-change of current

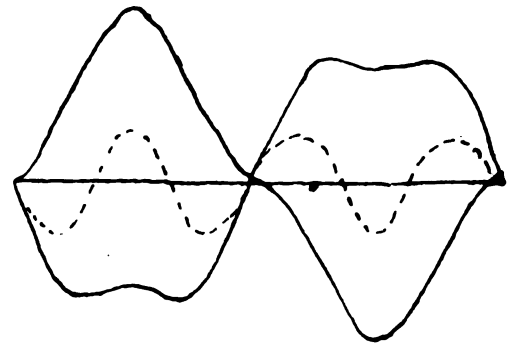

FIG. 1.

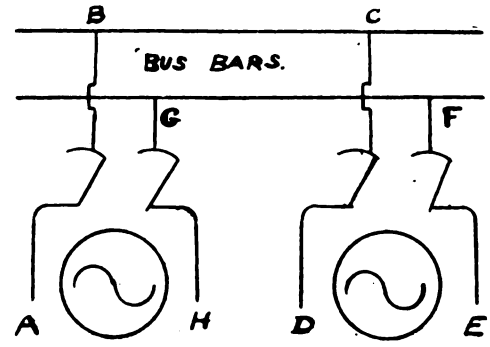

FIG. 2.

will take place between any two machines, provided that the E.M.F. waves of the alternators are exactly alike. But if the E.M.F. waves of two machines are altogether different, shown by the peaked and flat-topped waves in the diagram, there will be a resultant E.M.F. (shown dotted) in the local circuit, A, B, C, D, E, F, G, H (Fig. 2), then there will be a current in this circuit whose periodicity is different from that of the main current. This local current does not pass into the external circuit, and contributes nothing towards the useful output of the machines. It reduces the power factor and lowers the efficiency on account of the additional heating of the machines with the larger current. It will be seen from this that for parallel working it is desirable to use machines of the same type. However, it must not be thought that machines giving widely different E.M.F. waves will not run in parallel. Machines giving similar E.M.F. waves will work more economically than those whose waves differ much. In central-station work it is often necessary to parallel different types of alternators.

In reply to the second part of this question, the smooth running of alternators in parallel depends chiefly on the

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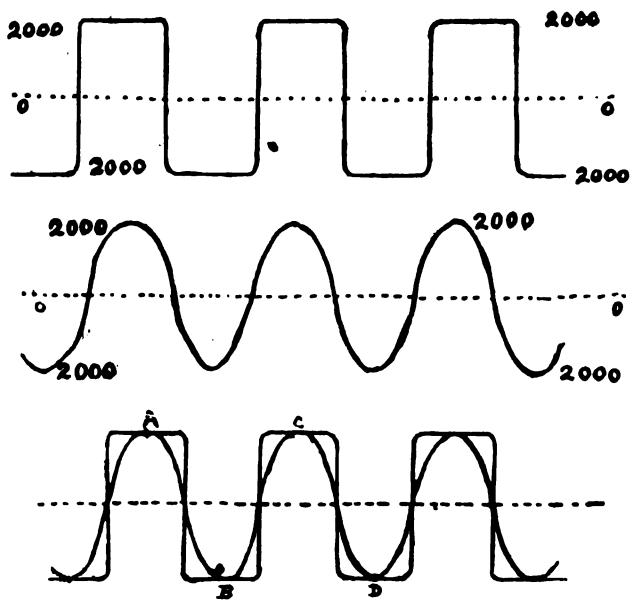
prime movers driving them. From this point of view, turbines and triple-expansion engines with three cranks set 120deg. apart give the most even turning moment possible, and are more suitable for parallel running than single or double cranked engines. Gas-engines are of little use, for the torque exerted by such engines, even when fitted with heavy flywheels, varies a good deal during the engine cycle. For successful parallel running the engines driving the alternators should not have independent governors, for unless the governors are adjusted exactly, which is impossible in practice, difficulty is experienced in making each machine take its fair share of the load—the machines which tend to run faster taking too much load, those which tend to run slower too little. The steam supply should be regulated by hand until the machine is properly loaded, the governors acting only in case of accident—such as fuse blowing—where the engine tends to race. When parallel running was first thought of, it was supposed that the successful working of two alternators in parallel depended entirely on the kind of machine; but this is not so. Although the controlling current passing between two machines is determined to some extent by the type of alternator, the main determining factor is not the type of alternator, but the type of engine.—F. BRUTON.

Answer to No. 89 (*awarded* 5*s.*).—Although it is convenient for many reasons to keep to the same type of alternator in planning extensions, other things being equal, it is often advisable to consider whether an alteration should



be made—*e.g.*, if the existing plant is obsolete, or uneconomical, or if an equally good new type can be got more heaply or expeditiously than that similar to the plant laid down. In parallel running, however, care should be taken that the machines will run continuously in parallel at all loads. This depends chiefly on the wave-form of the E.M.F. developed by the machine—that is, a curve in which instantaneous values of E.M.F. are plotted as ordinates and time as abscissæ. We get different forms of curves for different machines. For example, in the Mordey machine the curve is somewhat as shown, the E.M.F. springing up almost instantaneously to its full value. But in the case of an iron-cored machine, such as the Johnson and Phillips alternator, where the iron core chokes back any sudden increase or decrease of voltage, the curve will be approximately a sine curve, as shown in the diagram. The form of these curves varies for every type of machine, and depends on the shape and dimensions of the pole-pieces, and the space occupied by the coils relatively to the pole-pieces.

Now suppose we attempted to put these two machines in parallel. The machines are synchronised when both machines reach their maximum voltage at the same instant Representing it graphically, the machines are put into parallel at A. Now at B, C, D, etc., the volts developed by the two machines are equal. But between these points there is always a greater or less difference of potential, except, of course, at the instant when the voltage is nil. Now, as these machines are connected in parallel on the same bus bars, there is a circuit of low resistance between one machine and the other. So long as the voltages of both machines are equal, no current will flow from one to the other, but as the voltage of one machine drops below that of the other, a rush of current ensues. Hence by running two machines having different voltage wave forms in parallel we are likely to get a surging current between the two machines. This is injurious for several reasons. It is a waste of power both in supplying the current between the two machines and in overcoming the increased resistance of the armature coils due to heating. Also it racks the coils, and the racking comes chiefly on the type of coil (that without iron core) that is not mechanically strong.

Any two different types of machines running in parallel are liable to surging currents from this cause, as it is almost certain that the varying dimensions of coils and their relative positions will cause a difference in the wave form—*e.g.*, a Siemens and a Mordey. If an iron-cored machine is called upon for a sudden increase of current, this increase will set up sudden additional magnetic lines of force, which will retard the E.M.F. from rising to its full value. This retardation will react on the current, and hence the frequency of the current will be irregular for a moment. In a light armature the frequency is perfectly regular, as there is no choking effect. Hence, at the instant of the change there will be a rush of current from one to the other, due to the retarding effect of the iron core.

Another consideration in running alternators of different types in parallel is the weight of the revolving part. If there is a sudden increase of load, it is important that both machines should take it up equally; otherwise one will motor, and current will be wasted until it pulls up to speed. For example, if a Siemens alternator be run in parallel with a Mordey, the Siemens will probably take most current under a sudden increase or decrease of load. All iron-cored machines are slow in picking up load, whether armature or field revolve, for iron in an armature means weight, and iron is also essential in the field. The machine is not always responsible for bad parallel running. The governors, if they are the slightest bit uncertain, will cause a lot of motoring current. This is less so in machines with heavy rotating parts than in those with light armatures. If the machines are belt driven, a sudden increase of load may cause the ropes to stretch or slip momentarily, and motoring may result.

Machines with light armatures pull into phase quicker than heavy-armatured machines, but they are often more trouble to get in, as they answer very quickly to the governor, which may be erratic. It is a simple matter to get a machine with a heavy armature into parallel so long as one is careful to synchronise as the engine is coming up to her speed, and not slowing down again. If a bad shot is made, two machines with heavy armatures will keep up a surging current for some time.—J. A. SEAGER.

MAGNETIC CLUTCH FOR HEAVY STATION WORK.*

In the course of a very interesting paper, read at the recent Omaha meeting of the A.I.E.E, on a modern central station — namely, that of the Imperial Electric Light, Heat, and Power Company, of St. Louis, Mo.—Mr. George A. Damon described the "Arnold system" of connecting engines and generators, which had been adopted in this plant. This system of power-station design is well known, but as applied in this instance it embodied several novel features, not the least interesting of which is the coupling device or clutch, described below, it being the first magnetic clutch applied upon a large scale to power-station work.

The figure shows a cross section of the clutch. One part, B, is bolted to the engine flange, N. A corresponding part, D, is bolted to the generator quill, H, and this part carries an annular armature, A. Radial arms, F, keyed to the solid shaft, G, carry an interior armature, C. Each coupling is provided with five circular coils

* From the *Electrical Engineer* (New York).

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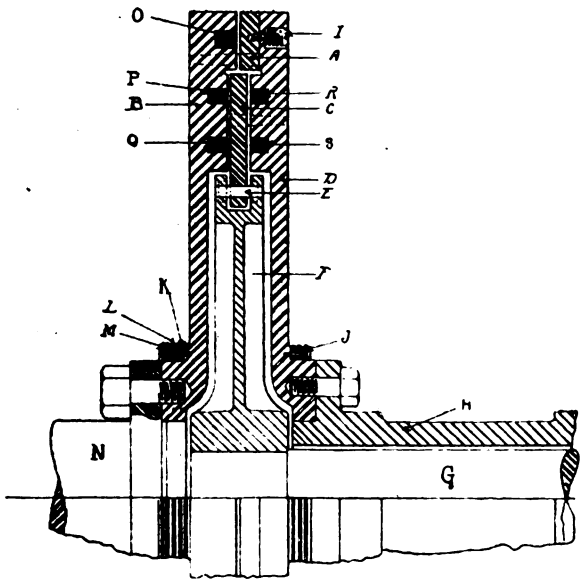
of magnet wire, O, P, R, and S. These coils are electrically connected to contact rings, J, K, and L, carried on insulating bushings bolted to the hubs of the clutch. Stationary brushes which are connected through a system of switches to the storage battery 'bus bars make it possible to send a current around any coil. The parts of the clutch containing the coils are made of cast steel of high permeability, so that when a current is sent around any coil the surrounding metal becomes a magnet and the armature facing the coil is immediately magnetically attracted. The two surfaces of the clutch parts being held in contact by a pressure of at least 80lb. per square inch, it becomes possible to transmit power from one to the other. Thus to connect engine shaft, N, to generator quill, H, a current is sent through coil O in that part of the clutch, B, attached to the engine shaft. Armature A, which is attached by means of strong studs to that part of the clutch, B, which is securely bolted to the generator quill, is immediately attracted, and overcoming the small resistance of the spring, G, the two parts become firmly attached to each other, making it possible to run the generator from the engine. If it is desired to revolve the interior shaft by means of the engine, the current is sent through coils P and Q in parallel, attracting armature C, while if the solid shaft is being turned by the other engine and it is desired to connect the shaft to the generator quill,



Detail of Magnetic Clutch.

then coils R and S are energised, and the armature C is attracted in the other direction. The circuits to these coils are all controlled by means of switches on the main switchboard. These switches are so arranged that when the circuit of any coil is broken the discharge of the extra current is taken up through a carbon resistance, and the insulation of the coil is therefore protected from the liability to puncture. When the current in any coil is discontinued spiral springs have been provided to overcome the residual magnetism and bring the armature back to its original position.

If both parts of the clutch which are to be attached are stationary the connection becomes an easy matter, but if one part is revolving it becomes necessary to put the other part in motion before the current is sent through the coils. This is accomplished by starting the dynamos as motors and bringing them up to speed before closing the magnet-coil switch. For this purpose regular starting boxes have been installed, one for the boosters and the other for the generators, so that any machine may be thrown into or out of service directly from the switchboard. The result of the whole arrangement is that a number of combinations between the engines and the generators becomes possible. Under all normal running conditions the centre engine will run its two adjacent generators, and the outside engines will operate the end generators. Each booster may be run when necessary from either of two engines. The entire line of machinery may be connected together, so that all the engines and generators operate in unison as one large unit, the speeding attachment on the engines making it possible to operate them satisfactorily in this manner.

In case of accident to any generator that particular machine may be stopped without stopping its corresponding engine, and the electrical load will be immediately taken up by the other generators, but without overloading the engines. In case of accident to any engine the ability of the other engines to carry an overload of 100 per cent. may be taken advantage of, if necessary, without overloading any of the generators. Thus the centre engine is capable of carrying all four of the generators fully loaded, while the smaller end engines can operate two of the generators, if necessary, in case of a breakdown of the larger engine. The plant may therefore operate at period of maximum load at its full rated capacity, depending entirely upon the advantages of the system of arrangement for a reserve in case of a breakdown to any part of the equipment.

THE ARCHÆOLOGY OF SUBMARINE TELEGRAPHY.

BY J. J. FAHIE, M.I.E.E.

(Concluded from page 278.)

Schilling's first application of electricity was to warlike ends. We learn from Hamel that the war impending between France and Russia in 1812 made him anxious to devise a conducting wire which could be laid, not only through moist earth, but through long stretches of water, and which should serve for telegraphic correspondence between fortified places and the field as well as for exploding powder mines.

So diligently did he work at this task that before the autumn of the same year he had "contrived a subaqueous galvanic conducting cord" (a copper wire insulated with a solution of indiarubber and varnish), and an arrangement of charcoal points, by means of which he was able to explode powder mines across the Neva, near St. Petersburg. At Paris, during its occupation by the allied troops, in 1814, he also frequently ignited gunpowder across the Seine with this *electric exploder*, to the great astonishment of the *gamins*.*

In the next 10 years (1815-25) Schilling divided the spare moments of a busy diplomatic and military career between lithography, an art then recently developed at Munich, and electricity. In these circumstances, then, the surprise is, not that he brought out an electric telegraph of his own construction, but that he did not do so at an earlier date than the one usually assigned. Dr. Hamel vaguely fixes this date at about 1825, for he says that the Emperor Alexander (who died on Dec. 1, 1825) "had been pleased to notice the invention in its earlier stage."

Schilling's apparatus was based on the property of a voltaic current to deflect a magnetic needle. It is sometimes described as a single-needle telegraph, and sometimes as one with five or six needles. What seems probable is that he tried many arrangements, that he first constructed a telegraph with one needle, and was thence led on to combine several into one system, so as to be able to transmit a number of signals at once.

The signal-indicating part of the single-needle telegraph consisted of an ordinary Schweigger galvanometer. The needle was suspended horizontally by a silken thread, to which was attached, parallel to the needle, a little disc of paper, painted black on one side and white on the other. By the deflection of the needle to the right, or to the left, according to the direction in which the current moved in the coil, either face of the disc could be shown at pleasure, and two primary signals could be thus obtained, whose repetitions variously combined would represent the 26 letters of the alphabet, the 10 ciphers, and four conventional signs.

In order to prevent the prolonged or violent swinging of the needle after each deflection, he fixed to the lower extremity of the axle a thin platinum plate, or scoop, which, dipping into mercury placed beneath, deadened the motions, changing what might otherwise be prolonged oscillations into *dead-beat* movements—a method since adopted in a modified form in some of Prof. Thomson's (now Lord Kelvin) mirror galvanometers.

* Prof. Ayrton (*Sixty Years of Submarine Telegraphy*, lecture at the Imperial Institute, Feb 15, 1897) has lately thrown doubt on these experiments, but without any reason. He adds, "However, whether this be correct or not, it is quite certain that Colonel Pasley sent a current through a wire under the Medway, and that he also blew up the wreck of the "Royal George" at Spithead with a wire insulated with tarred rope, covered with an outer layer of pitched yarn." But this was in 1839, or 27 years after Schilling, and 44 years after Cavallo. In the *Philosophical Magazine* for June, 1826 William Sturgeon has a paper "On the Ignition of Gunpowder by the Electric Discharge; and On the Transmission of Electricity through Water." The latter part should probably find a place in these articles, but as I cannot now look it up, I must content myself with this reference. My London readers can easily verify it for themselves.

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As a means of attracting attention, Schilling added a contrivance, the idea of which he clearly borrowed from Sömmerring's alarum. It differed from that instrument only in that the rod whence the needle was suspended was made of rigid metal (wire) and carried a horizontal arm, which, when the needle was deflected, struck a finely-balanced lever, and caused a leaden ball resting upon it to fall upon another lever, and so release the detent of an ordinary clockwork alarum.

In 1830 Schilling set out for a voyage in China, and took with him a small model of his (? single-needle) telegraph, with whose performances he astonished the natives wherever he went. He returned to Europe in March, 1832, and again occupied himself with telegraphic experiments, and hence, possibly, the date, 1832, which many writers assign to his inventions.

In May, 1835, he started for a tour in southern and western Europe, taking with him a working model of his one-needle telegraph. At Vienna he engaged in a series of experiments upon it in conjunction with Baron Jacquin and Prof. A. von Ettingshausen. Amongst others, they tried the comparative merits of leading the wires over the roofs of the houses, and burying them in the earth. The result was, as may be supposed, in favour of the former plan, for, owing to the defective insulation afforded by a thin coating of indiarubber and varnish, the earth in the latter case conducted the current from one wire to the other which lay parallel to it and at a little distance.

In September, 1835, he attended the meeting of German naturalists at Bonn, and there, on the 23rd inst., exhibited his apparatus before the section of natural philosophy and chemistry, over which Prof. Muncke, of Heidelberg, presided. Muncke was so pleased with its performance that he had a model made for exhibition at his own lectures at Heidelberg, and other members of the congress took away with them to their respective homes such wonderful accounts of its action that Schilling's telegraph was henceforth an object of great curiosity, and became a stock subject for popular lectures, and for articles in all the scientific papers.

Dr. Hamel tells us that, on his return home from Germany in 1836, Schilling received two letters urging him to bring his inventions to England, but he declined the suggestion, saying that he preferred to try to introduce them first in his own country. He was soon after honoured by a visit from the Emperor Nicholas, who witnessed with the greatest interest the performances of the telegraph "through a great length of wire," and ended by expressing the desire of having it established between St. Petersburg and Peterhoff."

As was the custom in such cases, a commission of enquiry was appointed, with Prince Alexander Menshikoff as president. Schilling submitted his plans, and gave the commissioners a choice of two modes of effecting the communication: (1) either the wires (copper) should be covered with silk, well varnished with resin, then bound together with tarred hemp and deposited along the bottom of the Gulf of Finland; or (2) foreseeing the expense and difficulty of such a plan, they could be suspended on posts erected along the Peterhoff road.

An experimental telegraph was at once set up at the Admiralty, the line being partly overground and partly cable submerged in the canal. The ends, with the appropriate instruments, were some distance apart, one being at the window of Prince Menshikoff's study, and the other in a room near the main entrance of the buildings office.

The results were eminently successful, and in due course Prince Menshikoff presented to the Emperor a report in favour of submarine wires, wires in the air being considered by the commissioners "truly ridiculous." On receipt of this report an Imperial decree was issued, dated May 19 (old style), 1837, ordaining the construction of a telegraph to connect Cronstadt with the capital by means of a cable in the Gulf of Finland. Schilling placed the order for a cable with a rope manufactory at St. Petersburg, but he died very soon after—on Aug. 6, 1837—when the enterprise was abandoned, and thus he and his country just missed the glory of establishing not only the first really practical telegraph, but also the first submarine line.

Edward Davy—1836-39.

To those who have read the chapters on Edward Davy in the writer's *History of Electric Telegraphy to 1837*, it will not be surprising to learn that his faith in the practicability of submarine telegraphy was very great. The idea of a telegraph first occurred to him in 1836, when he drew up a plan to be worked by static or frictional electricity, but this, as he says himself, was not what he would recommend in practice, and was drawn up merely as an aid to a clear perception of the principles involved. Accordingly, he very soon afterwards constructed an apparatus which was based on the electromagnetic properties of the voltaic current, and this, in its turn, was followed by his electro-chemical instrument in the summer of 1837, but not patented until July 4, 1838, owing to the opposition of Cooke and Wheatstone. While referring to my history for a very full account of Davy's most interesting labours, I need only mention here the passages bearing on our present subject.

As regards the best way of treating the conducting wires, he says: "Either they may be bound together with interposed pieces of cloth soaked in pitch or resin, etc., the whole being enveloped with canvas tarred, or impregnated with melted caoutchouc and linseed oil, or the like; or they may be secured in a tube (jointed laterally) of iron or earthenware. In the former case they would admit of being suspended in the air, from post to post, *protected by lightning conductors*; while in the latter they would be laid along or under ground; or they may be separately coiled round with cotton and bound together, each covering being of a different colour for guidance in case of repairs.

"Marine Telegraphs.—Communications may be effected through or under water by further enclosing the conductors in ropes well coated or soaked in an insulating and protecting varnish, as melted caoutchouc, etc. The ropes could then be sunk to a certain depth by weights, and supported by small floats or buoys.* In connection with the rope we may have an air-tight and watertight electrical renewing apparatus at each requisite interval.† On this subject further experiments are necessary."

A working model of Davy's needle telegraph was shown, November-December, 1837, at the Belgrave Institution, London; and from the great interest which it there excited he resolved upon a more public exhibition. Accordingly, he rented a room in Exeter Hall, and there installed his apparatus from December, 1837, to November, 1838, never tiring of explaining its action and potentialities to all who would listen. This is how he inspired at least one of his visitors:

"What shall then prevent a patient ill of the cholera in India from procuring (per galvanism) the advice and prescription of Sir A. Cooper, in England, and acting thereupon within an hour of the attack; indeed (if Sir A. be not at dinner, and otherwise disengaged) within three minutes? Then will the *Sydney Gazette* contain in this day's paper a full report of last night's debate in the British House of Commons; and the scattered members of a family settled apart on the four quarters of the globe may hold daily converse. Indeed, half the valuable time of the world will be saved. From New York to Pekin, from Pole to Pole, man will be enabled to converse with man, as though in the same house, in the same chamber; it will be one step towards making all nations as one family."—(*Mechanics' Magazine*, January 20, 1838.)

During the summer of 1838, Davy delivered a public lecture in London on the electric telegraph and the uses it would subserve, as well in the internal economy of railways as in the political and social economy of the nation and the world at large. The following are his concluding sentences: "Should the system ever be adopted generally throughout Europe, what a vast field does it not open to us. Whatever is going on in Turkey, or in Russia, may be known in London the same hour; and, though it may seem a bold speculation, I can see no improbability that this will be realised. In fact, the greater the distance the more valuable in proportion will be the information communicated.

"Goods ordered from a distant country will, of course, arrive in just half the time they otherwise would, because the outward voyage for carrying out the order by letter is dispensed with. On general principles, whatever tends to promote intercourse between distant countries, or distant parts of the same country, will inevitably promote civilisation and increase the comforts of life.

"I must now conclude by stating that the electrical telegraph is already in progress of being established through a considerable line of this country, and there is every encouragement for supposing that it will, without delay, be brought into operation on a still more extended scale. I trust, therefore, that the company present will live long enough to see that, while we have not presumed to use the thunderbolts of Jupiter for destructive ends, we have acquired a command over the same electrical principle, for purposes infinitely more beneficial."

Edward Davy in England, like Baron Schilling in Russia, just missed the glory of being the father of his country's telegraphs. His chemical recording apparatus was an excellent contrivance, and I cannot help thinking that had it had a fair start in 1838, and been fined down in practice as it could have been, and as Cooke and Wheatstone's first inventions were, it would have given to English telegraphy a different character from that so long impressed upon it by rival plans.

* This plan, extravagant as it now reads, was actually patented by Jacob Brett, Nov. 13, 1845. After all, it is not so extravagant as the plans of an aerial line supported by gas balloons over water and land, which were patented in England Nov. 19, 1857, and July 13, 1858, or the proposal of a Mr. Granier during the siege of Paris, 1870-71, to float the wire a thousand yards high in air enclosed in guttapercha tubing, inflated to the necessary degree with hydrogen gas, and paid out from a balloon. There is a still more extravagant proposal for connecting Dover and Calais, and Port Patrick and Donaghadee, by means of a flexible galvanised wire in a flexible watertight tube, supported on rollers fixed on steamers, moored at intervals across the water, in the *Mechanics' Magazine* for Sept. 7 and 14, 1839. It reads like a Gargantuan joke, and perhaps it was meant as such, for the author was the brilliant and eccentric Irishman, "Honest" Tom Steele, of O'Connell and Repeal days.

† As in Van Choate's patent of Jan. 19, 1865.

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Indeed, at one time his inventions were on the point of being adopted by more than one English railway. His letters show that he was in treaty with Brunel and Tite, of the Great Western; with Fox and Creed, of the Birmingham line; with Easthope, the chairman of the Southampton Railway; and with other railway and financial magnates. Of Easthope, he wrote on Aug. 17, 1838: "Mr. Easthope seemed to take very enlarged views of the applications of the telegraph and the revenues to be derived from it, and has promised his strenuous influence for its immediate adoption on the Southampton and Portsmouth line. The encouragement which he has given has put a new life into the thing. He is a Member of Parliament, proprietor of the *Morning Chronicle*, and a large shareholder in the Southampton, and in the Havre and Paris, Railways. He speaks of opening up communications between London or Liverpool and the Mediterranean! You will perceive that if I have been in error as to the prospects of this invention, I have now some people of high standing to keep me in countenance in the "moonshine."*

A few days later he wrote to his brother: "I am trying hard to dispose of my telegraph. I wish to get it clean off my hands, and, if possible, an employment in laying it down at an annual salary. I believe I may now almost calculate on the Birmingham Railway, the best line in the kingdom; there is little now to fear from the rivals, Cooke and Wheatstone, and there are no others. My object is to form a company of affluent people, who will purchase my patent right, and, if this succeeds, it will produce a large sum of money, as £10 or £20,000, just as easily as so many hundreds. The value of the invention has very greatly increased since what it was six months ago, and I would not now sell it to Cooke and Co. for any sum they would be likely to offer, and which I would gladly have accepted once.† I have every assurance that I shall get together a set of wealthy directors, and that the shares will be taken up. We have, as you will perceive, some first-rate people already engaged, and much interested in it. Mr. Wright could, if he chose, advance £200,000. We are promised the Marquis of Douro and Lord Sandon for trustees, through the interest of Messrs. MacDougall, the solicitors in Parliament-street. There is no present reason to apprehend but that I shall get my price for it by persevering and securing influence step by step. But for all this my presence here is indispensable. It would come to nothing if I left London at this juncture, which would be madness. There is no one able or willing to push it forward for me, and, if allowed to sleep, the patent would not be worth a rush. I am now anxious to connect with some sharp, wary solicitor, not too young, whom I can engage to protect my own personal interests in driving the bargain with the directors, which will be very essential—one is so apt to be talked over by these keen moneyed men. . . .

"The enclosed piece of paper contains a statement of the progress made in organising our company. Only the names with asterisks are fully secured, but the others we have not much reason to doubt of.

"When a meeting of the directors can be called together, I shall propose that as soon as the deposits are paid up they give me £10,000 in money and one or two thousand shares; in fact, the best bargain I can make. Something will come of it."

VOLTAIC TELEGRAPH COMPANY.

TRUSTEES:

Marquis of Douro and Lord Sandon.

DIRECTORS:

*Sir F. Knowles, Bart., F.R.S.	Mr. Bagge (of Norfolk), M.P.
*John Wright, Esq. (banker).	Mr. Harrison (chairman of the Southampton Railway).
Em. Tennant, Esq., M.P.	

ENGINEER:

Mr. Fox.

SUPERINTENDENT OF MACHINERY:

E[dward] D[avy].

SOLICITORS:

* Messrs. M'Dougall and Co.

Capital: £500,000 in 10,000 shares—£50 each; deposit, £5.‡

Alas! just as his labours seemed on the point of fruition, he suddenly lost heart, and, angered by the dilatoriness of the railway officials, and by the coldness of his relatives (to which were added family troubles of another kind), he fled from England in despair, like a second Childe Harold, and, of course, left his rivals—Cooke and Wheatstone—an easy triumph.* Davy sailed from the Thames for Australia on April 15, 1839, and, amid the new cares of an unsettled Colonial life, soon forgot all about the telegraph. Indeed, nobody was more surprised than the old man himself when the present writer unearthed and published his long-forgotten papers 45 years later (in July, 1883). In a letter to me, dated Oct. 10, 1883, he says, in answer to my enquiry, "How is it you have never asserted your claims?": "When the Solicitor-General passed Cooke and Wheatstone's first patent in the face of my opposition and of the grounds thereof, how could I say that he had not done rightly? Again, when my father sold the patent for so insufficient a sum, I looked upon it that all hope of pecuniary benefit to myself was gone. I might still have fought for the credit of the invention, but I *was not aware* that the documents, which you have unearthed, had been so carefully preserved; besides, being at such a distance, I should have had to carry on a controversy at a great disadvantage, with the risk of being considered an imposter. I had friends in England, but none able, if ever so willing, to defend the claim. The other party was in the midst of friends, and in possession of the field."

For a year or two after Davy's departure, his father, Mr. Thomas Watson (a London dentist) and one or two other friends tried in a half-hearted way to carry on the negotiations from the point where he himself had left them. Another exhibition of both the needle and chemical telegraphs was opened in Exeter Hall for a few months in 1839-40, but as those in charge of the instruments did not understand them, and could not always get them to work properly, no good came of it, or of the negotiations.

His last (pathetic) words on the telegraph are contained in a letter to his brother dated Adelaide, March 8, 1841: "With respect to the telegraph, it was with much regret I received intelligence some months ago of the steps Mr. Watson had advised, but was silent on the subject, considering that any suggestions I could offer would arrive too late. Mr. W. is, I believe, a sincere and zealous friend, but though he has very shrewd ideas in many instances, he is little versed in the theory of electricity, and not competent, on the score of mechanical tact, to carry out in practice the invention. But it would be imprudent, on the other hand, to set it down that there is some vital imperfection in the patent, and that it ought to be altogether abandoned. A public exhibition of the machinery was unnecessary, and unless in very able hands was more calculated to injure than promote the credit of the invention (which has cost me no little thought, time, labour, and anxiety) which I have now had ample time to cool upon, but which I am nevertheless confident is sufficiently sound as far as it goes.

"Let me hope that the patent itself will not be altered, amended, or interfered with, unless by the inventor; let it rest on its own merits. The only further steps I should consider necessary are: (1) An ample number to be published of the specification, to be distributed from time to time amongst influential parties, as railway directors, members of Government, eminent commercial and scientific men, editors of publications, etc., and an ample reserve supply of copies to be used as future circumstances may suggest; (2) that in case the patent should not come into profitable operation before its expiration, an application for its renewal should be made for another 14 years, more or less; (3) patience and perseverance. These things are not taken up by the public in a day or a year. The steam-engine was not approved or brought into profitable operation during the 14 years of the original patent. Let it sleep if needs be, but do not let it die."

With the exception of the letter just quoted, and a few others which are still in my hands, all Davy's letters and papers relating to the telegraph (extracts from which will be found in my *History of Electric Telegraphy to 1837*) are in the library of the Institution of Electrical Engineers. They should be read side by side with Cooke's letters covering the same period, 1836-39, as lately published by a committee of the Institution. It is simply marvellous how alike the two men were in their struggles for recognition, and in their hopes and fears of ultimate success—often even to the phrases in which they express them.

The public recognition of Davy's telegraphic labours came late, but it still came in time to cheer his last days. Consequent on the publication of his papers, and through the exertions of the present writer and other friends, he was elected an honorary member of the Institution of Electrical Engineers, and a Fellow of the Royal Society of Victoria; and he was voted a pension from the Civil List by the Government of that colony, only one instalment of which he drew, as he died at Malmsbury on Jan. 26, 1885, in the seventy-ninth year of his age.

Worried as Davy must have been with the telegraph in the years 1836-39, yet he found time for the pursuit of his first and favourite occupation—chemistry. In 1835 he invented a cement for mending broken china and glass, which brought him in a clear £100 a year, and is still made and sold as "Davy's

* Davy's relatives, to the last, believed him a visionary, and called his telegraph ideas "all moonshine."

† From a letter of Wheatstone to Cooke, in Mr. Latimer Clark's possession, dated July 18, 1839, it seems that they then contemplated buying up Davy's patent. Ultimately it was bought for £600 by the old Electric Telegraph Company, and—smothered, like a good many others.

‡ The original draft of the prospectus is preserved amongst the Davy MSS. No. 9 in the library of the Institution of Electrical Engineers. It is a very interesting and exhaustive document, and will well repay perusal.

* See extract from a letter of Wheatstone to Cooke, dated July 18, 1839, at p. 443 of my *History of Electric Telegraphy to 1837*,

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diamond cement" by Barclay and Sons, 95, Farringdon-street, London, to whom he sold the secret in February, 1839. In 1836, he published his *Experimental Guide to Chemistry*, an excellent little book for the period, in which he refers to several of his own contrivances, as "Davy's blow-pipe," "Davy's improved mercurial trough," etc.; and in 1838 he devised a plan for saving fuel in the process of smelting ores, a patent for which was taken out on Sept. 2, 1847, in his brother Henry's name. The rest of poor Davy's chequered life is briefly but sufficiently indicated at pp. 520 and 528 of my history, to which I have already so often referred.

Hubert Recy—1838.

In a *brochure* of 35 pages, entitled *Télétatodydaxie, ou Télégraphie Electrique*, Paris, 1838, descriptive of a crude system of the spark form, the author, Hubert Recy, contemplated its application to both land and sea telegraphs. At p. 34 he says: "I long had a thought of offering my teletatodydax to civilisation, because, notwithstanding some respectable opinions to the contrary, I believe it useful to man in seasonable times; but I did not wish to make it known in 1830, or during the stormy years that followed."

The line wires, of which there were two, were to be of iron enveloped in wax-cloth, then well tarred, and enclosed in leaden tubing, to effectually exclude the moisture and so prevent the dissipation of the electric force. They might then be placed at some feet underground along the high roads, like water-pipes; while as regards those parts destined for submersion in water, across the sea to England, Algeria, and other remote places, they should be prepared with extra care, so as to entirely exclude the moisture.

In certain cases, he says, the metals of a railway could be used as lines of communication for the electric spark, and nothing would be easier than to put them into a condition to fulfil this function, each rail representing a line. This is interesting in view of the fact that it was while actually trying (July, 1838) to carry out this idea on the Nurenberg-Furth Railway, that Steinheil rediscovered the use of the earth circuit for dynamic electricity. I say rediscovered, for it had long previously been employed, as I have shown in my history, pp. 343-47.

Dr. O'Shaughnessy—1839.

Dr. O'Shaughnessy (afterwards Sir William O'Shaughnessy Brooke) will always occupy a prominent place in the history of telegraphic enterprise as the introducer and organiser of electric telegraphs in India; but that he suggested a subaqueous line in 1839 is another of the many popular errors with which the early history of electric telegraphy is crowded. The late Sir William Siemens was, I believe, the author of this fiction. In a paper read before the Society of Arts, April 25, 1858, he says: "Regarding the history of submarine cables, it appears that the first experiments, on a small scale, to submerge an insulated conductor (copper wire, coated with cotton thread, saturated with pitch and tar) were made at Calcutta in 1839 by Dr. (now Sir) William O' Shaughnessy."

Now, as a matter of fact, Sir William, who died at Southsea, Jan. 8, 1889, never deserved and never claimed this honour for himself. He published a very interesting account of his experiments of April and May, 1839, in the *Journal of the Asiatic Society of Bengal*, for September of the same year; and again in a little volume entitled *Extracts from Notes of Lectures on Natural Philosophy* (Calcutta, 1841), and in his *Electric Telegraph in British India* (London, 1853), he has a few brief references to his earlier publications. In these he merely throws out the suggestions of (1) "a subterranean line for India, to be constructed of wire, coated with pitch and cloth, and buried in a trench 2ft. deep along the common road;" and (2) "burying the wire in a trench rammed with powdered brick and mortar, which would doubtless give both insulation and security to the extent required," but in no place does he speak of a subaqueous line in 1839. The truth is, it was not until 10 years later, in 1849, that he turned his attention to this subject, by which time it was far beyond the experimental stage.

Sir William Siemens's error was probably due to a hasty perusal of the following words which occur in the preface of the *Electric Telegraph in British India*: "In April and May, 1839, the first *long* line of telegraph ever constructed in any country was erected by the writer of these pages in the vicinity of Calcutta. The line was 21 miles in length, embracing 7,000ft. of river circuit." At a glance this might be taken to mean that the 7,000ft. of river circuit was formed by a submerged insulated conductor, whereas it really means nothing more than that the ends of the line dipped into the water of the River Hooghly (or, as we should now say, were earthed) at points 7,000ft. apart.

I have now brought the history of submarine telegraphy down to the year 1840, the date of Wheatstone's proposals. As Mr. Charles Bright gives a full account of these and subsequent practical developments in the work referred to at the commencement of these articles, the reader cannot do better than study his pages. The trouble will well be repaid.

HAMPSTEAD ELECTRICITY ACCOUNTS.

The following is the report of Mr. A. P. Johnson, clerk to the Vestry of St. John, Hampstead, to the Lighting Committee, on the working of the electricity department of the Vestry for the 12 months ended March 25, 1898. The revenue account, balance sheet, and statement of electricity generated, sold, etc., are appended:

As in previous years, I beg to submit a short report explanatory of the annexed accounts, prepared according to the Board of Trade requirements, in connection with the electric lighting undertaking in this parish for the year ended Lady Day last. As anticipated much progress has been made and increasing profits realised, and there is no doubt that the Vestry has now under its control a most important and highly remunerative branch of administration, such as must undoubtedly prove itself a source of gratification to the Vestry which has conducted its development, and an inestimable boon to the ratepayers generally. Since my last report no fresh loan has been obtained, although negotiations have been in operation for some months past for a loan of £51,500, which will more than meet the expenditure to Lady Day, 1898. Considerable, difficulty, however, is experienced in satisfying the County Council as to the amount applied for, fullest details being required and a minute investigation made into every pound that is allocated to the capital account. More than ordinary difficulty is encountered with the granting of electric lighting loans, inasmuch as the work is continuous, and the extent of each individual loan cannot be so easily defined and limited as, for instance, in the case of paving and sewerage loans. Another loan has also been applied for, amounting to £17,436, to cover the extensions of plant recently ordered by the Vestry; but this is the estimated cost only. When these two loans are obtained the present large overdraft, on which we have been paying a rather heavy interest, will be completely annulled. It will be observed that the total amount of loans repaid is now £2,246. 9s., although it must be remembered that the temporary loan from the bankers, such as the overdraft may fairly be called, has not necessitated any repayment; so that next year, when the present pending loans are completed, this amount will be considerably augmented. On the other hand, it may be pointed out as a set-off against this that the Vestry have had to pay a heavier rate of interest to the bank for the temporary accommodation than would have been the case if a loan had been obtained earlier in the year, 3½ per cent. being charged by the bankers on the overdraft as against 3 per cent. on loan. Of the 12 months' expenditure, that on mains, as usual, is the highest, although both buildings and machinery show appreciable figures. Mains are laid down in those roads where the Vestry has sufficient applications to warrant the expenditure, the cost of house connections, and arc lamps and mains, being also included under this head. The policy initiated by the Vestry at the opening of the station, and steadily adhered to ever since, of laying mains wherever possible is now bearing fruit, and must continue to do so in the future to an ever-increasing amount. Nearly every street of importance in the borough is wired, and the Vestry are therefore in the enviable position of being able to face with confidence the threatened competition from outside companies, even if, as appears most doubtful, those companies should be successful in obtaining the powers which they seek. The £3,030. 12s. 4d. expended on buildings is mainly for the completion of the additions to the station, and the £3,496. 5s. 11d. on account of extension of plant recently ordered by the Vestry. A testimony to the increase of consumers is furnished by the outlay on meters, which has reached nearly £2,000—considerably more than in either of the two preceding 15 months, although it is to be borne in mind that a small proportion of this amount is represented by demand indicators, which are included under this head. The total capital expenditure for the year is £16,845. 13s. 6d., which, with previous years' expenditure, brings the total to £100,176. 18s. 4d., including the valuation of land appropriated for site of station at £1,160. The revenue account shows the year's working expenses and the profit on the same. This latter has somewhat exceeded expectations, for it was hardly thought that the profit for this 12 months would very much exceed that for the previous 15 months, in which there were three dark quarters and three corresponding heavy quarters' revenue. The figures, however, are £8,081. 0s. 9½d., as against £5,257. 12s., an increase of £2,823. 8s. 9½d., or nearly 54 per cent. It is mainly the increased revenue (combined, however, with increased economy in expenditure) that gives this pleasing feature to the accounts, for whereas for the preceding five quarters ending Lady Day, 1897 (including three dark quarters, be it remembered), the total income amounted to £13,425. 17s. 11d., the income for the four quarters under review yielded £15,930. 3s. 10d. Perhaps the following will show the growth of income somewhat clearer:

Average income per quarter, 15 months ended March, 1897	£2,685	3	7
Average income per quarter, 12 months ended March, 1898	3,982	10	11
Showing an average increase of about 48 per cent., or	1 297	7	4

The expenditure is much the same for the past 12 as for the previous 15 months, and taking into consideration the number of units consumed, the costs per unit (shown in detail in the engineer's annual report) show an appreciable diminution. The coal bill, the heaviest item of expenditure on this account, amounts to £3,330. 1s. 3d., as against £3,100. 12s. 11½d. for the preceding 15

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months. This must be a source of gratification to your chief engineer, and tends to show more than anything the care and economy displayed by the staff at the station. The other items are generally proportionate, but the drop in expenditure for repairs and maintenance of engines and boilers is more marked, the figures reading now £254. 3s. 2d., instead of £776. 17s. 9½d. The discount is somewhat heavier this year, owing to the fact that it was allowed on the five quarters' consumption to Lady Day, 1898, instead of four quarters to Christmas as hitherto, the change being made in order that the electric lighting accounts should close simultaneously with the other accounts of the Vestry. The item for compensation also swells the expenditure this year owing to the unfortunate fatal accident to one of the Vestry's workmen in a transformer chamber in March, 1897. In connection with this, it should be stated that the total amount of agreed compensation made to Mrs. White, the widow, was £200, of which we are to receive £100 from the insurance company, leaving a net charge on the revenue account of £100—the £4. 2s. 2d. being represented by plaintiff's agreed costs in this matter. The net revenue account shows the net profit on the undertaking after discharging the interest and principal of loans and providing for bad debts, etc. With increased capital expenditure, the former items must of necessity increase correspondingly—the amount paid being together £2,917. 7s. 10d., as compared with £2,287. 10s. 7d. for the previous 15 months. Added to this, however, is the interest on the bank overdraft, which has risen from £1,066. 0s. 9d. to £1,250. 13s. 3d. for the like periods. Bad debts and allowances amount to £7. 16s. 4d.; but it should be pointed out that even of this small sum (proving, as it does, the sound *clientèle* with which the Vestry has to deal) the allowances amount to £3. 17s. 4d., leaving only £3. 19s. as actual bad debts. It may be of interest to point out that since the commencement of the supply in October, 1894, the total amount of bad debts has been £7. 1s. 2d , and that the total amount of money collected is £33,963. The net profit, therefore, after these charges have been met, is £3,905. 3s. 4½d.—a highly gratifying result for the third year's working. This represents nearly 4 per cent. on the total capital expended; but assuming, as in my last report, that as a private company the amount paid for repayment of principal of loans is equivalent to a contribution to a sinking fund, the dividend that would be declared on the remainder would be £6,885. 11s. 7½d., or nearly 7 per cent. For the previous 15 months the "dividend" was 5·59, so that the success of the undertaking has substantially increased, and of course there is every reason to hope for and anticipate even larger profits in future years. These figures must be very welcome to the Vestry's consumers, as in the event of the net profit reaching 5 per cent. on the total capital outlay, which appears likely next year, the price of the current must be reduced by the Vestry under the terms of their provisional order. I subjoin a statement comparing the income and expenditure for the three periods from October, 1894, to Lady Day, 1898, which will perhaps better reveal the growth of the undertaking since its inauguration:

Item of income and expenditure.	15 months to Christmas, 1895.	15 months to Lady Day, 1897.	12 months to Lady Day, 1898.	Total.
INCOME.	£	£	£	£
Sale of current	3,432	11,583	14,238	29,253
Public lighting	1,030	1,470	1,145	3,645
Rental of meters	142	365	531	1,038
Sundry receipts	3	8	16	27
	4,607	13,426	15,930	33,963
EXPENDITURE.				
Generation—	£	£	£	£
Coal	2,036	3,181	3,330	8,467
Oil and stores	351	353	403	1,107
Wages at generating station	948	1,101	998	3,047
Repairs and maintenance:				
Buildings	81	13	9	103
Engines and boilers	214	777	254	1,245
Dynamos, etc.	4	8	3	15
Machinery, tools, etc.	25	21	11	57
Distribution—				
Wages to fitters, etc.	8	—	—	8
Mains (repairs)	10	115	100	225
Consumers' apparatus	13	15	10	38
Distributing	67	104	17	188
Public Lamps—				
Repairs and renewals	164	259	271	694
Rates and taxes	394	442	362	1,198
Management Expenses—				
Salaries of engineers	670	875	868	2,413
Stationery and printing	154	159	166	479
Establishment charges	290	282	280	852
Special Charges—				
Insurances	81	117	95	293
Discount	98	356	550	1,004
Testing, etc., of meters	—	2	11	13
Sundries	—	69	109	178
	5,608	8,169	7 847	21,624

The balance-sheet needs no comment, being self-explanatory, showing as it does the actual assets and liabilities at the time of closing the accounts, while the table of units "generated," "sold," etc., hardly calls for remark.

Dr. REVENUE ACCOUNT.				£	s.	d.
Generation.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£3,330	1	3			
Oil, waste, water, and engine-room stores	403	3	7			
Wages at generating station	997	18	9			
Repairs and maintenance of buildings, £9. 8s. 11d.; engines and boilers, £254. 3s. 2d.; dynamos, etc, £3. 1s. 4d; machinery, instruments, tools, etc., £10. 16s. 1d.	277	9	6			
				5,008	13	1
Distribution.						
Repairs and maintenance of mains	100	3	10			
Transformers, meters, switches, and other apparatus on consumers' premises	10	6	9			
Apparatus at distributing stations	17	5	5			
				127	16	0
Public Lamps.						
Public lamps, repairs	259	14	3			
,, renewals	11	7	9			
				271	2	0
Rates and taxes				362	8	0
Management Expenses.						
Salaries of engineers	867	10	10			
Stationery and printing	166	4	7			
General establishment charges	280	8	11			
				1 314	4	4
Special Charges.						
Insurances	95	4	7			
Discount — public lighting, £150. 18s. 5d.; private consumers, £399. 2s. 9d.	550	1	2			
Testing and certification of meters	10	11	9			
Compensation to Mrs. White, including solicitors' costs	104	2	2			
Sundries	5	0	0			
				764	19	
				7,849	3	1
Balance carried to net revenue account				8,081	0	9
				£15,930	3	10
Cr.				£	s.	d.
Sale of current per meter at 2½d., 4d., and 6d. per B.T.U.				14,238	1	9
Public lighting				1,145	0	1
				15,383	1	10
Rental of meters				531	4	2
Sundry receipts				15	17	10
				£15,930	3	10

BALANCE-SHEET. Dr. Liabilities.	£	s.	d.
Capital account—amount received	60,560	0	0
Sundry Creditors	5,160	7	4
Amount contributed by the general account out of lighting rate towards deficits on revenue account	1 659	5	11
Net revenue account	2,820	13	1
Balance due to treasurer	37,451	11	4
	£107,651	17	8
Cr. Assets.	£	s.	d.
Capital account—amount expended for works	100,176	18	4
Stores on hand: coal, £82. 6s. 8d.; oils, waste, etc., £14. 15s. 3d.; general, £1,541. 18s. 8d.	1,639	0	7
Electric light consumers for current and meter rent to Lady Day, 1898	5 211	17	5
Other debtors	624	1	4
	5,835	18	9
	£107,651	17	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		840,002
Quantity sold { Public lamps	45,792	655,927
Quantity sold { Private consumers	610,135	
Quantity used on works		12,000
Total quantity accounted for		667,927
Quantity not accounted for		172,075
Number of public lamps		24
Total maximum supply demanded		613

Brussels.—Tenders are invited for the supply of electricity for the lines Liège-Vottem and Liège-Beileur. The deposit required is £1,000. Conditions, etc. (10d.). are to be obtained from Société Nationale des chemins de fer Vicinaux, rue de la Science 26, Brussels. Tenders by Sept. 7, at 11 a.m.

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COMPANIES' MEETINGS AND REPORTS.

LONDON TRAMWAYS COMPANY.

An extraordinary general meeting of this Company was held at the office of the Company in Camberwell New-road on Monday for the purpose of confirming a special resolution passed at the extraordinary general meeting held on the 5th inst., authorising the sale of the undertaking to the County Council.

Colonel C. E. Macdonald presided and formally moved the acceptance of the resolution—viz: "That the directors be and they are hereby authorised to accept on behalf of the Company the offer which the Highways Committee of the London County Council have decided to recommend the Council to make for the purchase of the whole of the Company's undertaking (other than the 2⅛ miles of tramways and the Lawson-street depôt, already agreed to be sold for £22,872 to the London County Council) for the sum of £850,000, in addition to a sum to be agreed upon as the value of stores, unexpired licences, excise duties, and insurance, and that the directors be and they are hereby authorised to take such steps as may be necessary for completing and carrying out the sale of the undertaking of the Company to the London County Council upon the above mentioned terms."

The motion was agreed to without discussion.

YORK TRAMWAY COMPANY.

The half-yearly meeting of this Company was held at York on Wednesday.

Mr. Jos. Kincaid (the chairman) presided, and in moving the adoption of the report said he was a little disappointed with the negotiations that had taken place with the Corporation as to the application of electrical power to the tramway, for as yet the negotiations had resulted in nothing definite. He attended a meeting of the Corporation Committee some months ago, and had a long conversation with regard to applying electrical traction to the trams, but up to the present no communication had been made to him by the Corporation, and the directors did not know what were the ideas of the Corporation with regard to the requirements of the Company. That was unfortunate for the Company and unfortunate for the public, because the better the service the better the public would be pleased. They would be able to carry on the traffic better, and also be better able to proceed with the repairs of the roadway if they knew what plans the Corporation had in view for the tramways of York.

ALUMINIUM COMPANY.

The eleventh ordinary general meeting was held on Tuesday at Cannon-street Hotel.

Lieutenant-General Sir Andrew Clarke presided, and, in moving the adoption of the report, said that, notwithstanding certain exceptional conditions which prevailed in respect of the working of the business at Oldbury during the year, the result of their trading for the period under review was satisfactory. The gross profit had been £17,189. The Castner Kellner Company was working very satisfactorily, and it was announced at their last annual meeting that an interim dividend would probably be paid in October at the rate of 8 per cent. per annum. In view of this company's large holding in shares, such a dividend would alone mean almost 10 per cent. on their share capital in future. The business of the Niagara Electro-Chemical Company was an exceedingly prosperous one. They had only received from it a dividend of 5 per cent. this year, as the directors of that company decided that the bulk of the profits of the first year should be used in writing down the amount expended on the works. He concluded by stating that he thought they had every reason to be satisfied with the present position and the prospects of the Company.

Mr. John S. Parkin seconded the motion, and the report was agreed to unanimously.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Buxton.—The Urban District Council invite tenders for various works in connection with their electric light station. Tenders by Sept. 5.

Bury St. Edmunds.—The Corporation invite tenders for the erection of buildings for their electric lighting station. Tenders by Sept. 10.

King's Lynn.—The Corporation invite tenders for various works in connection with the electric lighting of the borough. Tenders by Sept 7.

Bexhill.—The Urban District Council are prepared to receive tenders for various works in connection with their electric light station. Tenders by Sept. 28.

Southport.—Tenders are invited for the construction of an electric railway from Southport to Lytham. Two guineas for quantities, which will be returned if not accepted. Apply to Mr. Stewart Speddy, 7, Post Office-avenue, or 118, Hampton-road, Southport.

Aberdeen.—The Corporation invite tenders for the supply for one year of electricity supply meters, house fuse boxes and service cables. Booklet of specifications and conditions of contract may be obtained on application to Mr. J. Alex. Bell, city electrical engineer, accompanied by a deposit of 10s., which amount will be refunded on receipt of a bona fide tender for any one of the above classes of goods. Tenders are due by Sept. 17.

Belfast.—The Harbour Commissioners invite tenders for the supply of 50 electric light masts (tubular), in strict accordance with the outline specification and blue print, which may be obtained from the harbour engineer, Mr. G. F. L. Giles. Sealed tenders, on the special forms provided for the purpose, to be addressed to Mr. W. A. Currie, secretary, Harbour Office, Belfast, endorsed "Tender for Electric Masts," and sent in by Sept. 12

Torquay.—The Electricity Committee invite tenders for the supply and delivery of (1) meters, (2) arc lamp carbons, for a period of 12 months from Oct. 1, 1898. Further particulars and form of tender may be obtained from Mr. P. Storey, the borough electrical engineer. Sealed tenders, endorsed "Meters" or "Arc Lamp Carbons," as the case may be, to be sent in to the Town Clerk, Fredk. S. Hex, Esq., Torquay, not later than 2 p.m. on Sept. 19.

Leeds.—The City Council invite tenders for the supply of (a) poles, (b) trolley wire and attachments, in connection with the extension of their electric tramway systems. Tenders must be sent in by noon on Sept. 20. Plans may be seen and forms of tender obtained on payment of a deposit of £5, which will be returned on receipt of a bona fide tender, from the City Engineer, Municipal Buildings, Leeds, or from 5, Victoria-street, Westminster, S.W.

Huddersfield.—The Electric Lighting Committee invite tenders for the supply of two alternating-current motors, each to give 25 b.h.p. Persons tendering must send full particulars and efficiencies guaranteed to the Borough Electrical Engineer, St. Andrew's-road, Huddersfield, not later than Sept. 5 Sealed tenders, endorsed "Tender for Motors," must be delivered free of charge, in the handwriting of the tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield, not later than Sept. 6.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Kingston-upon-Thames.—Tenders are invited by the Committee for the fitting-up of an installation of electric light at the Kingston Victoria Hospital, Coombe-lane, Kingston-upon-Thames. Specification, form of tender, and further particulars can be obtained at the office of the Hon. Consulting Engineer, Central Electric Station, Down Hall-road, Kingston-upon-Thames, between 10 a.m. and 5 p.m. Tenders, endorsed "Tender for Electric Light Installation, Kingston Victoria Hospital," to be sent to Mr. J. E. Edgcome, hon. consulting engineer, Central Electric Station, Kingston-upon-Thames, by noon on Sept. 5.

Hull.—The Electric Lighting Committee invite tenders for the supply of the following cars, etc.—viz, 45 electric motorcars, 20 trail cars, 2 sprinkler cars, 2 traversing platforms. Specifications and forms of tender may be obtained of Mr. A. E White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Rolling Stock," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 30.

Potteries (Staffs).—The British Electric Traction Company, Limited, invite tenders for the provision of materials and construction of the track and permanent way of about 13 miles of tramways (in sections) in the Potteries district of North Staffordshire. Drawings may be seen, and specifications, stipulations, bills of quantities, forms of tender, and particulars obtained, on payment of a deposit of £3. 3s., which will be refunded on receipt of a bona fide tender and the return of the documents, at the Company's Permanent-Way Engineer's Office, Donnington House, Norfolk-street, Strand, W.C. Tenders before 10 a.m. on Sept. 5.

Rochdale.—The Corporation invite tenders for the following plant: Specification No. 2: (Section A) boilers, fittings, etc.; (B) economisers; (C) condensing plant; (D) feed pumps, tanks, etc.; (E) steam and exhaust pipes; (F) travelling cranes; (Specification No. 3) switchboards; (4) accumulators; (5) cables. Specifications, forms of tender, and conditions of contract may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 12, Delahay-street, Westminster, on payment of £3. 3s. for each specification, which sum will be returned on receipt of a bona fide tender. Tenders (endorsed "Electricity Works") must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by noon on Sept. 6.

Bexhill.—The Bexhill Urban District Council invite tenders for the following work in connection with their electric lighting station: (Section A) water-tube boilers; (B) steam dynamos and balancer; (C) switchboards; (D) storage battery; (E) underground cables and pipes, arc lamps and posts. Copies of the specifications, with form of tender and general conditions, can be obtained at the office of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster, S.W. Applications for any or all of above must be accompanied by a cheque for £5. 5s., which will

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be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting, Tender for Section —," must be delivered at the offices of Mr. Fred. A. Langham, clerk, Council Office, Bexhill, by 10 a.m. on Sept. 28

Bangor.—The Corporation invite tenders for the supply and erection of the following plant: (Contract No. I.) two water-tube boilers, economiser, brickwork, and flues; (II.) steam. exhaust, and other pipes, steam pumps, and feed-water heater; (III.) two 60 kw. steam dynamos, balancer, boosters, and 5-ton overhead travelling crane; (IV.) switchboard and instruments; (V.) accumulators; (VI) mains. General conditions, specifications, forms of tender, etc.. may be obtained from Mr. F. Hastings Medhurst, B.Sc., M.I.E.E, the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., on payment of a deposit of £3. 3s. for each section, which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Electricity Works, Contract No. —," must be delivered to Mr. R. Hughes Pritchard, town clerk, Bangor, North Wales, by Sept. 10.

RESULTS OF TENDERS.

Portsmouth.—The Electric Lighting Committee have accepted the tender of the Brush Electrical Engineering Company for three transformers at £95 each.

Whitehaven.—The Town Council have accepted the following tenders for stores: Electricity meters, Messrs. Chamberlain and Hookham; dynamo spindle oil and gauge glasses, Messrs. Ramsay Bros.

Sydney (N.S.W.).—Seven tenders have been received by the Public Works Department for the construction of the power-house for the George and Harris streets electric tramway. The lowest tender was that of J. Stewart and Co. for £19,797. The others were as follow: J. C. Waine, £20,250; J. M'Sweeney, £20,573; Phippard Bros., £21 435; J. C. Harrison and Son, £21,748; J. Ahern, £22,890. 14s. 6d., Hungerford and Sons, £23,007. 4s. 2d.

BUSINESS NOTES.

Hastings.—The Council's electric lighting provisional order has been confirmed.

Pemberton.—The Council have decided to advertise for electric lighting schemes, but without offering a premium.

Worksop.—The Council have unanimously resolved to apply next session for an electric lighting provisional order.

Bath.—It is in contemplation to instal incandescent lamps on the arc lamp pillars to replace the arcs after midnight.

Londonderry.—The Board of Trade have granted the Corporation an extension of their electric lighting provisional order for 12 months.

Cults.—The electric supply works have been acquired by Messrs. Middleton and Co., who have taken them over from the Northern Electric Supply Company.

Liskeard.—The telephone system rapidly gains ground in Cornwall. We learn that it has reached Liskeard, and is being pushed forward to Lostwithiel.

Darwen.—The Corporation have received sanction from the Local Government Board to borrow the money required for the erection of the electricity works.

Keighley.—A special meeting of the Council will be held on the 27th inst. to consider a motion in favour of applying next session for an electric lighting provisional order.

Rhyl.—A Midlands firm have applied to the Council for permission to lay down an electric tramway from the Grand Pavilion along the sea front, a distance of four miles, to Prestatyn.

Haslingden.—The Council have carried the resolution to apply for a provisional order for the supply of electricity. The scheme as agreed upon includes the provision of a refuse destructor.

Hampstead.—As was to be expected, the new extension of the workhouse will be lighted electrically. The Vestry's electric lighting accounts for the past year will be found in another column.

Removal.—On and after the 25th inst. the warehouse and office portion of the business of Messrs. Williamson and Joseph will be conducted from the Northampton Works, Northampton-grove, Canonbury.

Fulwood.—The Council have received a letter from the National Electric Supply Company stating that they were about to lay their mains from the Preston Corporation boundary to the boundary of the Fulwood Council.

Yarmouth.—The Council have been written to by Mr Rucker respecting the Zipernowski-Deri patent, and have resolved to repudiate all liability. The clerk has been instructed to co-operate with the several corporations affected.

Eastern Railway Construction Syndicate, Limited.—This Company has been formed, with a capital of £3,600 in £1 shares, to construct and maintain rail and tram roads, electric light works, telegraph and telephone systems, etc.

Appointment Vacant.—The Willesden District Council require an electrical engineer to design an electric light installation and to take over the management of the same after completion. For further particulars see our advertisement columns.

Maidstone.—The Town Council have resolved "that competitive designs for a combined electric station and dust destructor on the lines of the Shoreditch system be advertised for, such designs to be submitted to Messrs. Kincaid and Co., as assessors."

Aberdeen.—The Corporation have paid the purchase price of £84.734 for the tramway system of the city. A letter has been received from the Secretary for Scotland granting extra borrowing powers for the electric lighting station, amounting to £67,000.

Heckmondwike.—At the annual meeting of the Heckmondwike Gas Company the chairman, Mr. J. Stead, stated that the spread of electric lighting had caused a slight falling off in the consumption of gas, and the profits were a trifle less than in the previous year.

Winchester.—It is stated that it is in contemplation to establish a service of electrical omnibuses between Winchester and the Worthys, in the suburbs of Winchester. The generating power will be obtained from the new electricity works in Hyde Abbey-road.

Metropolitan Railway.—The *City Press* states that experiments in lighting their trains by electricity having proved successful, the Metropolitan Railway Company have had several carriages built and fitted with electric light, and these will be running by the end of September.

Suffolk Electricity Supply Company, Limited.—This Company has been registered with a capital of £10,000 in 980 £10 ordinary and 200 £1 founders' shares to carry on the business of supplying electric heat, light, and power in the town of Stowmarket and elsewhere in England.

Newmarket.—Letters from the Board of Trade and from the Newmarket Electric Lighting Company with plans and explanations of the proposed arrangements for laying down mains for the distribution of electrical energy have been referred by the Council to the Surveyor's Committee.

Eccles.—The Corporation notify in the *London Gazette* that it intends to lease, by way of supplemental lease, to the Manchester Carriage and Tramway Company all the tramways within the borough belonging to the Corporation from March 31 next to April 27, 1901, at the annual rental of £900.

Garston.—Colonel W. R. Slacke opened an enquiry at Grassendale on the 25th ult. into an application by the Council to borrow £25,000 for the erection of a refuse destructor and electric light station in Garston Old-road, Grassendale. Strong opposition was offered to the proposed site of the destructor.

Manchester Electrical Works Company, Limited.—A general meeting of the shareholders in this Company (successors to Woodhouse and Rawson) will be held at 147, Leadenhall-street, E.C., on Monday next, to consider a report from the directors and to sanction the proposed sale of plant and stock.

Elland.—A committee of the Council is now engaged in considering the best method of introducing electric light into the district. Huddersfield appears to be willing to give a supply, but there is a feeling in favour of a local supply if possible. The committee has visited Nelson to see if the conditions there are akin to those at Elland.

British Insulated Wire Company.—Applications have been made to the Stock Exchange Committee to appoint a special settling day for 29,935 ordinary shares of £5 each fully paid, Nos. 1 to 29,625 and 39 651 to 39,960, and to allow to be quoted in the official list 39,960 ordinary shares of £5 each fully paid, Nos. 1 to 39,960.

Margate.—The Town Council have approved of the draft agreement for the transfer of the electric lighting order of the Corporation to the Isle of Thanet Light Railways (Electric) Company, subject to the insertion of a clause stipulating that all the buildings and plant for the generation of electric light are in the borough of Margate.

Hemel Hempstead.—A lamp-lighting difficulty was discussed by the Parish Council the other day, but the Rev. E. J. Gallop hinted to his colleagues that they would possibly have electric light instead of gas in the near future. A contemporary states that the Town Council, when it comes into being on Nov. 9, would do well to take Mr. Gallop's hint.

Stourbridge.—Among other matters respecting electric traction the Railway Committee recommend the Council to empower them to conclude the negotiations pending with the British Electric Traction Company and the Worcestershire Council concerning the terms of the order in relation to the Kinver Light Railways. The Council have agreed to the recommendation.

Barnsley.—The Town Council, on Tuesday, had before it a recommendation of the Park and Lighting Committee, that the Local Government Board be asked to sanction a loan of £25,000, instead of £23,322. 15s., as previously ordered, to meet the cost of carrying out the proposed scheme of electric lighting in the borough. The recommendation was adopted.

Govan.—A local paper states that the proposal to instal electric light into the place has hung fire somewhat. The Glasgow Corporation have practically withdrawn from their hostile attitude to the supply of electricity by Govan to the Clyde Trust works, and about 30 shopkeepers have signified their willingness to adopt the electric light if supplied by the Municipality.

Buxton.—The Council have received a letter from the Local Government Board with regard to the application to borrow £20,000 for the purpose of electric lighting, and asking for a copy of the order, and a plan of the works, etc. The Board also require to be supplied with evidence that the approval of the Board of Trade has been obtained to the system proposed to be adopted.

Accident.—A collision occurred on Saturday night on the new electric tram system between Bradford and Horton Bank Top.

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In running on to a single line at Great Horton two cars collided with sufficient force to throw several people down, while others jumped off the vehicles. One of the cars was a little damaged, but the passengers escaped with nothing more serious than a shaking.

"The Cromer Express."—This is the title of a nicely printed pamphlet illustrative of the scenery along the route from London to Cromer, and which is issued by the Great Eastern Railway. Leaving Liverpool-street Station at 1.30 p.m., the Cromer express is timed to reach its destination at 4.25 p.m., and with this interesting little guide in hand the passenger's journey should be pleasant.

Cork.—At the recent half-yearly meeting of the Cork, Black rock, and Passage Railway the Chairman stated that the question of working the line by electricity had been considered by the directors. An electric company went very fully into it with them, and gave a tender for electrically working the line, which, after very full and mature consideration, they could not see their way to accept.

Grimsby.—The Town Council have decided to adopt the Lighting Committee's report recommending the lighting of the borough by electricity, and the supplying of current to the tramway company for electric traction, the lease of the company to be extended 21 years. Strong opposition was offered to the extension of the lease.—A new telegraph office is about to be opened at Habrough.

Catalogues.—We have received from Messrs. Walker and Hall, of Sheffield, a copy of their illustrated catalogue of electro-plate, sterling silver, and cutlery. Committees and others in search of presentation plate would do well to consult this catalogue.—We have received from Messrs. Davies, Kent, and Stewart, of Berners-street, W., a copy of their new illustrated price list of electric lighting accessories, bells, etc.

Barrow.—The work of laying the electric mains in Barrow has been commenced from Monkscroft, and is progressing towards the town. We hear, however, that at a meeting of the Highways and Lighting Committee it has been decided not to electrically light the important thoroughfares of the town at present. Progress is also being made at the generating station in Crellin-street, the boilers now being in course of construction.

Agency.—The Stewart Electrical Syndicate have made arrangements with Mr. J. E. Bunce, of Messrs. Bunce Bros. and Co., Saville Park street, Halifax, to represent them generally for all their electrical specialities. This in no way alters existing arrangements with Mr. S. Jevons, The Minories, Birmingham, who is still sole agent for the sale of "Stewart" enclosed arc lamps within the counties of Stafford, Warwick, and Worcester.

Southsea.—A contemporary states that some time ago complaint was made by the Government authorities that the electric light cables along the esplanade at Southsea seriously interfered with the working of the service telephones in that neighbourhood, and it was feared that considerable alterations would have to be made in the system of lighting. It transpires, however, after a long delay, that a Government expert has reported that the fault rests with the telephones and not the electric light apparatus.

Wolstanton.—The following resolution was passed at a recent meeting of the Rural District Council: "That this Council consent to the application of the Burslem Town Council for a provisional order empowering them to supply electricity within the parish of Wolstanton subject to a clause or clauses being inserted giving power to this Council or the Wolstanton Parish Council to terminate the arrangement at any time they think fit to do so on giving reasonable notice, and purchasing the plant and apparatus on equitable terms."

Drumcondra.—On Monday morning a special meeting of the Drumcondra Commissioners was held to consider the action of the tramway company in commencing works in connection with the electrical equipment of their lines in the township without giving sufficient notice to the Commissioners. A resolution was carried calling on the company not to carry out any other work in such electrical equipment after the laying of the cable conduits had been completed until all the requirements of the Dublin United Tramway Company's Act had been complied with.

Leith.—On the 24th ult., Bailie Manclark, convener of the Electric Lighting Committee of Leith Town Council, laid the last brick on the top of the chimney of the electric lighting station, which is now nearing completion. The chimney is 135ft. in height, 18ft. in diameter at the bottom, and 12ft. at the top. Addressing several members of the Corporation and officials who were present at the ceremony, he said they already had 33 applications for the electric light, and had made 22 connections, besides having erected 30 street lamps. The work was going on very expeditiously.

Brush Electrical Engineering Company, Limited. — The directors have decided, after placing £5,000 to reserve and £1,000 to a Workmen's Compensation Act fund, to recommend payment of a dividend to the preference shareholders at the rate of 6 per cent. per annum for the half-year ended June 30, 1898 (making the full dividend of 6 per cent. on the preference shares for the year), and a dividend at the rate of 3 per cent. on the ordinary shares for the year, leaving a sum of about £3,000 to be carried forward to next account. The share transfer-books of the Company are closed to Sept. 13 next.

Ashton.—The town clerk has been instructed to write to the neighbouring local authorities enquiring whether, in the event of the Corporation promoting a Bill in Parliament authorising them to take a lease of electric lighting, etc., powers outside the borough, the outside authorities would be willing at the same time to apply for provisional orders under the Electric Lighting Acts. The Corporation have also resolved to ask, on the necessary powers being obtained, whether such authorities would be prepared to enter into an arrangement for the former to supply electrical energy in their districts, either to the authorities wholesale or to consumers direct.

Bristol.—The demand for the electric lighting supplied by the Corporation is increasing, and it is stated that applications come not only from within the area of the recently enlarged city, but also from over the borders, in districts which successfully opposed their inclusion in the Greater Bristol. In Clifton mains are being laid for supplying private residents, who have made applications in large numbers. The tramways company has asked for permission to make an extra line and crossing for the purpose of entering an extended depôt at Horfield. Members of the Sanitary Committee at its meeting raised objections on the matter of the paving between the lines, and eventually it was agreed to request the company to submit all their proposals at once.

Staines.—The Highways Committee reported to the last Council meeting that they had further considered the notice given by the Electrical Power Distribution Company of its intention to apply for a provisional order for the supply of electrical energy in the district, together with a letter from the company suggesting a discussion of the terms on which the Council would co-operate in obtaining the order, and an arrangement under which the Council might at stated periods acquire that portion of the undertaking which was within its area. The committee, however, recommended the Council to oppose the application on the ground that any provisional order for supplying the district should be applied for by the Council. The recommendation was agreed to.

Tunbridge Wells.—On Friday last the Mayor switched on the electric light in Mount Ephraim. The general effect of the light is fine. There are 10 handsome and lofty pillar lights on each side of the promenade alternately, and 20 lesser lamps, half as high, on the same pillar posts. It is said that the lights on Mount Ephraim can be seen distinctly as far into East Sussex as Crowborough Beacon one way, and Frant village by way of the forest. The Tunbridge Wells Farmers' Club have passed a resolution in favour of a municipal telephone system. It is thought that direct communication by wire between the urban and rural districts would confer a great boon on the farmers and hopgrowers in outlying districts, where at present there is only one postal delivery each day.

Sunderland.—Early in the present year the Council sent a deputation abroad to glean information respecting electric traction. Though we have not seen any report from the deputation in question, we learn that Mr. Snell, the borough electrical engineer, has reported, and that he is strongly in favour of the overhead trolley system. After enumerating reasons for this system familiar to our readers, Mr. Snell says the Corporation have their own electric lighting station, and it must be borne in mind that the same station, with certain additions of plant, will serve both for lighting and traction, reducing the cost of management and wages and materially helping in the reduction of the general engineering cost of both concerns; and the combination of the two systems will materially increase the prosperity of not only the tramways scheme, but also the electric light undertaking. At present the tramways are worked by a company by means of horse power.

Colchester.—The laying of the cables for the electric light has been commenced, and is proceeding very rapidly. The contractors laying the cables are Messrs. Siemens Bros., London, and the work is being done under the superintendence of Mr. E Stanley Franklin, engineer, who represents the firm; but the opening and closing of ground and relaying of the pavements is being carried out by the borough surveyor's own staff, who are also supplying the labour for laying the cables. Although it is doubtful whether the authority will be in a position to supply current for lighting before the middle of October, it is stated that already a large number of persons have decided to take the light, and that a good many orders are in the hands of the authority and of the firms who are undertaking the wiring and fitting-up of premises. As many of our readers are aware, the central lighting station has already been erected, and two large Economic boilers (Davey, Paxman, and Co.'s) are already in position, and the engines will shortly be fixed. Thirty-four drums of cable, each drum weighing two tons, are being used, making a total of 68 tons.

Aron Electricity Meter, Limited.—This Company has been registered, with a capital of £250,000 in £1 shares, to acquire and take over as a going concern and to further develop the business of electric meter and clock manufacturers now carried on by Dr. H. Aron in Berlin, Vienna, Paris, and London, together with the patent and other rights in connection therewith, and, with a view to the above object, to adopt and carry into effect an agreement expressed to be made between Dr. H. Aron of the one part and this Company of the other part; to acquire, turn to account, deal with, and work any patent, patent rights, and inventions relating to the generation, utilisation, storage, accumulation, measurement, distribution, transmission, and employment of electricity; as manufacturers of and dealers in lamps, electric switches, cut-outs, apparatus, machinery, appliances, etc., which may be considered convenient or necessary for the purposes of the Company; as metallurgical and chemical engineers, battery makers, brass, iron, and other metal founders, forgers and workers, smiths, carpenters, builders and contractors, manufacturers of cables, wires, lines, plant, etc.

Tees-Side Tramways.—A correspondent to the *Newcastle Daily Chronicle* writes that since the opening of the line on July 16 over

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a million and a quarter passengers have been carried, and the system has achieved a success unforeseen by the most optimistic. Already the directors, because of the instantaneous success, have decided to extend the line to Eaglescliffe on the Stockton side and to Grangetown on the Middlesbrough side, it being eventually proposed to carry the system down to Redcar from Grangetown and to Darlington on the other hand from Eaglescliffe. The length of the system from Norton to North Ormesby is 6½ miles, and the charge for this is only threepence, the cars being run every five minutes. Starting yesterday, workmen's trams are to be run over the whole of the system at the charge of one penny. The overhead construction, about which so much popular prejudice exists, has been of the most satisfactory nature. Altogether, the correspondent concludes, the inhabitants of Tees-Side have nothing but praise to give to their new system, and their hope is that their neighbours on Tyne and Wearside may be equally well provided for in the matter of smart and luxurious locomotion.

Dewsbury.—We hear that the Corporation have instructed their electrical engineer to prepare plans for a local electric traction scheme. A local paper states that, "Not only in Dewsbury, but in the surrounding districts, the electric tramways' question is still being freely discussed. Great interest is taken in the matter, and it is probable that ere long electric cars will be running from Dewsbury to Heckmondwike, Ravensthorpe, Thornhill, and other places. Whether the British Electric Traction Company—who have given notice to several of the local authorities of their intention to apply for powers to construct lines—will be allowed to come into the district seems uncertain." A representative of the same paper has interviewed several councillors, and has elicited varied opinions on the utility of a combined or a local scheme.—Tenders will shortly be invited for the extension of the Corporation's electric lighting cables from the top of Carlton-road to Oxford-road and West Park-street. Arrangements are being made for having the extension carried out as early as possible, so as to get the scheme completed before winter. To serve the district mentioned it will be necessary to lay about six miles of feeders and distributing wires.

Sheffield.—Progress is being made with the laying of the tramlines on Sheffield Moor, and on Saturday this thoroughfare was thrown open to traffic as far down as Jessop-street and Prince-street. It is anticipated that in a day or two the whole length of the Moor down to near Ellin-street will be free for the passage of vehicular traffic. From the bottom of Cemetery-road to the terminus the rails on the Nether Edge route—the first section taken in hand—have long been relaid. The pipes for the electric cables have yet to be laid underneath the footpath, but this will not occupy much time. The side standards are being erected. The work on the Walkley section, in the neighbourhood of Winter-street and Crookes Valley-road, is being pushed on, and is now progressing up Barber-road beyond Crookesmoor-road. The granite setts, which will run along each side of the tramrails, have been laid, and the remaining portion of the work is being dealt with. A start has been made in West-street, near the top of Broomhall-street. A length of rails is in position, and this week the wood paving has been begun. Another portion of this route is now being dealt with—namely, in Church-street. A cable trench has been got out opposite the parish churchyard, and the wood paving will be taken in hand at once, beginning from the end of the junction laid at the top of High-street some time ago, and working up Bow-street, West-street, Glossop-road, to the bottom of Hounsfield-road, where the laying of the rails and the paving of the roadway has been completed. On the Attercliffe section, the relaying of the rails and paving of the track has been completed from near Nursery-street down to the terminus. A great deal of work remains to be done along the sides of the road, and the most urgent cases are being dealt with first. Many of the centre standards, side poles, and refuges on this section are in position.

Leeds.—The *Yorkshire Post* says: "A conference took place yesterday week between representatives of the Parliamentary Committee of the Leeds Corporation and directors of the Yorkshire House-to-House Electric Supply Company in reference to the purchase by the City Council of the undertaking of the company. There was a very long but friendly discussion, which resulted in an agreement being arrived at. This agreement will be elaborated and signed in due course. It will first provide that the capital expenditure from which the company shall benefit is to cease on Sept. 1. From that date all capital expenditure will be for and on behalf of the Corporation. The second provision is that the company shall receive all the earnings up to Sept. 30, which is the usual quarter end. This being the case, the company will only begin to receive interest on any unpaid purchase money from Oct. 1. The date definitely fixed for handing over Corporation scrip and cash to the company in payment for their concern is Nov. 15. The worth of the stores is to be ascertained by valuation, the Corporation and the company each appointing a valuer. It is further provided in the agreement that the Corporation shall take and pay for the book debts, the latter being guaranteed by the company. The Corporation will take over contracts, wayleaves, and other matters. In regard to the purchase money, the Corporation have, as is known, obtained parliamentary sanction to the issuing of 5 per cent. irredeemable stock for the amount properly expended on capital account and cash for book debts, stores, etc. We understand that at a certain stage of the proceedings the directors of the company voluntarily undertook to carry on the business for the benefit of the Corporation until Nov. 15, and the municipal representatives suggested that as this arrangement would be a great convenience the City Council should pay the usual fees to the directorate for the six weeks commencing on Oct. 1 and concluding on Nov. 15."

Kirkcaldy.—The minutes of the Joint Committee of the Town Council and the promoters of the local company on the subject of tramways and electric light, and a long letter bearing on the subject from the town clerk, have been issued to the members of the Council. The minutes contain a report from Prof. Kennedy, in which he recommends a tramway route which begins at the public park, proceeds to near the station, down Wemyssfield to High-street, thence proceeding along High-street, Nether-street, and St Clair-street to the northern end of Sinclairtown. The length of the route is three miles. The total cost, including plant, buildings, and mains required for electric lighting, he puts down at £60,000. The committee, however, after examination of the figures, are of opinion that they do not see their way to make any recommendation to the Town Council in regard to the proposed scheme. They resolved to lay before the Council an abstract of the figures that they had before them, and the clerk was instructed to prepare such an abstract, and to issue it to the Council, along with the minutes. The town clerk, in his letter to the members of Council, expressed his opinion that he would strongly recommend the Council not to take up at the present time a combined scheme of tramways and electric lighting, but to consent to private companies taking up the scheme of electric lighting and tramways. He also states that he believes an application for a combined scheme of electric lighting and tramways is incompetent. In the first place, by the rules of Parliament, powers for electric lighting can only be obtained by a provisional order under the Electric Lighting Act, and not by an Act of Parliament. In the second place, electric lighting and tramways are, by the public legislation of the country, two separate things, and a town council, as a local authority, are entitled to purchase either scheme without purchasing the other. He, however, thinks it will be necessary for the Town Council, in the case of the electric lighting, to apply for powers at once, more especially seeing that the Edmundson Company have already given the statutory notice that they intend to apply for such an order.

Light Railways.—The Board of Trade have recently confirmed six orders authorising light railways—viz. (1) Dornoch—for a line between the Mound Station on the Highland Railway and the village of Embo and the town of Dornoch; (2) Goole and Marshland—for a line from a junction with the North-Eastern Railway near Goole to Swinefleet and Adlingfleet; (3) Isle of Thanet—for lines from Ramsgate through Broadstairs to Margate; (4) North Sunderland—for an extension of an existing line in the parishes of North Sunderland and Shoreston, and the working of the original line as a light railway; (5) Vale of Rheidol—for an extension from Aberystwyth to Aberayron of an authorised railway; (6) West Hartlepool—for an extension line to Seaton Carew.—The Local Government Board enquiry relative to the proposed light railway from Bridlington to Flamborough will be held in the Victoria Rooms, Bridlington, on Sept. 17.—The Broughty Ferry Commission met again on the 25th ult. to consider as to the proposed light railway. The Commission agreed, subject to a satisfactory arrangement of details, to approve in principle of the construction of a light railway between Dundee and Barnhill.—In connection with the proposed Selby and Stamford Bridge light railway, the Escrick and Riccall Rural District Council have appointed representatives to serve upon a Statutory Joint Committee under the Light Railways Act, 1896, and this committee held their first meeting on Friday last. The matter was fully discussed, and especially with reference to the application to be made to the Light Railway Commissioners for an order authorising the railway. A sub-committee was appointed to engage an engineer and surveyor, and to go over and fix upon the route of the line. This will be proceeded with at once.—Messrs. Webb and Co., solicitors and parliamentary agents to the Isle of Thanet Light Railways (Electric) have informed the Broadstairs and St. Peter's District Council that the order authorising the construction of the line had received the confirmation of the Board of Trade.—The Southall Norwood District Council object to the draft order for the proposed light railway through their district on account of their wishes being ignored in certain particulars.

PROVISIONAL PATENTS, 1898.

AUGUST 22.

18024. Improvements in or relating to electric alarms or call boards and the like. Albert Edward Drew, 8, Quality-court, Chancery-lane, London.

18028. An improvement in the construction of electrical bridge fuses. Arthur Wellington Sowry, 2, Hafer-road, Clapham Junction, London.

18051. An electric fuse. Joseph Gershom Childs, 33, Myddleton-square, Clerkenwell, London.

18057. Improvements in or relating to electric lamps. Leo Horwitz, 111, Hatton-garden, London.

AUGUST 23.

18087. An apparatus for automatically starting and stopping electromotors pumping water into storage tanks without any personal attendance whatever. John Harding and John Williams Milner, Walton, near Stone, Staffs.

18090. Improvements in tubular conduits for electric wiring. Thomas Taylor, 12, Cherry-street, Birmingham.

18101. Improvement in dynamo electric machines. William Turvey, 4, Aubrey-walk, Campden Hill-road, London.

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18093. Improvements in dynamo-electric machines and motors. Thomas Preece and John Alfred Edmondson, Globe Electrical Works, Kirstall-road, Leeds.

18119. Improvements in electric switches. Joseph Foxcroft and Woolmore James Victor Duncan, 24, Queen's-road, Dalston, London.

18137. Improvements in contact apparatus for electric railways with underground current feed and partial conductors. Carl Friedrich Philipp Stendebach, 18, Buckingham-street, Strand, London. (Complete specification.)

18156 Improvements in the manufacture of electrical resistances. Adolf Vogt, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18165. Improvements in or relating to electric signalling or indicating apparatus. Alfred Julius Boult, 111, Hatton-garden, London. (Victor Julien Busson and Eugene François Busson, France.) (Complete specification.)

AUGUST 24.

18172. Improvements in continuous-current electric motors or generators of iron-clad or enclosed type. Herbert William Wilson, The Grange, Wendling, East Dereham, Norfolk.

18213. Improvements in electric motors and in their application to motor carriages. The Britannia Motor Carriage Company, Limited, and John Smith, 77, Chancery lane, London.

18231. Electrical heating appliances formed of artificial stone. Josef Franz Bachmann, Adolf Vogt, Carl Camille Weiner, Albert König, Josef Kirchner, and Alexander Jörg, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18232. Electrical resistances of artificial stone composition. Josef Franz Bachmann, Adolf Vogt, Carl Camille Weiner, Albert König, Josef Kirchner, and Alexander Jörg, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 25.

18241. Improved secondary battery. Richard Norman Lucas and Ernest Sandford, New Spring Cottages, Byfleet.

18261. Improvements in relays for use on telegraph cable and other lines. Sidney George Brown, 9, Queen's-road, Bournemouth.

18272. Improvements in apparatus for the measurement of alternating currents. George Keith Buller Elphinstone and Arthur Cecil Heap, 101, St. Martin's-lane, London.

AUGUST 26.

18309. Improvements in or relating to hammers or tappers actuated electrically. Charles Turnbull, jun., Hylton Lodge, North Shields.

18353. Improvements in connection with electric lamp and like apparatus for signalling, advertising, and similar purposes. Cornelius Edward Kelway, 111, Southwark Bridge-road, London.

18366. Improvements relating to the regulation of electromotive force. Norman Rowe, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Section 103, Jan. 27, 1898, being date of application in United States.)

18369. An improved form of electric glow lamp for general lighting purposes. Thomas Edwin Andrews, 11, Burlington-chambers, New-street, Birmingham.

AUGUST 27.

18396. An improvement in lampholders for electric light incandescent lamps. Samuel Edward Foster, 21, Bull-street, Harborne, Birmingham.

SPECIFICATIONS PUBLISHED.

1897.

17676. Coin-freed electricity meters. Emmott.

17826. Electric lanterns. Prasse.

19573. Means for supplying current to electric tramcars. Sowden.

20317. Dynamo electric machinery. Rosenqvist.

22633. Electrical connecting boards. Whalley.

30205. Coin controlled mechanism for electric meters. Browne.

1898.

4409. Third rail underground electric railway system. Wheatley. (Walkens and Jewett.)

8301. Construction of Morse's registering telegraphic instruments. Ducretet.

9779. Testing and protecting apparatus used in conjunction with telephone, telegraph, or other electrical circuits. Sinclair and Aitken.

10599. Electrical devices for igniting liquid burners. The Reform Petroleum Beleuchtung Gesellschaft M.B. Haftung and Weinhagen.

11440. Dynamos. Unterberg.

13477. Commutator brush-holders and brushes for electric motors or dynamo electric machines. Johnson and Lundell.

13709. Electric propulsion of railway trains. Kaselowsky.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns week ending.	1898.	1897.	Increase or decrease.	Total receipts since July 1. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway Company, Limited	Aug. 27	3,811	3,584	+ 227	—	—
Bristol Tramways and Carriage Company, Limited	,, 26	3,171	2,661	+ 510	—	—
City and South London Railway	,, 28	866	838	+ 28	8,696	8,153
Dover Tramways	,, 27	278	—	—	5,072	—
Dublin S.D. Electric Tramways Company	,, 26	1,306	986	+ 320	9,245	7,056
Liverpool Overhead Railway Company	,, 28	1,661	1,535	+ 126	—	—
South Staffordshire Tramways Company	,, 26	700	695	+ 5	21,289*	21,527*

* Receipts since Jan. 1.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	13-14
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9½-10½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (issued at £2. 10s. premium, all paid)	10	13-14
Brush Company, Ordinary	2	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9½-10½
——	6	5½ 6½
—— Pref. Half-Shares	1	1½-1⅝
—— ,, ,,	5	4¼-4¾
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24½-25½
—— 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	2⅞-3¼
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½ 15½
—— ,, ,, ,, '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— ,, ,, ,,	6	8½-9½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	1⅞ 2¼
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2¼-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ordinary Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2¼-2½
—— 7 per cent. Cumulative Pref.	2	2⅞-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅜-½
Elmore's Wire Company	2	¼-⅜
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½ xd
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½ xd
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5¼-5½
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	7¼ 7⅞
—— £4½ shares	4	6½-6¾
Royal Electrical Company of Montreal	1½	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	3-3½
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	125-131
Westminster Electric Supply, Ordinary	5	16-17 xd

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NOTES.

Central London Railway.—The excavations on this line are now almost finished, and it is possible to walk through one tunnel from the Bank of England to Shepherd's Bush.

Electric Mail Carts.—The engineering department of the General Post Office is reported to be considering a number of tenders for the supply of electric motorcarts to be used in the postal service.

Paris-Berlin.—According to the *Moniteur Industriel*, these two capitals are to be connected telephonically *vid* Brussels. The circuit will be a metallic one throughout of phosphor-bronze, the wire having a diameter of 5mm. The total length of the line is over 1,000km.

Church Lighting.—The fine church of St. Andrew, at Leytonstone, which was designed by Sir Arthur Bloomfield, is now lighted by electricity. The arrangements and fittings have been well designed to match the Gothic structure, the beauty of which is enhanced by the new means of lighting.

Electric Lighting of Trains.—We note from the report of the Waterford and Limerick Railway Company that the electric lighting of the railway carriages on the company's lines is being extended. Nine new carriages have been fitted up during the year, much to the satisfaction of the travellers on the line.

Electricians.—What constitutes the claim to the title "Electrician"? Whatever the answer may be, the self-styled or properly-styled electrician is having a rough time of it lately. The daily papers chronicle one shot at one place by roughs, another injured and sent to the hospital in another place, a third assaulted, and so on, till, as we say, the "Electricians" seem to be having a bad time. Really there is little kudos in being styled an electrician when a wire-stretcher or a cable-layer is included in that category.

Waterloo and City Railway.—We understand that during the week following the date of the opening nearly 100,000 passengers were carried. A number of these made the journey out of curiosity, and owing to this fact, and also to the holiday season, which greatly affects the suburbs the line mainly serves, the returns for the last fortnight show a falling off. Still, the traffic is equal to the most sanguine expectations, and those best competent to give an opinion express confidence that these early records will be beaten before long.

Tramways in Paris.—Paris is affording an example of the great development in tramways. The city is already well served with omnibuses, and has tramways driven by steam, electricity, cable, and horse traction. The Conseil General of the department has just sanctioned schemes for three dozen new lines, providing better communication between the centre of the city and the suburbs. The cars will be run by mechanical power, and will pass through some of the finest boulevards and most crowded streets. The Opera, for instance, will be the terminus of three lines coming from Villemonble, Noisy-le-Sec, and Raincy. Others will terminate before the Palais Bourbon, and three will end in the magnificent Place de la Concorde.

Durham College.—We have received the calendar of the Durham College of Science for the ensuing session. It is becoming a bulkier volume with each issue, containing full information as to the work of the college, with a complete set of examination papers. Naturally we turn to the examination papers in electrical subjects, and find them far better than is usually the case. Many examiners ignore the syllabus given to guide the student, air crotchets of their own, and set questions to find out what the candidate does not know rather than to find out how much he knows. We should be glad to see the example set by the examiners at Durham College more widely followed, and then there would be fewer growls at examination papers.

Paris, 1900.—It is early, but not too early, to express the hope that suitable arrangements may be made for photographing exhibits at the exhibition. Those who have to describe exhibits know that outside of America there has never been a satisfactory arrangement. In many instances, as at the Crystal Palace, if a photograph is wanted you must obtain it through a certain firm, and must not take a negative for yourself. Such a system is "idiotic, and largely prevents" really good descriptions. Again, the exhibitor, who is usually ready to supply photographs, has them taken for a particular object, and his object is not always that of the technical expert. We think that under certain regulations technical papers should be permitted to obtain their own photographs.

The General Electric Company of America.—This large manufacturing and financing concern does an enormous business, but has not been able for years past to make money for its shareholders. Hence the conclusion arose that the business was over-capitalised, and by a special resolution the capital has been reduced from £6,092,000 to £4,165,400. There is no doubt that the company originally valued its patent rights too highly, and that the smaller sum more nearly represents the value of the undertaking. Even at this value no figures are published to show that dividends can be paid, but the officers of the company say that this is the case. It is a pity that such large ventures should not be run, at least to some extent, in the interests of those who have found the money to start them.

Opening of the Schools.—The meeting of the British Association is always a warning that the long vacation is nearing its close and that a new session of the schools is about to begin. Even if there were no British Association the syllabuses which arrive at this time of the year would give ample warning. We have received such *brochures* from King's College, the City of London College, the City Polytechnic, etc., showing that the student desirous of assistance from competent teachers need not seek long or far. All classes of students can be accommodated, whether they desire day or evening instruction. One thing we would emphasise: do not attempt too much; better study one subject thoroughly than ten superficially. It does not pay to be superficial nowadays. There is plenty of room for men, only the room is at the top, and those who get there must be thorough.

The Baker-street and Waterloo Railway.—Preparation for work on this railway, which is to be worked electrically, is being rapidly pushed forward by the contractors, Messrs. Perry and Co. The large staging in the Thames by the side of the South-Eastern Railway Bridge at Charing Cross is now approaching completion. The line when completed will be three miles and one furlong in length, and will connect the station at Baker-street with the Waterloo station. The route will be as follows: from under the Thames near the above bridge, up Northumberland-avenue to Trafalgar-square, Haymarket, Piccadilly-circus, Regent-street, Great Portland-street, to Baker-street. Stations will provide connections with the Metropolitan and District Railway at Charing Cross and Baker-street, and with the Central London Railway at Oxford-circus. The Great Central Railway will also be connected at Baker-street.

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The engineers for the line are Sir Benjamin Baker and Messrs. Galbraith and Church.

Non-Transferable Transfers.—In the States through fares are arranged to take a passenger over different companies' tramlines. These are accompanied by transfer tickets at the junctions between any two lines, but the tickets are only supposed to be used by the person to whom they are issued. Several roads have, says the *Electrical Engineer* of New York, adopted illustrated transfer tickets for passengers, using several styles of bearded faces for the men, and elderly and young faces for the ladies. The conductors must do their duty, and on several occasions have "punched" the "face" on an elderly female ticket when the fair passengers laid claim to being classed among the young women. In some instances they have thrown away the transfer and paid another full fare rather than suffer the humiliation of being put in the wrong class. The conductors claim that they are doing the very best they can. The question will require some thought before being settled to the satisfaction of both the passenger and the conductor.

Telephony in Sweden.—We venture to say that all the talk and all the writing of the experts who have told us about telephony in Sweden has made very little impression upon the ordinary Britisher's mind. It requires a visit to Sweden in order to understand the manner in which telephony has been utilised in that happy telephonic country. The means of conversation is everywhere, and is used by everybody. In country districts as well as in the larger towns the ubiquitous wire places everybody in communication with everybody else. There are several reasons for this state of things. In the first place education is more general than with us. In the next place, the Swedes are a practical business people, and the Government realises the value of all aids to business men, and thus provides a good service at an extremely moderate cost. Our good friend, Mr. A. R. Bennett, has again and again emphasised these facts, but Englishmen are a conservative crew and only a boulder of dynamite will move them to express speed.

The Late Dr. John Hopkinson.—At a special meeting of the council of the Institution of Electrical Engineers, held Aug. 31, the following resolution was passed unanimously: "That the council of the Institution of Electrical Engineers do hereby place on record this expression of their sincere sorrow and deep regret for the great and irreparable loss sustained by the Institution through the untimely and calamitous death of Dr. John Hopkinson, F.R.S., past-president of the Institution of Electrical Engineers, major commanding the corps of Electrical Engineers, Royal Engineers (Volunteers), and professor of electrical engineering in King's College, London." It was further decided that, subject to it being consonant with the wishes of the family, the members of the council should attend the funeral as representatives of the Institution. Owing to the sudden alteration in the arrangements for the interment, however, it was impossible for them to carry out their intention, but Prof. Ewing, member of council, who was in Switzerland at the time, was accessible by telegraph, and was therefore able officially to represent the Institution, and in its name to lay a wreath of flowers upon the grave of his former colleague.

Electric Distribution of Power.—The question of how far it is economical to put a motor to each machine tool in a workshop has to be decided on local circumstances. The comparatively low efficiency of small motors makes it advisable as a rule to group the smaller tools on to a short length of counter-shafting, driven by, say, a 1 h.p. or 2 h.p. motor. The extreme sub-division of one motor to each driving head may at times be advisable, and a case in point is described by our namesake of New York. This is at the factory of the American Electric Telephone Company, where many small coils have to be wound by very fine wire. In this case a small motor is used for each operation, and the cores of the coils are held on extensions of the motor shafts. Extreme variability of speed is thus obtained by rheostats. This is a good example of the extremes to which the subdivision of electric motive power in shop transmission is being carried in these days, and shows that mere economy of power is by no means the only object to be gained by electric shop transmission in many cases. Convenience of location, utilisation of waste room, and perfection of individual machine control may be far more important factors in the output of a factory, shop, or printing office than simple cost of power alone.

Para Rubber.—The report of the British Consul at Para on the trade of the Amazon contains many references to the rubber industry. The report gives a full account of the growth of the rubber industry, the mode in which it is now carried on, and the varieties of the plants producing elastic gum. The supply is regarded by competent authorities as inexhaustible, as the "hevea" is being continually reproduced by nature. Some areas, such as Cameta, on the Tocantins, have become exhausted, but when abandoned for a time they recover, and many districts have not been tapped at all. The area producing Para rubber amounts to a million square miles, and further exploration will probably show that this is under-estimated. The richest zones at present known are along the banks of the southern tributaries of the Amazon, and on the islands in the main stream. Some of the northern tributaries have not been explored. The great demand for rubber and the ever-increasing prices offered for it have had the natural result of attracting the bulk of the people to this remunerative industry. There are many thousands of collectors, but the number is not nearly sufficient. Still, we fancy that the profession of rubber collecting on the Amazon is not one at which an English lad is likely to gain much beyond a tombstone.

A New Use for Electric Heat.—The boring of the tunnel for the Jungfrau railroad, in Switzerland, has been progressing steadily in spite of the severe climate of the high Alps in winter, and as electricity is used not only for light and motive power, but for heating as well, where this is necessary, some new developments in the heating line have been worked out with great success. One of them is, says the *Electrical World*, the warming of high explosives. On this work blasting gelatine is used, an explosive which freezes at about 40deg. F., and which is, in its frozen condition, very dangerous to handle, being unlike dynamite in this respect. The contractors who are blasting out the Jungfrau tunnel keep their explosive in a sort of safe heated by electricity, so that the danger of the gelatine freezing is entirely obviated. Dynamite or some other derivative of nitroglycerine is in very common use for blasting and other purposes, and is commonly frozen for safety, as this explosive is very inert at low temperatures, It is usual to thaw it out before it is used, and scarcely a week passes that the newspapers do not chronicle an accident from carelessness in the use of heat for this purpose. A dynamite thawer operated by electricity would be safe and perfectly regulable, as well as very convenient in use, and some manufacturers of electric heaters might find it worth while to investigate the needs of those using the explosive.

The "Lancet's" Students' Number.—The appearance of this issue of the *Lancet* is a sign that the autumn is with us, and that the courses of study at all teaching institutions will shortly be resumed. The information given in this number about means of preparing for the professions

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of a doctor or surgeon is invaluable, as is also the leader giving friendly advice to young men commencing to study for their professional careers. In it attention is drawn to the fact that the value of practical work is incalculable. Reading should supplement it and never be substituted for it. Anatomy can only be learned in the dissecting-room and not from books and plates; diseases, medical and surgical, can only be thoroughly studied by the bedside; and a knowledge of pathology and of the newly-introduced science, bacteriology, can be only attained in the post-mortem room and in the laboratory. Such instances can be multiplied to any extent, but we need only refer to the development of the tendency to go to text-books rather than reality for information to show how unfortunate such a spirit is to its possessor. The same applies to all professions, and in our's especially the practice of observation first-hand cannot be dispensed with if good results are to be attained. The other point insisted on is the need of physical recreation, which in the rush to get knowledge is apt to be neglected. Students are urged to avail themselves of the various athletic clubs attached to the hospitals and colleges.

Water-Power Plant in Drought.—It seems from the *Western Electrician* that the San Joaquin Electric Company depends solely on water power for driving its machinery, and that this year has had trouble in consequence of want of storage. A Mr. Eastwood's communication upon the failure of the water supply shows the necessity of engineers making careful and thorough examinations of the records of the section of the country upon which dependence is to be placed for water. Mr. Eastwood says that "the condition that prevails in the present season occurs in California about once in 30 years, the present season being the shortest in precipitation since 1864." In spite of this knowledge, the company was found unprepared. The fact that other companies are experiencing the same trouble does not help those depending upon San Joaquin for power. Thus the city of Sacramento has also been suffering from lack of power, due to shortage of water. Electric current for the cars and lights of the city is generated on the American River at Folsom, but the water became so low that the Folsom power-house had to shut down. The Sacramento Electric, Gas, and Railway Company, which owns the plant, at once took steps to run the plant with steam power generated in Sacramento. Power is furnished to manufacturers from the Folsom plant, and the shortage has consequently affected these industries quite seriously. It is feared that this condition will prevail until the winter rains relieve the situation. These failures show the wisdom of the British Aluminium Company in providing the water storage they have done at their works at Foyers.

Electricity in Turkey.—The current report that electric lighting in Turkey was being kept back because of the similarity between the words "dynamo" and "dynamite," can hardly be further believed after the following news contributed to the *Financial News* by its special correspondent: "The presence of Sir Ellis Ashmead-Bartlett in Constantinople is said to be due less to political considerations than to business motives. It is well known that he is representing a British syndicate anxious to obtain concessions of the most varied character. As the sympathies of officials in the highest ranks here are pro-German, Sir Ellis was advised to make a journey to Germany and place himself in communication with certain firms at Nuremberg. He is understood to have done so; but the negotiations entered upon were fruitless. From Nuremberg he proceeded to London, and thence returned to Constantinople. Of all the numerous requests preferred, only one has been taken into consideration, and an iradé of the Sultan now orders the competent authorities to receive a proposal for the establishment of electric lighting works at Salonica. This departure is considered very important—in principle, at any rate—as hitherto it has been contrary to the Sultan's wish that any demand for electric concessions should be entertained. Such requests have formerly failed even to elicit the courtesy of a reply. Even the introduction of appliances used in the manufacture of electric light was strictly vetoed. Should the English syndicate in this instance be successful, a large field will at once be opened to electrical enterprise, which has been hitherto discouraged and tabooed, presumably for religious reasons."

Throat Cutting.—Our contemporary the *Western Electrician* has the following, which will recall many instances of competitive suicide on this side. The Detroit correspondent of the *Western Electrician* sends the following account of a transaction in that city: "The General Electric Company and the Adams-Bagnall Electric Company have a warm fight on in this city to see which firm will have the honour of furnishing the city 100 arc lights. At the last meeting of the Public Lighting Commission bids were opened from these two companies. The General Electric Company offered the lamps at 20dol. each, and the Adams-Bagnall Electric Company made a bid of 17·25dol. The bids were referred to City Electrician Steele for a report on the relative value of the lamps, and at the meeting of the Commission on Monday night (Aug. 15) Mr. Steele submitted his report, stating that the two lamps were of equal value. In the meantime the bids had been published in the local papers, and each company saw what the other had bid. The agent of the Adams-Bagnall Company made no attempt to do anything further about it, but J. H. Livsey, representing the General Electric Company, appeared at the meeting and offered his lamps at 25 cents per lamp cheaper than the bid of the other company. The commission would not accept this, but offered to reject the former bids and advertise for new ones, provided his offer of 17dol. per lamp held good if the new bids were rejected. This offer was accepted, and new bids for the lamps will be advertised. Mr. Livsey states that all the lamps in the city at present were furnished by his company, and he wanted to secure the contract on account of the advertisement it would prove for the company. He asked that his offer be suppressed in his daily newspapers, but the Commissioners would not assent to his request."

Parallel Running of Alternators.—The following is from an abstract appearing in the *Electrical World* of a discussion on parallel running which was held at Ohio recently: The conditions of parallel running of alternators are, briefly, to have uniform speed of the driving power, and to adjust the speeds of the alternators which are to run in multiple so that they run at the same rate. Alternators capable of absorbing approximately the full capacity of their driving powers, and operated from independent prime movers, are most readily run in multiple. Thus, for instance, two alternators, each of which is belted to a steam-engine of its own size, present an easy problem, and can most readily be run in parallel, at least if the engines are of the cross-compound type and the belts are reasonably good. Such alternators can be thrown in parallel, even should the speed not be exactly the same, but with the phasing lamps flickering at the rate of, say, one pulsation in two seconds. Alternators driven from the same countershafting offer a somewhat more difficult problem, and in such a case it is necessary that their speeds should be closer when thrown in multiple, therefore great care has to be taken that the pulleys are

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of exactly the same size and the belts running smoothly. A flickering of phase lamps corresponding to a period of, say, five seconds at least should be obtained before attempting parallel running. Alternators driven from independent countershafts, which are supplied with much more available power than the alternators can absorb, offer an exceedingly difficult problem in parallel operation. This is particularly the case if the two countershafts are not interconnected by a large belt; thus, briefly, the ease with which alternators can be thrown in multiple depends not so much on the alternators themselves, but upon the condition of the driving power.

American Duties on Arc Lamp Carbons.—There has been some trouble recently over the import duty on arc lamp carbons in the United States. According to the Tariff Act of July 24, 1897, imported carbons were chargeable with duty at the rate of 3s. 9d. per hundred. Prior to the above date carbons were commonly imported in lengths of from 4½in. to 14in., and occasionally as long as 16in. and even 20in. No sooner had the Act of July 24, 1897, become a law, however, than foreign manufacturers began turning out carbons in lengths of 24in., 29in., and 36in. each, with the evident intention of getting around the Tariff Act then in force. By cutting these sticks into proper lengths the importer would be getting practically two to three hundred carbons while only paying the tariff on one hundred. With a view to preventing this apparent evasion of the Tariff Act, the Treasury Department on Oct. 27, 1897, issued instructions to the collector to charge as though every 12in., or part of 12in., was a complete carbon. Thus the collector divided the carbons into lengths of 12in. each, and assessed each of the fractional parts thereof as a separate carbon suitable for electric lighting at the rate of 3s. 9d. per hundred. This was not accepted by the importers, who denied that the question of length could be considered under the Act. Judge Somerville supports this view, and says that goods must be assessed for duty as they are and not as the collector may fix them up by some mental process, otherwise there would be no certainty in any tariff law, therefore he held it was illegal to assess the duty at the rate of 3s. 9d. for every 12in. Still, the duty authorities were not to be beaten, and they have decided that rods of carbon a yard long are not arc lamp carbons, but that they come under another paragraph in the Act which puts a 35 per cent. duty on "articles composed of carbon." This partial victory is threatened to be extended by a revision of the Act.

Long-Distance Transmission of Power.—Mr. E. J. Berg read a paper on this subject before the Ohio Electric Light Association last month, in which he gave some useful conclusions and some which we feel inclined to traverse. Thus, the author rightly pointed out the advantages of low frequencies where alternators have to be worked in parallel and the various advantages in respect to line induction and copper resistance when moderate frequencies are used. In spite of all his own arguments, Mr. Berg favours the 125 cycles per second in ordinary cases, although he says 60 cycles may be preferable if motors have to be supplied. Another point is that the author does not favour the multiphase system. This, we gather, is due to difficulties in distribution, but the argument, which reads as follows, is not very clear: "From the nature of things it is evident that the system must be divided when laid out multiphase, therefore when alternating current is used single phase should be adopted. Against this argument it is often stated that in a territory where the load is scattered greatly a secondary network cannot well be laid out, but each customer, or each set of customers, has to be supplied from his own transformer, in which case the distribution is single phase, regardless of whether the system is single phase or multiphase. If a multiphase system is used, single-phase mains are brought over to the individual customer or groups of customers. This arrangement may look feasible on paper, particularly so if no investigations are made to determine the regulation in these single-phase mains. By a few calculations, however, it is readily found that, although apparently everything is nicely balanced, such system is very often much unbalanced and consequently perfectly unsuited for its purpose." The author should consider what would happen if the multiphase system was distributed in such a way as is often done in Germany. There one consumer does not upset the pressure supplied to the rest.

X-Rays and the Luminosity of Gases.—Mr. A. de Hemptinne's paper in the *Zeit. Physikal. Chem.* on "The Influence of X-Rays on the Luminosity of Gases," is abstracted as follows from the *Journal* of the English Chemical Society: When a tube containing gas, at low pressure, is exposed to electrical oscillations, it becomes luminous when the pressure is reduced sufficiently, but if exposed also to the influence of X-rays the pressure at which luminosity occurs is increased. This effect of the rays was examined quantitatively, and the subjoined table gives the pressure at which the gas becomes luminous (I.) by the oscillations alone, (II.) by the simultaneous action of X-rays; (III.) gives the percentage increase of pressure.

	Molecular weight.	I.	II.	III.
Hydrogen	2	... 71 mm.	... 94 mm.	... 32·4
Oxygen	32	... 51 „	... 68 „	... 33·3
Methylic alcohol	32	... 17·5 „	... 27·5 „	... 57·1
Ethylic alcohol	46	... 16·5 „	... 26 „	... 57·5
Ethylic ether ...	74	... 14 „	... 24 „	... 64·3
Chloroform	119	... 10 „	... 18 „	... 80

The influence of the X-rays increases with the molecular weight and molecular complexity of the gas. The author does not consider the effect to be due to decomposition into atoms, or ions, and advances, with reserve, the hypothesis that a certain mobility is imparted to the ether by the rays, and this causes acceleration of the intramolecular oscillations, and hence, under the influence of the electrical oscillations, causes dissociation of some molecules, and brings about a multitude of minute discharges from molecule to molecule. As the luminous gas in a vacuum tube has conducting properties, the author considers it possible that it also, like metals, would absorb the X-rays, but experiments show that this was not the case, the luminous tube being as transparent in this respect as a non-luminous tube.

Electricity in Naval Warfare.—The *New York Sun* published at the end of last month an article on the part played by electricity in the war with Spain. In it we, reading between the lines, see that the editorial staff of the paper are disappointed with the modesty of electricity. The electric gun, the electrified water, and the thousand other horrible and destructive agents devised on paper and credited to Edison and others, did not get under way. To quote literally: "Ships were to be blown up while sailing over mine fields unconnected by wires with shore batteries. They were even to photograph themselves on a chart in the shore room of an operator, who would then send a direct current to the mines through salt water. Torpedoes were to be projected through the air to drop on a ship and destroy it. Electricity was to be their propelling as well as their guiding force. Now, asks the editor, what of all this has been realised? What have we learned of mines and torpedoes? About all that is practical, as the lesson from the mines in Santiago and Guantanamo harbours, of which the one on our desk is a specimen, is that submarine mines ought to be taken up and inspected at least once a

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month to keep them efficient. Otherwise, in tropical climates at least, mines will be so injured by general fouling and the contact pins so overgrown with barnacles that the whole thing will be useless and harmless. Not a torpedo has been exploded in the course of the war, and the attempts of the Spanish torpedo-boats to get near our vessels were so quickly frustrated by the use of the searchlight that this arm of naval warfare for which so much was prophesied may be pronounced practically barren of results. It is in the operation of the searchlight, by the way, that electricity seems to have been of the greatest practical benefit. In blockading work, such as has principally occupied the American squadron off Cuba, the usefulness of the searchlight in guarding harbour entrances and sweeping the shallow inshore waters where light-draught vessels may otherwise slip by unobserved, has proved of the greatest value. When Admiral Cervera was bottled up in Santiago Harbour, the "Texas" and the "Brooklyn" or some other of the fleet kept their searchlights playing on the narrow harbour entrance every night, and it would have been an impossibility for the Spanish commander to sneak out under cover of darkness, as some of his critics have suggested he should have done."

The Snoqualmie-Seattle Tacoma Transmission. This is one of the largest transmission schemes now under construction in the States. The falls of the Snoqualmie River are about 24 miles as the crow flies east of Seattle, and 34 miles north-east of Tacoma. The falls have a drop of 268ft. Two iron pipes, 7ft. in diameter, will convey the water from above the falls to the turbines, and a shaft, 25ft. by 8ft. has been cut through the solid rock to receive these pipes. The first batch of machinery will include four 1,500-kw., 1,000-volt Westinghouse three-phase generators with a frequency of 60. They will be direct connected to water-wheels running 300 revolutions per minute. These generators are to be of the revolving armature type. The current will be conducted at 1,000 volts to the top of the shaft where the switchboard and static step-up transformer-house will be located. The full-load voltage for the transmission line will be 29,000 at the falls, and 25,000 at points of delivery. By altering the method of connecting the step-up and step-down transformers, the voltage can be reduced to 21,000 with a correspondingly greater loss in the line, but without interfering with the power consumers' voltage at Seattle and Tacoma. The company has decided on the use of aluminium wire for the transmission line, and has succeeded in making contracts for a supply of aluminium wire at prices that make it cheaper than copper for the purpose. The metal to be used is guaranteed to contain 99·30 per cent. of aluminium, and not more than 0·25 per cent. of iron and 0·30 per cent. of silicon. This will be alloyed with 1·50 per cent. of pure lake copper. About 150,000lb. of wire will be required. This is the first long-distance transmission to use aluminium, and marks an important step in electrical engineering. The pole-line is for the most part on the country roads, but in some cases a private right-of-way has been secured for a small sum. Wooden pins and cross-arms will be used. Two circuits of three No. 2 aluminium wires each will run to Seattle, and two circuits of three No. 3 aluminium wires each will run to Tacoma. Thus each pole-line will carry six wires. There will be two cross-arms on a pole and the pins will be arranged so as to bring the three wires of each circuit at the corner of an equilateral triangle. Triple-petticoated porcelain insulators, known as the Redlands type because used on the Redlands, Cal., transmission, will support the aluminium conductors. Poles will be set about 120ft. apart. The flow of the Snoqualmie River is such that 30,000 h.p. will be available at extreme low water, but a system of catching flood water might increase this many times should it ever be demanded by the needs of the two cities. About 12,000 h.p. is to be made immediately available at the falls, according to the present work being carried out.

Lightning Discharges into Electric Lines.—The following is an editorial comment on a most interesting article contributed to the *Electrical World* by Mr. C. P. Steinmetz on "The Natural Period of a Transmission Line and the Frequency of Lightning Discharges Therefrom." In this connection it might be seen at first sight as though the frequency of the lightning discharge itself would be an important factor in that it would inductively impress itself upon the line and affect particularly such parts of the line as were approximately tuned by virtue of capacity and self-induction to resonance therewith. This, however, is probably not an important consideration due to the nature of the lightning discharge and its action upon the line. Mr. Steinmetz advances the idea that the lightning discharge proper may not be as a whole oscillatory. The stroke may start as a small discharge from rain or cloud particle to particle which occurs as soon as the difference in potential between the two drops of water rises to a sufficient value to strike across the intervening air-gap, this almost infinitesimal equalisation spreading from drop to drop, in general along the path of greatest charge of potential, increasing in intensity by accumulation of the charge of successive particles or decreasing and dying out when reaching parts of the cloud having lesser electrostatic charges. Thus the lightning stroke would be made up of an infinite series of successive discharges following each other as the disturbance spreads through space, and while each of these discharges might in itself be oscillatory the stroke as a whole would not have a definite period of oscillation. This theory is borne out more or less by the photographic reproductions of lightning discharges which show numerous forks and branches deviating from the main path throughout its length, these branches being as a rule inclined so as to follow more or less closely the general direction through space of the potential gradient. The theory is also borne out, as Mr. Steinmetz states, by the fact that it would not require such an extraordinarily high potential as would be required for a single stroke across a mile or so of space. This hypothesis would not apply, however, to a stroke to ground, which might be considered the result of a gradual accumulation of small discharges until the aggregate accumulated sufficient volume to leap over the intervening space to the earth. The principal effect of a lightning discharge in any case on an overhead transmission wire is a statically inductive one, instances of an actual stroke to the wires being rare. The accumulated charge in a cloud attracts and binds to the surface of all conductors near it and connected with the ground a charge of the opposite polarity. When, however, the charge of the cloud is neutralised by a lightning discharge to a neighbouring cloud, the bound charge on the surface of the ground below is immediately released and flows off, leaving instantaneously a difference of potential of many thousands of volts between the line and the ground. This tends to discharge disruptively, and, owing to the influence of capacity and self-induction, to oscillate. The oscillations thus set up will be determined solely by the conditions of the line, so that the frequency can be correctly determined, as Mr. Steinmetz derives it, by a quantitative discussion of the electrical properties thereof. The distribution of the line capacity renders the oscillations of an exceedingly complex wave form, with a fundamental not very much higher than frequencies in commercial use and a large number of harmonics.

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THE BRITISH ASSOCIATION.

The sixty-eighth meeting of the British Association for the Advancement of Science was officially commenced at Bristol last Wednesday by the presidential address by Prof. W. Crookes, F.R.S. The well-arranged reception-rooms have, however, been open since Monday for the enrolling of members and distribution of literature. The opening of the Cabot Tower on Brandon Hill on Tuesday, to commemorate the discovery of North America in 1497, by John Cabot and a crew of Bristol sailors, may also be considered as part of the present meeting, as most of those present at the ceremony were members of the British Association.

On Thursday, the 8th, the presidential addresses were delivered in all the sections, except that dealing with anthropology, and papers were read in all sections as well. In the afternoon the Biological Exhibition at the Zoological Gardens, Clifton, was opened at 3 p.m. by Sir John Lubbock, Bart., M.P. In the evening a conversazione at Clifton College was given by the chairman of the Council (the Lord Bishop of Hereford), the Head Master, and Mrs. Glazebrook.

The programme for the remaining days is as follows:

Friday, Sept. 9.—Sectional meetings in the morning. Garden party, given by Mr. and Mrs. Frank Jolly, at Rockwell, Henbury, 3.30 to 6 p.m. Garden party, given by Mr. Lewis Fry, M.P., and Miss Fry, at Goldney House, Clifton, 3.30 to 6 p.m. Garden party, given by Mr. J. Colthurst Godwin and Miss Godwin, at Ellenthorpe, Stoke Bishop, 3.30 to 6 p.m. Lecture by Prof. W. J. Sollas, F.R.S., on "Funafuti: the Study of a Coral Island," in the People's Palace, at 8.30 p.m. A symposium in honour of the president, Sir William Crookes, F.R.S., at the Merchant Venturers' Technical College, at 9.30 p.m. There will be a certain number of invited guests, and there will be a few tickets (probably 250) issued to a limited number of applicants.

Saturday, Sept. 10.—Some sectional meetings, followed by a number of most varied excursions in the afternoon. In the evening a lecture to working men will be delivered by Prof. E. B. Poulton, F.R.S., on "The Ways in which Animals Warn their Enemies and Signal to their Friends." The lecture will be given in the hall of the Young Men's Christian Association at 8 p.m. A public banquet has also been arranged by the president and members of the Bristol Chamber of Commerce at the Grammar School.

Monday, Sept. 12.—Sectional meetings in the morning. Garden party, given by the headmaster and assistant masters of Clifton College, 3.30 to 6 p.m. A lecture by Herbert Jackson, Esq., on "Phosphorescence," will be delivered in the Y.M.C.A. Hall at 8.30 p.m.

Tuesday, Sept. 13.—Sectional meetings in the morning. Garden party, given by Mr. and Mrs. Edward Robinson, at The Towers, Sneyd Park, 3.30 to 6 p.m. Garden party, given by Mr. and Mrs. G. A. Wills, at Burwalls, Leigh Woods, 3.30 to 6 p.m. Conversazione at the Clifton College, given by the Local Committee, 8.30 to 11.30 p.m.

Wednesday, Sept. 14.—Some sectional meetings. Concluding general meeting in the Lecture Theatre, Bristol Museum, at 2.30 p.m. Garden party, given by Mr. and Mrs. Herbert Ashman, at Cook's Folly, Sneyd Park, 3.30 to 6 p.m. Ball to the officers of the fleet.

On the next two days many excursions have been arranged, and will end up in a five-days' trip through Devonshire.

The papers to be read in Section A include the following: "Hydrometers of Total Immersion," by A. W. Warrington, M.Sc.; "The Mathematical Representation of Statistics," by Prof. F. V. Edgeworth; "The Construction of Magnets of Constant Intensity under Changes of Temperature," by J. C. Ashworth, B.Sc.; "On the Dissipation of Energy in the Dielectric of a Condenser," by E. B. Rosa and A. W. Smith; "On the Conservation of Energy in the Human Body," by E. B. Rosa and W. O. Atwater; "Comparison between Charging a Secondary Cell at Constant Potential and at Constant Current, and more especially as regards Efficiency," by A. A. Catren and J. M. Donaldson; "Analogies between the Yearly Ranges of some Meteorological and Magnetic Phenomena," by Dr. Van Rijckevorsel; "On the Determination of the State of Ionisation in Dilute Aqueous Solutions containing Two Electrolytes" (No. 2), by Prof. J. G. MacGregor; "Experiments on the Influence of Electricity on Plants," by S. Lenström.

In the international conference on terrestial magnetism and atmospheric electricity, the presidential address will be delivered by Prof. A. W. Rucker, M.A., and papers will afterwards be read on the following subjects: "On Magnetic Observations in the Azores," by Albert Prince of Monaco; "On the Influence of Altitude above the Sea on the Elements of Terrestial Magnetism," by Dr. van Rijckevorsel and Dr. W. van Bemmelen; "On the Diurnal Movement of the North Poles of a Bar Magnet Suspended from its Centre of Gravity," by J. B. Capello; "On the Relations between the Variations in the Earth Currents, the Electric Currents from the Atmosphere, and the Magnetic Perturbations," by S. Lenström; "On a Simple Method of Obtaining the Expression of the Magnetic Potential of the Earth in a Series of Special Harmonics," by A. Schuster, F.R.S. Prof. W. G. Adams will also give an account of the late Prof. J. C. Adams' "Determination of the Gaussian Magnetic Constants."

The report of the committee on "Methods of Comparing and Reducing Magnetic Observations" will be presented in this sub-section. The committee consists of Prof. W. G. Adams, Dr. C. Chree, Lord Kelvin, Prof. G. H. Darwin, Prof. G. Chrystal, Prof. A. Schuster, Captain E. W. Creak, the Astronomer Royal, Mr. W. Ellis, and Prof. A. W. Rucker.

In the Geographical Section the following papers dealing with electrical matters will probably be read on the dates given: On Monday a paper by Mr. C. Bright on "The Pacific Cable," and on Tuesday a paper by Mr. Eric Stuart Bruce on "The Use of Electric Balloon Signalling in Arctic and Antarctic Expeditions."

The Mechanical Section papers we have referred to in a previous issue. These include: "Some of the Mechanical and Economic Features of the Coal Question," by T. Forster Brown; "Description of an Instrument for Measuring Small Torsional Strains," by E. G. Coker; "A New Instrument for Drawing Envelopes, and its Application to the Teeth of Wheels and for other Purposes," by H. S. Hele-Shaw; "Electric Power in Workshops," by A. Siemens; "The Application of the Electric Motor to Small Industrial Purposes and its Effects on Trade and on the Community Generally," by A. H. Gibbings; "Electric Power and its Application on the Three-phase System to the Bristol Wagon and Carriage Works," by W. Geipel; "Notes on the Electric Lighting System at Bristol, with Special Reference to Auxiliary Plant," by H. Faraday Proctor; "Corrosion of Gas and Water Mains by Earth Currents from Electric Tram Lines," by J. S. Fleming; "Combined Electric Lighting and Power Plant for Docks and Harbours," by T. G. W. Aldridge; "Electric Canal Haulage," by A. H. Allen; and "Electric Traction by Surface Contacts," by Prof. S. P. Thompson.

Several interesting papers not hitherto mentioned are to be read. Thus in Section A, Prof. W. F. Barrett, W. Brown, and R. A. Hadfield will discourse on electrical conductivity and magnetic permeability in a series of alloys of iron.

Arrangements have been made so that the reading of electrical papers in Sections A and G may not clash. To-day (Friday) Section A will hear papers on mathematics, physics, and electricity; on Saturday the papers will be on mathematics and on meteorology; on Monday there is to be a joint discussion on the results of recent solar eclipse expeditions; on Tuesday a joint discussion with G, and a conference on magnetic and electrolytic action connected with electric railways.

In Section G Friday is devoted to general engineering papers, Monday to electrical papers on electric power in workshops, electric motors in small industries, electric lighting, Bristol electric traction. Tuesday to papers on transport and transmission of power, including electric canal haulage.

Amongst the many works open for inspection at Bristol we may mention the Corporation electricity works, which

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Mr. Faraday Proctor will be pleased to show engineers over; the electric power station of the Bristol Tramway and Carriage Company, and the manufacturing works of the same firm.

From all the above it will be seen that the attractions to electrical engineers offered by the Bristol meeting of the British Association are much above the average.

Presidential Address.*

BY SIR WILLIAM CROOKES, F.R.S., V.P.C.S.

For the third time in its history the British Association meets in your city of Bristol. The first meeting was held under the presidency of the Marquis of Lansdowne in 1836, the second under the presidency of Sir John Hawkshaw in 1875. Formerly the president unrolled to the meeting a panorama of the year's progress in physical and biological sciences. To-day the president usually restricts himself to specialities connected with his own work or deals with questions which for the time are uppermost. To be president of the British Association is undoubtedly a great honour. It is also a great opportunity and a great responsibility; for I know that, on the wings of the Press, my words, be they worthy or not, will be carried to all points of the compass. I propose first to deal with the important question of the supply of bread to the inhabitants of these islands, then to touch on subjects to which my life work has been more or less devoted. I shall not attempt any general survey of the sciences; these, so far as the progress in them demands attention, will be more fitly brought before you in the different sections, either in the addresses of the presidents or in communications from members.

Before proceeding with my address I wish to refer to the severe loss the British Association has sustained in the death of Lord Playfair. With Sir John Lubbock and Lord Rayleigh, Lord Playfair was one of the permanent trustees of our association, and for many years he was present at our meetings. It would be difficult to overrate his loss to British science. Lord Playfair's well-matured and accurate judgment, his scientific knowledge, and his happy gift of clothing weighty thoughts in persuasive language made his presence acceptable, whether in the council-chamber, in departmental enquiries, or at light social gatherings, where by the singular laws of modern society momentous announcements are sometimes first given to the world. Lord Playfair (then Sir Lyon Playfair) was president of the British Association at Aberdeen in 1885; his address on that occasion will long be remembered as a model of profound learning and luminous exposition.

And now I owe a sort of apology to this brilliant audience. I must ask you to bear with me for 10 minutes, for I am afraid what I now have to say will prove somewhat dull. I ought to propitiate you, for, to tell the truth, I am bound to bore you with figures. Statistics are rarely attractive to a listening audience; but they are necessary evils, and those of this evening are unusually doleful. Nevertheless, when we have proceeded a little way on our journey, I hope you will see that the river of figures is not hopelessly dreary. The stream leads into an almost unexplored region, and to the right and left we see channels opening out, all worthy of exploration, and promising a rich reward to the statistic explorer who will trace them to their source—a harvest, as Huxley expresses it, "immediately convertible into those things which the most sordidly practical of men will admit to have value—namely, money and life." My chief subject is of interest to the whole world—to every race—to every human being. It is of urgent importance to-day, and it is a life and death question for generations to come. I mean the question of food supply. Many of my statements you may think are of the alarmist order; certainly they are depressing, but they are founded on stubborn facts. They show that England and all civilised nations stand in deadly peril of not having enough to eat. As mouths multiply, food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent on difficult and capricious natural phenomena. I am constrained to show that our wheat-producing soil is totally unequal to the strain put upon it. After wearying you with a survey of the universal dearth to be expected, I hope to point a way out of the colossal dilemma. It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned into plenty. The food supply of the kingdom is of peculiar interest to this meeting, considering that the grain trade has always been, and still is, an important feature in the imports of Bristol. The imports of grain to this city amount to about 25,000,000 bushels per annum—8,000,000 of which consist of wheat.

The President then proceeded to give statistics of wheat supplies, which we omit. Prof. Crookes shows by them that up to recent years the growth of wheat has kept pace with demands. As wheat-eaters increased, the acreage under wheat expanded. The world has become so familiarised with the orderly sequence of demand and supply, so accustomed to look upon the vast plains of other wheat-growing countries as inexhaustible granaries, that, in a light-hearted way, it is taken for granted that so many million additional acres can be added year after year to the wheat-growing area of the world. We forget that the wheat-growing area is of strictly limited extent, and that a few million acres regularly absorbed soon mount to a formidable number. Prof. Crookes considers that should all the wheat-growing countries add to their area to the utmost capacity, on the most careful calculation the yield would give us only an addition of some 100,000,000 acres, supplying at the average world yield of 12·7 bushels to the acre, 1,270,000,000 bushels, just enough to supply the increase of population among bread-eaters till the year 1931. At the present time there exists a deficit in the wheat area of 31,000 square miles—a deficit masked by the fact that the 10 world crops of wheat harvested in the 10 years ending 1896 were more than 5 per cent. above the average of the previous 26 years.

Prof. Crookes then considers how the want of land is to be supplied, and considers that starvation may be averted through a laboratory. He proceeds to consider in detail various methods of preventing the impoverishment of the soil in wheat-growing countries. He then says: I have passed in review all the wheat-growing countries of the world, with the exception of those whose united supplies are so small as to make little appreciable difference to the argument. The situation may be summed up briefly thus: the world's demand for wheat—the leading bread-stuff—increases in a crescendo ratio year by year. Gradually all the wheat-bearing land on the globe is appropriated to wheat-growing, until we are within measurable distance of using the last available acre. We must then rely on nitrogenous manures to increase the fertility of the land under wheat, so as to raise the yield from the world's low average—12·7 bushels per acre—to a higher average. To do this efficiently and feed the bread-eaters for a few years will exhaust all the available store of nitrate of soda. For years past we have been spending fixed nitrogen at a culpably extravagant rate, heedless of the fact that it is fixed with extreme slowness and difficulty, while its liberation in the free state takes place always with rapidity and sometimes with explosive violence.

Some years ago Mr. Stanley Jevons uttered a note of warning as to the near exhaustion of our British coalfields. But the exhaustion of the world's stock of fixed nitrogen is a matter of far greater importance. It means not only a catastrophe little short of starvation for the wheat-eaters, but indirectly scarcity for those who exist on inferior grains, together with a lower standard of living for meat-eaters, scarcity of mutton and beef, and even the extinction of gunpowder!

There is a gleam of light amid this darkness of despondency. In its free state nitrogen is one of the most abundant and pervading bodies on the face of the earth. Every square yard of the earth's surface has nitrogen gas pressing down on it to the extent of about seven tons—but this is in the free state, and wheat demands it fixed. To convey this idea is an object-lesson, I may tell you that, previous to its destruction by fire, Colston Hall, measuring 146ft. by 80ft. by 70ft., contained 27 tons weight of nitrogen

* We have had to condense the address in places where the matter is outside the scope of our journal.—ED. *E. E.*

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in its atmosphere; it also contained one-third of a ton of argon. In the free gaseous state this nitrogen is worthless; combined in the form of nitrate of soda it would be worth about £2,000.

For years past attempts have been made to effect the fixation of atmospheric nitrogen, and some of the processes have met with sufficient partial success to warrant experimentalists in pushing their trials still further; but I think I am right in saying that no process has yet been brought to the notice of scientific or commercial men which can be considered successful either as regards cost or yield of product. It is possible, by several methods, to fix a certain amount of atmospheric nitrogen; but to the best of my knowledge no process has hitherto converted more than a small amount, and this at a cost largely in excess of the present market value of fixed nitrogen.

The fixation of atmospheric nitrogen, therefore, is one of the great discoveries awaiting the ingenuity of chemists. It is certainly deeply important in its practical bearings on the future welfare and happiness of the civilised races of mankind. This unfulfilled problem, which so far has eluded the strenuous attempts of those who have tried to wrest the secret from nature, differs materially from other chemical discoveries which are in the air, so to speak, but are not yet matured. The fixation of nitrogen is vital to the progress of civilised humanity. Other discoveries minister to our increased intellectual comfort, luxury, or convenience; they serve to make life easier, to hasten the acquisition of wealth, or to save time, health, or worry. The fixation of nitrogen is a question of the not far distant future. Unless we can class it among certainties to come the great Caucasian race will cease to be foremost in the world, and will be squeezed out of existence by races to whom wheaten bread is not the staff of life.

Let me see if it is not possible even now to solve the momentous problem. As far back as 1892 I exhibited, at one of the soirées of the Royal Society, an experiment on the flame of burning nitrogen. I showed that nitrogen is a combustible gas, and the reason why when once ignited the flame does not spread through the atmosphere and deluge the world in a sea of nitric acid is that its igniting point is higher than the temperature of its flame—not therefore hot enough to set fire to the adjacent mixture. But by passing a strong induction current between terminals the air takes fire and continues to burn with a powerful flame, producing nitrous and nitric acids. This inconsiderable experiment may not unlikely lead to the development of a mighty industry destined to solve the great food problem. With the object of burning out nitrogen from air so as to leave argon behind, Lord Rayleigh fitted up apparatus for performing the operation on a larger scale, and succeeded in effecting the union of 29·4 grm. of mixed nitrogen and oxygen at an expenditure of 1 h.p. Following these figures it would require one Board of Trade unit to form 74 grm. of nitrate of soda, and therefore 14,000 units to form one ton. To generate electricity in the ordinary way with steam-engines and dynamos, it is now possible with a steady load night and day, and engines working at maximum efficiency, to produce current at a cost of ½d. per Board of Trade unit. At this rate one ton of nitrate of soda would cost £26. But electricity from coal and steam-engines is too costly for large industrial purposes; at Niagara, where water power is used, electricity can be sold at a profit for $\frac{1}{17}$d. per Board of Trade unit. At this rate nitrate of soda would cost not more than £5 per ton. But the limit of cost is not yet reached, and it must be remembered that the initial data are derived from small scale experiments, in which the object was not economy but rather to demonstrate the practicability of the combustion method, and to utilise it for isolating argon. Even now electric nitrate at £5 a ton compares favourably with Chili nitrate at £7. 10s. a ton; and all experience shows that when the road has been pointed out by a small laboratory experiment, the industrial operations that may follow are always conducted at a cost considerably lower than could be anticipated from the laboratory figures.

Before we decide that electric nitrate is a commercial possibility, a final question must be mooted. We are dealing with wholesale figures, and must take care that we are not shifting difficulties a little further back without really diminishing them. We start with a shortage of wheat, and the natural remedy is to put more land under cultivation. As the land cannot be stretched, and there is so much of it and no more, the object is to render the available area more productive by a dressing with nitrate of soda. But nitrate of soda is limited in quantity, and will soon be exhausted. Human ingenuity can contend even with these apparently hopeless difficulties. Nitrate can be produced artificially by the combustion of the atmosphere. Here we come to finality in one direction; our stores are inexhaustible. But how about electricity? Can we generate enough energy to produce 12,000,000 tons of nitrate of soda annually? A preliminary calculation shows that there need be no fear on that score; Niagara alone is capable of supplying the required electric energy without much lessening its mighty flow.

The future can take care of itself. The artificial production of nitrate is clearly within view, and by its aid the land devoted to wheat can be brought up to the 30 bushels per acre standard. In days to come, when the demand may again overtake supply, we may safely leave our successors to grapple with the stupendous food problem. And, in the next generation, instead of trusting mainly to food-stuffs which flourish in temperate climates, we probably shall trust more and more to the exuberant food-stuffs of the tropics, where, instead of one yearly sober harvest, jeopardised by any shrinkage of the scanty days of summer weather, or of the few steady inches of rainfall, Nature annually supplies heat and water enough to ripen two or three successive crops of food-stuffs in extraordinary abundance. To mention one plant alone, Humboldt—from what precise statistics I know not—computed that, acre for acre, the food-productiveness of the banana is 133 times that of wheat; the unripe banana, before its starch is converted into sugar, is said to make excellent bread. Considerations like these must in the end determine the range and avenues of commerce, perhaps the fate of continents. We must develop and guide Nature's latent energies, we must utilise her inmost workshops, we must call into commercial existence Central Africa and Brazil to redress the balance of Odessa and Chicago.

Having kept you for the last half-hour rigorously chained to earth, disclosing dreary possibilities, it will be a relief to soar to the heights of pure science and to discuss a point or two touching its latest achievements and aspirations. The low-temperature researches which bring such renown to Prof. Dewar and to his laboratory in the Royal Institution have been crowned during the present year by the conquest of one of Nature's most defiant strongholds. On May 10 last Prof. Dewar wrote to me these simple but victorious words: "This evening I have succeeded in liquefying both hydrogen and helium. The second stage of low-temperature work has begun." Static hydrogen boils at a temperature of 238deg. C. at ordinary pressure, and at 250deg. C. in a vacuum, thus enabling us to get within 23deg. C. of absolute zero. The density of liquid hydrogen is only one-fourteenth that of water, yet in spite of such a low density it collects well, drops easily, and has a well-defined meniscus. With proper isolation it will be as easy to manipulate liquid hydrogen as liquid air. The investigation of the properties of bodies brought near the absolute zero of temperature is certain to give results of extraordinary importance. Already platinum resistance thermometers are becoming useless, as the temperature of boiling hydrogen is but a few degrees from the point where the resistance of platinum would be practically nothing, or the conductivity infinite.

Several years ago I pondered on the constitution of matter in what I ventured to call the fourth state. I endeavoured to probe the tormenting mystery of the atom. What is the atom? Is a single atom in space solid, liquid, or gaseous. Each of these states involves ideas which can only pertain to vast collections of atoms. Whether, like Newton, we try to visualise an atom as a hard, spherical body, or, with Boscovitch and Faraday, to regard it as a centre of force, or accept the vortex atom theory of Lord Kelvin, an isolated atom is an unknown entity difficult to conceive. The properties of matter—solid, liquid, gaseous—are due to molecules in a state of motion. Therefore, matter as we know it involves essentially a mode of

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motion; and the atom itself—intangible, invisible, and inconceivable—is its material basis, and may, indeed, be styled the only true matter. The space involved in the motions of atoms has no more pretension to be called matter than the sphere of influence of a body of riflemen—the sphere filled with flying leaden missiles—has to be called lead. Since what we call matter essentially involves a mode of motion, and since at the temperature of absolute zero all atomic motions would stop, it follows that matter as we know it would at that paralysing temperature probably entirely change its properties. Although a discussion of the ultimate absolute properties of matter is purely speculative, it can hardly be barren, considering that in our laboratories we are now within moderate distance of the absolute zero of temperature.

I have dwelt on the value and importance of nitrogen, but I must not omit to bring to your notice those little known and curiously related elements which during the past 12 months have been discovered and partly described by Prof. Ramsay and Dr. Travers. For many years my own work has been among what I may call the waste heaps of the mineral elements. Prof. Ramsay is dealing with vagrant atoms of an astral nature. During the course of the present year he has announced the existence of no fewer than three new gases—krypton, neon, and metargon. Whether these gases, chiefly known by their spectra, are true unalterable elements, or whether they are compounded of other known or unknown bodies, has yet to be proved. Fellow-workers freely pay tribute to the painstaking zeal with which Prof. Ramsay has conducted a difficult research, and to the philosophic subtlety brought to bear on his investigations. But, like most discoverers, he has not escaped the flail of severe criticism.

There is still another claimant for celestial honours. Prof. Nasini tells us he has discovered, in some volcanic gases at Pozzuoli, that hypothetical element Coronium, supposed to cause the bright line 5316·9 in the spectrum of the sun's corona. Analogy points to its being lighter and more diffusible than hydrogen, and a study of its properties cannot fail to yield striking results. Still awaiting discovery by the fortunate spectroscopist are the unknown celestial elements Aurorium, with a characteristic line at 5570·7, and Nebulum, having two bright lines at 5007·05 and 4959·02.

The fundamental discovery by Hertz, of the electromagnetic waves predicted more than 30 years ago by Clerk Maxwell, seems likely to develop in the direction of a practical application which excites keen interest—I mean the application to electric signalling across moderate distances without connecting wires. The feasibility of this method of signalling has been demonstrated by several experimenters at more than one meeting of the British Association, though most elaborately and with many optical refinements by Oliver Lodge at the Oxford meeting in 1894. But not until Signor Marconi induced the British Post Office and foreign Governments to try large scale experiments did wireless signalling become generally and popularly known or practically developed as a special kind of telegraphy. Its feasibility depends on the discovery of a singularly sensitive detector for Hertz waves—a detector whose sensitiveness in some cases seems almost to compare with that of the eye itself. The fact noticed by Oliver Lodge in 1889, that an infinitesimal metallic gap subjected to an electric jerk became conducting, so as to complete an electric circuit, was rediscovered soon afterwards in a more tangible and definite form and applied to the detection of Hertz waves by M. E. Branly. Oliver Lodge then continued the work, and produced the vacuum filing-tube coherers with automatic tapper-back, which are of acknowledged practical service. It is this varying continuity of contact under the influence of extremely feeble electric stimulus alternating with mechanical tremor which, in combination with the mode of producing the waves revealed by Hertz, constitutes the essential and fundamental feature of "wireless telegraphy." There is a curious and widely spread misapprehension about coherers, to the effect that to make a coherer work the wave must fall upon it. Oliver Lodge has disproved this fallacy. Let the wave fall on a suitable receiver, such as a metallic wire, or, better still, on an arrangement of metal wings resembling a Hertz sender, and the waves set up oscillating currents which may be led by wires (enclosed in metal pipes) to the coherer. The coherer acts apparently by a species of end-impact of the oscillatory current, and does not need to be attacked in the flank by the waves themselves. This interesting method of signalling—already developing in Marconi's hands into a successful practical system which inevitably will be largely used in lighthouse and marine work—presents more analogy to optical signals by flash-light than to what is usually understood as electric telegraphy, notwithstanding the fact that an ordinary Morse instrument at one end responds to the movements of a key at the other, or, as arranged by Alexander Muirhead, a siphon recorder responds to an automatic transmitter at about the rate of slow cable telegraphy. But although no apparent optical apparatus is employed, it remains true that the impulse travels from sender to receiver by essentially the same process as that which enables a flash of magnesium powder to excite a distant eye.

The phenomenon discovered by Zeeman, that a source of radiation is affected by a strong magnetic field in such a way that light of one refrangibility becomes divided usually into three components, two of which are displaced by diffraction analysis on either side of the mean position and are oppositely polarised to the third or residual constituent, has been examined by many observers in all countries. The phenomenon has been subjected to photography with conspicuously successful results by Prof. T. Preston in Dublin and by Prof. Michelson and Dr. Ames and others in America.

It appears that the different lines in the spectrum are differently affected, some of them being tripled with different grades of relative intensity, some doubled, some quadrupled, some sextupled, and some left unchanged. Even the two components of the D lines are not similarly influenced. Moreover, whereas the polarisation is usually such as to indicate that motions of a negative ion or electron constitute the source of light, a few lines are stated by the observers at Baltimore, who used what they call the "small" grating of 5in. width ruled with 65,000 lines, to be polarised in the reverse way.

Further prosecution of these researches must lead to deeper insight into molecular processes and the mode in which they affect the ether; indeed already valuable theoretic views have been promulgated by H. A. Lorenz, J. Larmor, and G. F. Fitzgerald on the lines of the radiation theory of Dr. Johnstone Stoney; and the connection of the new phenomena with the old magnetic rotation of Faraday is under discussion. It is interesting to note that Faraday and a number of more recent experimenters were led by theoretical considerations to look for some such effect; and though the inadequate means at their disposal did not lead to success, nevertheless a first dim glimpse of the phenomenon was obtained by M. Fievez, of the Royal Observatory at Brussels, in 1885.

It would be improper to pass without at least brief mention the remarkable series of theoretic papers by Dr. J. Larmor, published by the Royal Society, on the relationship between ether and matter. By the time these researches become generally intelligible they may be found to constitute a considerable step towards the further mathematical analysis and interpretation of the physical universe on the lines initiated by Newton.

In the mechanical construction of Röntgen ray tubes I can record a few advances: the most successful being the adoption of Prof. Silvanus P. Thompson's suggestion of using for the anti-cathode a metal of high atomic weight. Osmium and iridium have been used with advantage, and osmium anti-cathode tubes are now a regular article of manufacture. As long ago as June, 1896, X-ray tubes with metallic uranium anti-cathodes were made in my own laboratory and were found to work better than those with platinum. The difficulty of procuring metallic uranium prevented these experiments from being continued. Thorium anti-cathodes have also been tried. Röntgen has drawn fresh attention to a fact very early observed by English experimenters—that of the non-homogeneity of the rays and the dependence of their penetrating power on the degree of vacuum; rays generated in high vacua have more penetrative power than when the

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vacuum is less high. These facts are familiar to all who have exhausted focus tubes on their own pumps. Röntgen suggests a convenient phraseology; he calls a low-vacuum tube, which does not emit the highly penetrating rays, a "soft" tube, and a tube in which the exhaustion has been pushed to an extreme degree, in which highly penetrating rays predominate, a "hard" tube. Using a "hard" tube he took a photograph of a double-barrelled rifle, and showed not only the leaden bullets within the steel barrels, but even the wads and the charges. Benoit has re-examined the alleged relation between density and opacity to the rays, and finds certain discrepancies. Thus, the opacity of equal thicknesses of palladium and platinum are nearly equal, whilst their densities and atomic weights are very different, those of palladium being about half those of platinum.

At the last meeting of the British Association visitors saw—at the McGill University—Profs. Cox and Callendar's apparatus for measuring the velocity of Röntgen rays. They found it to be certainly greater than 200 km. per second. Majorana has made an independent determination, and finds the velocity to be 600 km. per second with an inferior limit certainly of not less than 150 km. per second. It may be remembered that J. J. Thomson has found for cathode rays a velocity of more than 10,000 km. per second, and it is extremely unlikely that the velocity of Röntgen rays will prove to be less. Trowbridge has verified the fact, previously announced by Prof. S. P. Thompson, that fluor-spar, which by prolonged heating has lost its power of luminescing when reheated, regains the power of thermo-luminescence when exposed to Röntgen rays. He finds that this restoration is also effected by exposure to the electric glow discharge, but not by exposure to ultra-violet light. The difference is suggestive. As for the action of Röntgen rays on bacteria, often asserted and often denied, the latest statements by Dr. H. Rieder, of Munich, is to the effect that bacteria are killed by the discharge from "hard" tubes. Whether the observation will lead to results of pathologic importance remains to be seen. The circumstance that the normal retina of the eye is slightly sensitive to the rays is confirmed by Dorn and by Röntgen himself.

The essential wave-nature of the Röntgen rays appears to be confirmed by the fact ascertained by several of our great mathematical physicists that light of excessively short wave-length would be but slightly absorbed by ordinary material media, and would not in the ordinary sense be refracted at all. In fact a theoretic basis for a comprehension of the Röntgen rays had been propounded before the rays were discovered. At the Liverpool meeting of the British Association, several speakers, headed by Sir George Stokes, expressed their conviction that the disturbed electric field caused by the sudden stoppage of the motion of an electrically charged atom yielded the true explanation of the phenomena extraneous to the Crookes high-vacuum tubes—phenomena so excellently elaborated by Lenard and by Röntgen. More recently, Sir George Stokes has restated his "pulse" theory, and fortified it with arguments which have an important bearing on the whole theory of the refraction of light. He still holds to their essentially transverse nature, in spite of the absence of polarisation, an absence once more confirmed by the careful experiments of Dr. L. Graetz. The details of this theory are in process of elaboration by Prof. J. J. Thomson. Meantime, while the general opinion of physicists seems to be settling towards a wave or ether theory for the Röntgen rays, an opposite drift is apparent with respect to the physical nature of the cathode rays; it becomes more and more clear that cathode rays consist of electrified atoms or ions in rapid progressive motion. My idea of a fourth state of matter, propounded in 1881, and at first opposed at home and abroad, is now becoming accepted. It is supported by Prof. J. J. Thomson. Dr. Larmor's theory likewise involves the idea of an ionic substratum of matter; the view is also confirmed by Zeeman's phenomenon. In Germany, where the term cathode ray was invented almost as a protest against the theory of molecular streams propounded by me at the Sheffield meeting of the British Association in 1879, additional proofs have been produced in favour of the doctrine that the essential fact in the phenomenon is electrified radiant matter. The speed of these molecular streams has been approximately measured, chiefly by aid of my own discovery nearly 20 years ago, that their path is curved in a magnetic field, and that they produce phosphorescence where they impinge on an obstacle. The two unknown quantities, the charge and the speed of each atom, are measurable from the amount of curvature and by means of one other independent experiment.

It cannot be said that a complete and conclusive theory of these rays has yet been formulated. It is generally accepted that collisions among particles, especially the violent collisions due to their impact on a massive target placed in their path, give rise to the interesting kind of extremely high frequency radiation discovered by Röntgen. It has, indeed, for some time been known that whereas a charged body in motion constitutes an electric current, the sudden stoppage, or any violent acceleration of such a body, must cause an alternating electric disturbance, which, though so rapidly decaying in intensity as to be practically "dead beat," yet must give rise to an ethereal wave or pulse travelling with the speed of light, but of a length comparable to the size of the body whose sudden change of motion caused the disturbance. The emission of a high-pitched musical sound from the jolting of a dust-man's cart (with a spring bell hung on it) has been suggested as an illustration of the way in which the molecules of any solid not at absolute zero may possibly emit such rays. If the target on to which the electrically-charged atoms impinge is so constituted that some of its minute parts can thereby be set into rhythmical vibration, the energy thus absorbed reappears in the form of light, and the body is said to phosphoresce. The efficient action of the phosphorescent target appears to depend as much on its physical and molecular as on its chemical constitution. The best known phosphori belong to certain well-defined classes, such as the sulphides of the alkaline-earthy metals, and some of the so-called rare earths; but the phosphorescent properties of each of these groups are propoundly modified by an admixture of foreign bodies—witness the effect on the lines in the phosphorescent spectrum of yttrium and samarium produced by traces of calcium or lead. The persistence of the samarium spectrum in presence of overwhelming quantities of other metals, is almost unexampled in spectroscopy: thus one part of samaria can easily be seen when mixed with three million parts of lime.

Without stating it as a general rule, it seems as if with a non-phosphorescing target the energy of molecular impact reappears as pulses so abrupt and irregular that when resolved they furnish a copious supply of waves of excessively short wave-length, in fact, the now well-known Röntgen rays. The phosphorescence so excited may last only a small fraction of a second, as with the constituents of yttria, where the duration of the different lines varies between the 0·003 and the 0·0009 second; or it may linger for hours, as in the case of some of the ytttria earths, and especially with the earthy sulphides, where the glow lasts bright enough to be commercially useful. Excessively phosphorescent bodies can be excited by light waves, but most of them require the stimulus of electrical excitement. It now appears that some bodies, even without special stimulation, are capable of giving out rays closely allied, if not in some cases identical, with those of Prof. Röntgen. Uranium and thorium compounds are of this character, and it would almost seem from the important researches of Dr. Russell, that this ray-emitting power may be a general property of matter, for he has shown that nearly every substance is capable of affecting the photographic plate if exposed in darkness for sufficient time.

No other source for Röntgen rays but the Crookes tube has yet been discovered, but rays of kindred sorts are recognised. The Becquerel rays, emitted by uranium and its compounds, have now found their companions in rays—discovered almost simultaneously by Curie and Schmidt—emitted by thorium and its compounds. The thorium rays affect photographic plates through screens of paper or aluminium, and are absorbed by metals and other dense bodies. They ionise the air, making it an electrical conductor; and they can be refracted and probably reflected, at least diffusively. Unlike uranium rays, they are not polarised by transmission through tourmaline, therefore

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resembling in this respect the Röntgen rays. Quite recently M. and Mdme. Curie have announced a discovery which, if confirmed, cannot fail to assist the investigation of this obscure branch of physics. They have brought to notice a new constituent of the uranium mineral pitchblende, which in a 400-fold degree possesses uranium's mysterious power of emitting a form of energy capable of impressing a photographic plate and of discharging electricity by rendering air a conductor. It also appears that the radiant activity of the new body, to which the discoverers have given the name of Polonium, needs neither the excitation of light nor the stimulus of electricity; like uranium, it draws its energy from some constantly regenerating and hitherto unsuspected store, exhaustless in amount.

It has long been to me a haunting problem how to reconcile this apparently boundless outpour of energy with accepted canons. But, as Dr. Johnstone Stoney reminds me, the resources of molecular movements are far from exhausted. There are many stores of energy in nature that may be drawn on by properly constituted bodies without very obvious cause. Some time since I drew attention to the enormous amount of locked up energy in the ether; nearer our experimental grasp are the motions of the atoms and molecules, and it is not difficult mentally so to modify Maxwell's demons as to reduce them to the level of an inflexible law, and thus bring them within the ken of a philosopher in search of a new tool. It is possible to conceive a target capable of mechanically sifting from the molecules of the surrounding air the quick from the slow movers. This sifting of the swift-moving molecules is effected in liquids whenever they evaporate, and in the case of the constituents of the atmosphere, wherever it contains constituents light enough to drift away molecule by molecule. In my mind's eye I see such a target as a piece of metal cooler than the surrounding air acquiring the energy that gradually raises its temperature from the outstanding effect of all its encounters with the molecules of the air about it; I see another target of such a structure that it throws off the slow-moving molecules with little exchange of energy, but is so influenced by the quick-moving missiles that it appropriates to itself some of their energy. Let uranium or polonium, bodies of densest atoms, have a structure that enables them to throw off the slow-moving molecules of the atmosphere, while the quick-moving molecules, smashing on to the surface, have their energy reduced and that of the target correspondingly increased. The energy thus gained seems to be employed partly in dissociating some of the molecules of the gas (or in inducing some other condition which has the effect of rendering the neighbouring air in some degree a conductor of electricity) and partly in originating an undulation through the ether, which, as it takes its rise in phenomena so disconnected as the impacts of the molecules of the air, must furnish a large contingent of light waves of short wave-length. The shortness in the case of these Becquerel rays appears to approach without attaining the extreme shortness of ordinary Röntgen rays. The reduction of the speed of the quick-moving molecules would cool the layer of air to which they belong; but this cooling would rapidly be compensated by radiation and conduction from the surrounding atmosphere; under ordinary circumstances the difference of temperature would scarcely be perceptible, and the uranium would thus appear to perpetually emit rays of energy with no apparent means of restoration. The total energy of both the translational and internal motions of the molecules locked up in quiescent air at ordinary pressure and temperature is about 140,000 foot-pounds in each cubic yard of air. Accordingly the quiet air within a room 12ft. high, 18ft. wide, and 22ft. long contains energy enough to propel a one-horse engine for more than 12 hours. The store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of science to enable the twentieth century to cast into the shade the marvels of the nineteenth.

Whilst placing before you the labours and achievements of my comrades in science, I seize this chance of telling you of engrossing work of my own on the fractionation of yttria to which for the last 18 years I have given ceaseless attention. In 1883, under the title of "Radiant Matter Spectroscopy," I described a new series of spectra produced by passing the phosphorescent glow of yttria, under molecular bombardment *in vacuo*, through a train of prisms. The visible spectra in time gave up their secrets, and were duly embalmed in the *Philosophical Transactions*. At the Birmingham meeting of the British Association in 1886 I brought the subject before the chemical section, of which I had the honour to be president. The results led to many speculations on the probable origin of all the elementary bodies—speculations that for the moment I must waive in favour of experimental facts. There still remained for spectroscopic examination a long tempting stretch of unknown ultra-violet light, of which the exploration gave me no rest. But I will not now enter into details of the quest of unknown lines. Large quartz prisms, lenses, and condensers, specially sensitised photographic films capable of dealing with the necessary small amount of radiation given by feebly phosphorescing substances,* and above all tireless patience in collating and interpreting results, have all played their part. Although the research is incomplete, I am able to announce that among the groups of rare earths giving phosphorescent spectra in the visible region there are others giving well-defined groups of bands which can only be recorded photographically. I have detected and mapped no less than six such groups extending to λ 3060.

Without enlarging on difficulties, I will give a brief outline of the investigation. Starting with a large quantity of a group of the rare earths in a state of considerable purity, a particular method of fractionation is supplied, splitting the earths into a series of fractions differing but slightly from each other. Each of these fractions, phosphorescing *in vacuo*, is arranged in the spectrograph, and a record of its spectrum photographed upon a specially prepared sensitive film. In this way, with different groups of rare earths, the several invisible bands were recorded—some moderately strong, others exceedingly faint. Selecting a portion giving a definite set of bands, new methods of fractionation were applied, constantly photographing and measuring the spectrum of each fraction. Sometimes many weeks of hard experiment failed to produce any separation, and then a new method of splitting up was devised and applied. By unremitting work—the solvent of most difficulties—eventually it was possible to split up the series of bands into various groups. Then, taking a group which seemed to offer possibilities of reasonably quick result, one method after another of chemical attack was adopted, with the ultimate result of freeing the group from its accompanying fellows and increasing its intensity and detail.

As I have said, my researches are far from complete, but about one of the bodies I may speak definitely. High up in the ultra-violet, like a faint nebula in the distant heavens, a group of lines was detected, at first feeble and only remarkable on account of their isolation. On further purification these lines grew stronger. Their great refrangibility cut them off from other groups. Special processes were employed to isolate the earth, and using these lines as a test, and appealing at every step to the spectrograph, it was pleasant to see how each week the group stood out stronger and stronger, while the other lines of yttrium, samarium, ytterbium, etc., became fainter, and at last, practically vanishing, left the sought-for group strong and solitary. Finally, within the last few weeks, hopefulness has emerged into certainty, and I have absolute evidence that another member of the rare earth groups has been added to the list. Simultaneously with the chemical and spectrographic attack, atomic weight determinations were constantly performed. As the group of lines which betrayed its existence stand alone, almost at the extreme end of the ultra-violet spectrum, I propose to name the newest of the elements Monium, from the Greek μόνος, alone. Although caught by the searching rays of the spectrum, Monium offers a direct contrast to the recently discovered gaseous elements, by having a strongly marked individuality; but, although so young and wilful,

* In this direction I am glad to acknowledge my indebtedness to Dr. Schuman, of Leipzig, for valuable suggestions and detail of his own apparatus, by means of which he has produced some unique records of metallic and gaseous spectra of lines of short wave-length.

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it is willing to enter into any number of chemical alliances. Until my material is in a greater state of purity I hesitate to commit myself to figures, but I may say that the wave-lengths of the principal lines are 3,120 and 3,117. Other fainter lines are at 3,219, 3,064, and 3,060. The atomic weight of the element, based on the assumption of R_2O_3, is not far from 118—greater than that accepted for yttrium and less than that for lanthanum.

I ought almost to apologise for adding to the already too long list of elements of the rare earth class—the asteroids of the terrestrial family. But as the host of celestial asteroids, unimportant individually, become of high interest when once the idea is grasped that they may be incompletely coagulated remains of the original nebula, so do these elusive and insignificant rare elements rise to supreme importance when we regard them in the light of component parts of a dominant element, frozen in embryo, and arrested in the act of coalescing from the original protyle into one of the ordinary and law-abiding family for whom Newlands and Mendeleeff have prepared pigeon-holes. The new element has another claim to notice. Not only is it new in itself, but to discover it a new tool had to be forged for spectroscopic research. Further details I will reserve for that tribunal before whom every aspirant for a place in the elemental hierarchy has to substantiate his claim.

The remainder of the address touched on problems on the borderland of science interesting to psycologists, but hardly to our readers.

THURSDAY.

SECTION A.

This section, as is usual, was well attended to hear the president of the section (Prof. Ayrton, F.R.S.) give his address. Before commencing to do this, Prof. Ayrton referred to the great loss which the British Association and science generally had sustained by the sad death of Dr. Hopkinson. It was commonly said that he who leads in mathematics cannot succeed in engineering, but the late Dr. Hopkinson was an exception to any rule, if rule of the kind there be, for he was equally brilliant in each of those departments. The section and the association gave their deepest sympathy to Mrs. Hopkinson, for while they had lost much she had lost more.

Address to the Mathematical and Physical Section.

BY PROF. W. E. AYRTON, F.R.S, PRESIDENT OF THE SECTION.

A year ago Section A was charmed with a presidential address on the poetry of mathematics, and if, amongst those who entered the physics lecture theatre at Toronto on that occasion, there were any who had a preconceived notion that mathematics was a hard, dry, repellent type of study, they must, after hearing Prof. Forsyth's eloquent vindication of its charms, have departed convinced that mathematics resembled music in being a branch of the fine arts. Such an address, however, cannot but leave a feeling of regret amongst those of us who, engulfed in the whirl of the practical science of the day, sigh for the leisure and the quiet which are necessary for the worship of abstract mathematical truth, while the vain effort to follow in the footsteps of one gifted with such winning eloquence fills me with hopeless despair. Section A this year is very fortunate in having its meetings associated with those of an "International Conference on Terrestrial Magnetism and Atmospheric Electricity," which is attended by the members of the "Permanent Committee for Terrestrial Magnetism and Atmospheric Electricity" of the "International Meteorological Conference." It has been arranged that this Permanent Committee, of which Prof. Rücker is the president, shall form part of the General Committee of Section A, and also shall act as the Committee of the International Conference, which will itself constitute a separate department of Section A. For the purpose, however, of preparing a report to the International Meteorological Conference, and for similar business, this Permanent Committee will act independently of the British Association. My first duty to-day, therefore, consists in expressing the honour and the very great pleasure which I feel in bidding you, members of the International Conference, most heartily welcome.

Among the various subjects which it is probable that the conference may desire to discuss, there is one to which I will briefly refer, as I am able to do so in a triple capacity. The earth is an object of much importance, alike to the terrestrial magnetician, the telegraph electrician, and the tramway engineer; but while the first aims at observing its magnetism, and the second rejoices in the absence of the earth currents which interfere with the sending of messages, the third seems bent on converting our maps of lines of force into maps of lines of tramway. It might, therefore, seem as if electric traction—undoubtedly a great boon to the people, and one that has already effected important social developments in America and on the continent of Europe—were destined in time to annihilate magnetic observatories near towns, and even to seriously interfere with existing telegraph and telephone systems. Already the principle of the survival of the fittest is quoted by some electrical engineers, who declare that if magnetic observatories are crippled through the introduction of electric tramways, then so much the worse for the observatories. And I fear that my professional brethren only look at me askance for allowing my devotion to the practical applications of electricity to be tainted with a keen interest in that excessively small, but none the less extremely wonderful, magnetic force which controls our compass needles. But this interest emboldens me to ask again, Can the system of electric traction that has already destroyed the two most important magnetic observatories in the United States and British North America be the best and the fittest to survive? Again, do we take such care and spend such vast sums in tending the weak and nursing the sick because we are convinced that they are the fittest to survive? May it not, perhaps, be because we have an inherent doubt about the justness of the survival of the strongest, or because even the strongest of us feels compelled to modestly confess his inability to pick out the fittest that modern civilisation encourages not the destruction, but the preservation of what has obvious weakness, on the chance that it may have unseen strength? When the electrical engineer feels himself full of pride at the greatness, the importance, and the power of his industry, and when he is inclined to think slightingly of the deflection of a little magnet compared with the whirl of his 1,000-h.p. dynamo, let him go and visit a certain dark store-room near the entrance hall of the Royal Institution, and, while he looks at some little coils there, ponder on the blaze of light that has been shed over the whole world from the dimly-lighted cupboard in which those dusty coils now lie. Then he may realise that while the earth as a magnet has endured for all time, the earth as a tramway conductor may at no distant date be relegated to the class of temporary make-shifts, and that the raids of the feudal baron into the agricultural fields of his neighbours were not more barbarous than the alarms and excursions of the tramway engineer into the magnetic fields of his friends.

A very important consideration in connection with the rapid development of physical enquiry is the possibility of extending our power of assimilating current physical knowledge. For so wide have grown the limits of each branch of physics that it has become necessary to resort to specialisation if we desire to widen further the region of the known. On the other hand, so interlinked are all sections of physics that this increase of specialisation is liable to hinder rather than assist advance of the highest order. An experimenter is therefore on the horns of a dilemma. On the one hand, if he desires to do much he must confine himself more or less to one line of physical research, while, on the other hand, to follow that line with full success requires a knowledge of the progress that is being made along all kindred lines. Already an investigator who is much engaged with research can hardly do more as regards scientific literature than read what he himself writes—soon he will not have time to do even that. Division of labour and co-operation have, therefore, become as important in scientific work as in other lines of human activity. Like bees, some

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must gather material from the flowers that are springing up in various fields of research, whilst others must hatch new ideas. But, unlike bees, all can be of the "worker" class, since the presence of drones is unnecessary in the scientific hive.

Englishmen have long been at a disadvantage in not possessing any ready means of ascertaining what lines of physical enquiry were being pursued in foreign countries, or, indeed, even in their own. And so far from making it easier to obtain this information, our countrymen have, I fear, until quite recently, been guilty of increasing the difficulty. For every college, every technical school in Great Britain—and their number will soon rival that of our villages—seems to feel it incumbent on itself to start a scientific society. And in accordance with the self-reliant character of our nation, each of these societies must be maintained in absolute independence of every other society, and its proceedings must be published separately, and in an entirely distinct form from those of any similar body. To keep abreast, then, with physical advance in own country is distinctly difficult, while the impossibility of maintaining even a casual acquaintance with foreign scientific literature lays us open to a charge of international rudeness. There is, of course, the German *Beiblätter*, but the Anglo-Saxon race, which has spread itself over so vast a portion of the globe, is proverbially deficient in linguistic powers, and consequently, till quite recently, information that was accessible to our friends on the Continent was closed to many workers in Great Britain, America, and Australia. Influenced by these considerations, the Physical Society of London, in 1895, embarked on the publication of abstracts from foreign papers on pure physics, and, as it was found that this enterprise was much appreciated, the question arose at the end of the following year, whether, instead of limiting the journals from which abstracts were made to those appearing in foreign countries, and the papers abstracted to those dealing only with pure physics, the abstracts might not with advantage be enlarged, so as to present a *résumé* of all that was published in all languages on physics and its applications. The first application of physics which it was thought should be included was electrical engineering, and so negotiations were opened with the Institution of Electrical Engineers. After much deliberation on the part of the representatives of the two societies, it was finally decided to start a monthly joint publication, under the management of a committee of seven, two of whom should represent the Institution of Electrical Engineers, two the Physical Society, and three the two societies jointly. *Science Abstracts* was the name selected for the periodical, and the first number appeared in January of this year. A section is devoted to general physics, and a separate section to each of its branches; similarly a section is devoted to general electrical engineering, and a separate section to each of its more important sub-divisions. The value of *Science Abstracts* is already recognised by the British Association, as well as by the Institution of Civil Engineers, for those societies make a liberal contribution towards the expenses of publication, for which the Physical Society and the Institution of Electrical Engineers are responsible. At no distant date it is thought that other bodies may co-operate with us, and we have hopes that finally the scheme may be supported by the scientific societies of many Anglo-Saxon countries. For our aim is to produce, in a single journal, a monthly record in English of the most important literature appearing in all languages on physics and its many applications. This is the programme—a far wider one, be it observed, than that of the *Beiblätter*—which we sanguinely hope our young infant *Science Abstracts* will grow to carry out. The saving of time and trouble that will be effected by the publication of such a journal can hardly be overestimated, and the relief experienced in turning to a single periodical for knowledge that could hitherto be obtained solely by going through innumerable scientific newspapers, in many different languages, can only be compared with the sensation of rousing from a distracting and entangled dream to the peaceful order of wakeful reality. I therefore take this opportunity of urging on the members of the British Association the importance of the service which they can individually render to science by helping on an enterprise that has been started solely in its aid, and not for commercial purposes.

The greatness of the debt owed by industry to pure science is often impressed on us, and it is pointed out that the comparatively small encouragement given by our nation to the development of pure science is wholly incommensurate with the gratitude which it ought to feel for the commercial benefits science has enabled it to reach. This is undoubtedly true, and no one appreciates more fully than myself how much commerce is indebted to those whose researches have brought them—it may be fame, but certainly nothing else. The world, however, appears to regard as equitable the division of reward which meets out tardy approbation to the discoverer for devising some new principle, a modicum of the world's goods to the inventor for showing how this principle can be applied, and a shower of wealth on the contractor for putting the principle into practice. At first sight, this appears like the irony of fate, but, in fact, the world thus only proves that it is human by prizing the acquisition of what it realises that it stands in need of, and by valuing the possession of what it is able to comprehend. Now is there not a debt which those who pursue pure science are in their turn equally forgetful of—viz., the debt to the technical worker or to some technical operation for the inception of a new idea? For purely theoretical investigations are often born of technics, or, as Whewell puts it, "Art is the parent, not the progeny, of science; the realisation of principles in practice forms part of the prelude as well as of the sequel of theoretical discovery." I need not remind you that the whole science of floating bodies is said to have sprung from the solution by Archimedes of Hiero's doubt concerning the transmutation of metals in the manufacture of his crown. In that case, however, it was the transmutation of gold into silver, and not silver into gold, that troubled the philosopher. Again, in the "History of the Royal Society at the End of the Eighteenth Century," Thomson says regarding Newton, "a desire to know whether there was anything in judicial astrology first put him upon studying mathematics. He discovered the emptiness of that study as soon as he erected a figure; for which purpose he made use of one or two problems in Euclid. . . . He did not then read the rest, looking upon it as a book containing only plain and obvious things."

The analytical investigation of the motion of one body round an attracting centre, when disturbed by the attraction of another, was attacked independently by Clairault, D'Alembert, and Euler, because the construction of lunar tables had such a practical importance, and because large money prizes were offered for their accurate determination. The gambling table gave us the whole theory of probability, Bernoulli's and Euler's theorems, and the first demonstration of the binomial theorem, while a request made to Montmort to determine the advantage to the banker in the game of "pharaon" started him on the consideration of how counters could be thrown, and so led him to prove the multinominal and various other algebraical theorems. Lastly, may not the gambler takes some credit to himself for the first suggestion of the method of least squares, and the first discussion of the integration of partial differential equations with finite differences contained in Laplace's famous "Théorie Analytique des Probabilités"? The question asked Rankine by James R. Napier regarding the horse-power which would be necessary to propel, at a given rate, a vessel which Napier was about to build, resulted in the many theoretical investigations carried out by Rankine on water lines, skin-friction, stream lines, etc. For, as Prof. Tait has said, "Rankine, by his education as a practical engineer, was eminently qualified to recognise the problems of which the solution is required in practice; but the large scope of his mind would not allow him to be content with giving merely the solution of those particular cases which most frequently occur in engineering as we now know it. His method invariably is to state the problem in a very general form, find the solution, and apply this solution to special cases." Helmholtz studied physiology because he desired to be a doctor, then physics because he found that he needed it for attacking physiological problems, and lastly mathematics as an aid to

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physical research. But I need not remind you that it is his splendid work in mathematics, physics, and physiology, and not his success in ministering to the sick, that has rendered his name immortal. Did not Kepler ask: "How many would be able to make astronomy their business if men did not cherish the hope of reading the future in the skies?" And did he not warn those who objected to the degradation of mingling astrology with astronomy to beware of "throwing away the child with the dirty water of its bath?" Even now, may we not consider all the astronomical research work done at the Royal Observatory, Greenwich, as a by-product, since the observatory is officially maintained merely for the purpose of navigation? And are there not many of us who feel assured that, since researches in pure physics and the elucidation of new physical facts must quite legitimately spring from routine standardising work, the most direct way—even now at the end of the nineteenth century—of securing for the country a national physical laboratory is to speed forward a Government standardising institute? Lastly, as you will find in Dr. Thorpe's fascinating "Life of Davy," it was the attempt to discover the medicinal effect of gases at the Pneumatic Institution in this city that opened up to Davy the charm of scientific research. And, indeed, the Royal Institution itself, the scientific home of Davy, Faraday, Tyndall, Rayleigh, and Dewar, owes its origin to Romford's proposal "for forming in London by private subscription an establishment for feeding the poor and giving them useful employment . . . connected with an institution for introducing and bringing forward into general use new inventions and improvements by which domestic comfort and economy may be promoted."

Coming now to physics proper, there is one branch which, although of deep interest, has hitherto been much neglected. We possess three senses which enable us to detect the presence of things at a distance—viz., seeing, hearing, and smelling. The first two are highly cultivated in man, and, probably for that reason, the laws of the propagation of the disturbances which affect the eyes and the ears have been the subject of much investigation, whereas, although to many animals the sense of smell is of far greater importance than those of seeing or hearing, and although, even in the human brain, a whole segment—a small one in modern man, it is true—is devoted to the olfactory fibres, the laws of the production and propagation of smell have received practically no attention from the physicist. For some time past it has, therefore, seemed to me to be of theoretical and practical importance to examine more fully into the physics of smell. Various other occupations have hitherto prevented my advancing much beyond the threshold of the subject, but, as it seems to me to open up what is practically a new field of enquiry for the physicist, I take this opportunity of putting on record some facts that have been already elucidated. Various odoriferous substances have been employed in the experiments, and for several of these I am indebted to Mr. W. J. Pope. Although the physicist has been allowing the mechanical side of the subject to lie dormant, the chemist, I find, has been analysing flowers and other bodies used in the manufacture of scents, and then synthetically preparing the odoriferous constituents. In this way, Mr. Pope informs me, there has been added to the list of manufactured articles, during the past seven years or so, vanilin, heliotropin, artificial musk, irone and ionone, which give the perfume of the violet; citral, that of lemongrass; coumarin, that of hay; and various others; and specimens of several of these artificial scents, together with other strongly-smelling substances, he has kindly furnished me with. If it be a proof of civilisation to retain but a remnant of a sense which is so keen in many types of dogs, then I may pride myself on having reached a very high state of civilisation. But with the present investigation in view, this pride has been of a very empty character, since I have been compelled to reject my own nose as quite lacking the sensitiveness that should characterise a philosophical measuring instrument. The ladies of my family, on the contrary, possess a nasal quickness which formerly seemed to me to be rather of the nature of a defect, since, at any rate in towns, there are so many more disagreeable odours than attractive ones. But on the present occasion their power of detecting slight smells, and the repugnance which they show in the case of so many of them, have stood me in good stead, and made it possible to put before you the following modest contribution to the subject. There is a generally accepted idea that metals have smells, since if you take up a piece of metal at random, or a coin out of your pocket, a smell can generally be detected. But I find that, as commercial aluminium, brass, bronze, copper, German-silver, gold, iron, silver, phosphor-bronze, steel, tin, and zinc are more and more carefully cleaned, they become more and more alike in emitting no smell, and, indeed, when they are very clean it seems impossible with the nose, even if it be a good one, to distinguish any one of these metals from the rest, or even to detect its presence. Brass, iron, and steel are the last to lose their characteristic odour with cleaning, and for some time I was not sure whether the last two could be rendered absolutely odourless, in consequence of the difficulty of placing them close to the nose without breathing on them, which, as explained later on, evolves the characteristic "copper" and "iron" smell. But experiment shows that, when very considerable care is taken both in the cleaning and the smelling, no odour can be detected even with iron or steel.

Contrary, then, to what is usually believed, metals appear to have no smell *per se*. Why, then, do several of them generally possess smells? The answer is simple; for I find that handling a piece of metal is one of the most efficient ways of causing it to acquire its characteristic smell, so that the mere fact of lifting up a piece of brass or iron to smell it may cause it to apparently acquire a metallic odour, even if it had none before. This experiment may be easily tried thus: Clean a penny very carefully until all sense of odour is gone; then hold it in the hand for a few seconds, and it will smell—of copper, as we usually say. Leave it for a short time on a clean piece of paper, and it will be found that the metallic smell has entirely disappeared, or at any rate, is not as strong as the smell of the paper on which it rests. The smell produced by the contact of the hand with the bronze will be marked if the closed hand containing it be only opened sufficiently for the nose to be inserted, and it can be still further increased by rubbing the coin between the fingers. All the metals enumerated above, with the exception of gold and silver, can be made to produce a smell when thus treated, but the smells evolved by the various metals are quite different. Aluminium, tin, and zinc, I find, smell much the same when rubbed with the fingers, the odour, however, being quite different from that produced by brass, bronze, copper, German-silver, and phosphor-bronze, which all give the characteristic "copper" smell. Iron and steel give the strong "iron" smell, which again is quite different from that evolved by the other metals. In making these experiments it is important to carefully wash the hands after touching each metal to free them from the odour of that metal. It is also necessary to wait for a short time on each occasion after drying the hands, since it is not until they become again moist with perspiration that they are operative in bringing out the so-called smell of metals. That the hands, when comparatively dry, do not bring out the smell of metals is in itself a disproof of the current idea that metals acquire a smell when slightly warmed. And this I have further tested by heating up specimens of all the above-mentioned metals to 120deg. F. in the sun, and finding that they acquire no smell when quite clean and untouched with the hands.

Again, dealing with the copper group, or with aluminium, no smell is produced by rubbing any one of them with dry table salt, strong brine, or with wet salt, provided that a piece of linen is used as the rubber; but if the finger be substituted for the linen to rub on brine, a smell is observed with copper and German-silver, this smell, however, being rather like that of soda; and whether dry salt, brine, or wet salt be rubbed on aluminium, a smell is noticed if the finger be used as the rubber, this smell being very marked in the case of the brine or wet salt. Again, although even when linen soaked in brine, or having wet salt on it, is used to rub tin, iron, or steel, a faint smell is noticed. This is much increased when the finger is substituted for the piece of linen. As a further illustration of the part played by the skin in causing metallic smells, it may be mentioned

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that the explanation of certain entirely contradictory results, which were obtained in the early part of the investigation, when linen soaked in strong brine was rubbed on aluminium, was ultimately traced to one layer of moist linen of the thickness of a pocket-handkerchief allowing the finger to act through it, so that an odour was sometimes noticed on rubbing aluminium with the piece of linen soaked in brine. For it was found that when two or more layers of the same linen soaked in the same brine were employed to separate the finger from the aluminium during the rubbing, no smell could be detected. From the preceding it seems that the smell is these cases is evolved partly by contact with the finger, partly by the action of the solution of salt, and partly by the rubbing of the solid particles of salt against the metals. That the friction of solid particles against metals is operative in evolving smells is also illustrated by the smell noticed when iron is filed, or when aluminium, iron, or steel is cleaned with glass-paper or emery-paper in the air. Indeed, the smell thus evolved by aluminium, Mrs. Ayrton finds particularly offensive. A slight smell is also noticed if iron or steel be rubbed in the air with even a clean piece of dry linen, and each specimen of the copper group, with the exception of the phosphor-bronze, which was tried in this way, gave rise to a faint, rather agreeable smell. No indication of odour could, however, be thus produced with aluminium or zinc when both the metals and the linen rubber were quite clean. It should, however, be borne in mind that all these experiments, where very slight smells are noticed, and especially when the odour rapidly disappears on the cessation of the operation that produced it, are attended with a certain amount of doubt, for the linen rubber cannot be freed from the characteristic smell of "clean linen," no matter how carefully it may be washed.

Before, then, a metal can evolve a smell, chemical action must apparently take place, for rubbing the metal probably frees metallic particles, and facilitates the chemical action to which I shall refer. All chemical actions, however, in which metals take part do not produce smell; for example, no smell but that of soda, or sugar, respectively, can be detected on rubbing any single one of the series of metals that I have enumerated with a lump of wet soda, or a lump of wet sugar, although chemical action certainly takes place. Again, no metallic smell is observable when dilute nitric acid is rubbed on copper, German-silver, phosphor-bronze, tin, or zinc, although the chemical action is very marked in the case of some of these metals. Weak vinegar or a weak solution of ammonia are also equally inoperative. On the other hand, merely breathing on brass, copper, iron, steel, or zinc, which has been rendered practically odourless by cleaning, produces a very distinct smell, while a very thin film of water placed on iron or steel evolves a still stronger odour. Such a film, however, produces but little effect with any of the metals except these two, and if the whole series is lightly touched in succession with the tongue, the iron and steel smell as strongly as when breathed on, the German-silver more strongly than when breathed on or covered with a water film, and the other metals hardly at all.

Now, as regards the explanation of these metallic smells, which have hitherto been attributed to the metals themselves. This, I think, may be found in the odours produced when the metals are rubbed with linen soaked in dilute sulphuric acid. For here, apart from any contact of the metal with the skin, the aluminium, tin, and zinc, are found to smell alike; the copper group also smell alike, and the iron and steel give rise to the characteristic "iron" smell, which, in this case, can be detected some feet away. Now, it is known that when hydrogen is evolved by the action of sulphuric acid on iron, the gas has a very unpleasant smell, and this, Dr. Tilden tells me, is due to the presence of hydro-carbons, and especially of paraffin. I have been, therefore, led to think that the smell of iron or steel when held in the hand is really due to the hydro-carbons to which this operation gives rise; and it is probable that no metallic particles, even in the form of vapour, reach the nose or even leave the metal. Hence, although smell may not, like sound, be propagated by vibration, it seems probable that particles of the metal with which we have been accustomed to associate the particular smell may no more come into contact with the olfactory nerves than a sounding musical instrument strikes against the drum of the ear. And the same sort of result may occur when a metal is rubbed, for, although in that case particles may very likely be detached, it seems possible that the functions of these metallic particles may be to act on the moisture of the air, and liberate hydrogen similarly contaminated; and that in this case also it is the impurities which produce the smell, and not the particles of the metal with which we have been accustomed to associate it. This view I put forward tentatively, and to further elucidate the matter I am about to begin a series of smell tests in various gases, artificially dried, with metals as pure as can be obtained.

I next come to the diffusion of smell. From the experience we have of the considerable distance at which a good nose can detect a smell, and the quickness with which the opening of a bottle of scent, for example, can be detected at a distance, I imagined that tubes not less than 15ft. or 20ft. in length would be required for ascertaining, even roughly, the velocity at which a smell travels. But experiment soon showed that when the space through which a smell had to pass was screened from draughts it diffused with surprising slowness, and that feet could be replaced by inches in deciding on the lengths of the tubes to be used. These are made of glass, which is relatively easy to free from remanent smells. When the room and tube had been freed from smell by strong currents of air blown through them, the tube was corked up at one end and taken outside to have another cork, to which was attached some oderiferous substance, inserted at the other end. The tube was now brought back to the odourless room, and placed in a fixed horizontal or vertical position, and the unscented stopper was withdrawn. As a rule, immediately after the removal of the stopper a smell was observed, which had been transmitted very quickly through the tube by the act of corking up the other end with the stopper carrying the odoriferous material. This first whiff, however, lasted only a very short time, and then a long period elapsed before any further smell could be detected at the free end of the tube, whether that end was left open or closed between times. Finally, however, after, for example, about 18 minutes in the case of a 3ft. horizontal tube, having a large cotton-wool sponge saturated with oil of limes attached to one cork, the smell become definite and recognisable. It would, therefore, appear that the passage of smell is generally far more due to the actual motion of the air containing it than to the diffusion of the odoriferous substance through the air. And, as a striking illustration of this, the following is interesting: After the stopper had been in contact with the odoriferous substance for some time, it, of course, acquired a smell itself, which gradually spread in the room in which the experiment was made. And although this smell was due simply to the exposed part of the stopper, while the air inside the tube was at one end in contact with a mass of the odoriferous substance itself, the only place where the smell could not be detected during the course of the experiment was the space inside the open end of the glass tube. And what seemed very surprising, it was found necessary in several cases to blow air through the room to clear out the smell which emanated from the outside of the copper before the smell coming along the tube from the mass of odoriferous substance which was inside it at the other end could be detected. A further proof of the important part played by the motion of the air in diffusing smell was the fact that a strong smell at the free end of the tube could at any time be caused by merely loosening the stopper to which the scented sponge was attached; for sniffing at the free end then made a draught through the tube which brought the scent with it.

Further, although the glass tubes were coated outside with a thick layer of non-heat-conducting material, so as to check the formation of convection currents, due to difference in the inside and outside temperature, caused by handling, the rate of travel of a smell from a given odoriferous material was found to be much quicker when the tube was vertical than when it was horizontal. But this, I am inclined to think, may have been caused by a small convection current which still was produced in spite of these precautions.

(Continued on page 337.)

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THE BRITISH ASSOCIATION AT BRISTOL.

For the third time of asking the British Association has met at Bristol, a city whose real origin is hidden in the mists of legendary lore. We notice the excellent handbook which has been produced for the convenience and information of members does not venture into the realms of the legendary. Dr. Evans, in his history of Bristol published at the beginning of the century, is not so reluctant, and tells us that Malmutius, King of Cornwall, who became King of Britain, and who founded Malmsbury, formed four great roads through the kingdom, one of which lead direct to Bristol. Brennus, a son of Malmutius, is said to have enlarged and improved Bristol. Whatever the value of such legends, they serve to show that the city was of importance quite early in the history of the country. We could have wished that Mr. Latimer, in his "Modern History of Bristol," in the handbook above referred to, paid more attention to what might be termed the literary history of the city. Early in its modern history, one writer says about the year 700, there was formed a "Society of Kalendaries" in the city, whose chief object seems to have been the keeping of records of public acts and the formation of a library. This library was unfortunately destroyed by fire in 1466, and is said to have consisted almost entirely of books on Saxon antiquities. Mr. Matthews refers to this society in his short essay in the handbook "On Bristol Libraries." In 1607 the number of inhabitants was counted, and found to be 10,549. The reason for such counting was to know the corn weekly required to supply the city. In the eighteenth century a public library was founded, and a philosophical society instituted for the purpose of disseminating scientific knowledge. Quite recently we have heard a good deal about Columbus and his discovery of America, but it must be remembered that it was Cabot, a Bristolian, who first reached the mainland of America, after having discovered Newfoundland, soon afterwards colonised by John Guy, another native of Bristol. Thus the association is holding its meeting in no mean city, and if the keynote struck in the presidential address affords any indication of the value of the papers to be read, this meeting should be one of the most successful ever held by this association. Sir William Crookes took for his text the food supply of the world. At first sight this subject would not seem of interest to electrical engineers, but when examined it is of the most surpassing interest. We are told the demand is fast overtaking the supply, and to increase the supply it is necessary to have nitrogen fixed in the form of nitrate of soda. The natural stores of nitrate are becoming rapidly used up, so that the problem before chemists and other scientific men is how to artificially and cheaply form nitrate by fixing the uncombined nitrogen which forms so large a part of the atmosphere and which exists there in inexhaustible quantities. The method forecasted by the president in his address requires electrical apparatus. The construction of this electrical apparatus will be the work of electrical engineers, hence there is a bright

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outlook for work coming on for the next generation. Really we must use an old and much abused phrase and say that the applications of electrical energy are yet in their infancy, for there loom up in every direction applications which, so far as human mind can forsee, must in the no very distant future provide occupation for multitudes of men. Electric lighting bulks largely in our eyes at present, but the work of lighting is but small in comparison with that of power distribution, of which, however, as yet we have caught but a glimpse. The references in the address to the position of the president among those who are investigating problems within the borderland of science do not concern us, but we are a little interested to know the new weapon of attack by means of which another rare earth has been discovered. Sir William Crookes must be congratulated upon his address, which is conclusive proof that many of our most scientific investigators do not overlook problems of an extremely practical nature. The impetus which this address will give will no doubt lead to the construction of practical apparatus for the fixation of nitrogen in the form required in agricultural operations.

THE BRITISH ASSOCIATION.

Address to the Mathematical and Physical Section.

(Concluded from page 335.)

For, as suggested by Dr. Ramsay several years ago, a substance must have a molecular weight at least 15 times that of hydrogen to produce a sensation of smell at all, and, further, since camphor, with which many of my experiments have been made, has, when vaporised, a density about five times that of the air, it seems unlikely that scent vapour should diffuse much more quickly upwards through a vertical column of air than through a horizontal one. At the same time, not only are the tests with the glass tubes very striking, but the general impression which exists that smells rise, indeed the very fact that the nasal channels of animals open downwards, tends to show that, whether due to draughts or not, smells have really a tendency to ascend. And the following result obtained with glass tubes closed at one end with stoppers carrying respectively camphor, menthol, oil of limes, etc., and at the other end with corks, is instructive on this point. For, on uncorking such a tube after it had been closed for a long time and allowing the odour to stream out of it through the open air towards the experimenter's face, it was always found that the tube had to be brought much closer when the scent stream was poured downwards than when she was in a vertical position and it was allowed to ascend, although when it was poured downwards the experimenter brought her nose into as favourable a position as possible for receiving the smell, by lying down with her head thrown well back. As an illustration of the inefficiency of diffusion alone to convey a smell, you will find that if you hold your breath, without in any way closing your nose either externally or by contracting the nasal muscles, you will experience no smelling sensation even when the nose is held close to pepper, or a strong solution of ammonia, or even when camphor on a minute tube is introduced high up into the nostril. Mere diffusion from the lower nasal cavity into the upper cannot apparently take place with sufficient ease to produce the sense of smell, so than an actual stream of air through the upper portion of the nose seems necessary even when the nose is a very sensitive one. This stream, for substances placed outside the nose, is produced by breathing in, no smell being detected while breathing out. On the other hand, if a substance be placed inside the mouth its flavour is recognised when the air is forced outwards through the nostrils—that is, at each expiration. Hence we may experience alternately two totally different smells by placing one substance outside the nose and the other in the mouth, the one smell being noticed in inhaling and the other in exhaling. And the latter can be increased by smacking the lips, which, I think, has really for its object the forcing of more air through the nostrils at each expiration.

Experiments on the propagation of smells in a vacuum have also been commenced in my laboratory, and the results are no less surprising than those obtained with the propagation in air. A U tube, 7in. high, had the odoriferous substance placed inside it at the top of one limb, and a very good vacuum could be made by allowing mercury to flow out of the tube. Then the two limbs were separated by raising the mercury column, the air being admitted at the top of the other limb, without its coming into contact with the odoriferous substance; the nose was applied at the top of this limb. When liquids like ammoniated lavender, smelling salts, solution of musk, and amyl-acetate were employed, and various devices were used for introducing the liquid and preventing its splashing when it boiled on exhausting the air, it was found that the time that it was necessary to leave the two limbs connected for a smell to be just observable was reduced from a few minutes or seconds when the tube was filled with air to less than half a second for a good vacuum; with solid camphor it was reduced from 20 minutes to one second, and when moist rose leaves were used, from 50 minutes to two seconds. But with solid particles of musk the time was not reduced below 20 minutes by taking away the air, while with dried lavender flowers and dried woodruff leaves no smell could be detected after the two limbs had been connected for many hours, and a good vacuum maintained. These experiments are, of course, somewhat complicated by variations in the amount of odorous surface exposed, but they seem to indicate that with these particular dried substances either the rate of evolution of th scent, or its rate of propagation, or both, are very slow even in a good vacuum. I have also carried out some tests on the power of different substances to absorb various scents from the air. Lard, it is well known, is used to absorb the perfume from flowers in the commercial manufacture of scents, perhaps because it has little odour of its own, and because the scent can be easily distilled from it. But if lard, wool, linen, blotting-paper, silk, etc., be shut up for some hours in a box at equal distances from jasmine flowers, dried woodruff leaves, or from a solution of ammonia, I find that it is not the lard, but the blotting-paper, that smells most strongly when the articles are removed from the box. On the other hand, when solid natural musk is employed, it is the wool that alone acquires much smell, even after the box has been shut up for days.

Another noteworthy fact is the comparatively rapid rate at which grains of natural musk are found to lose their fragrance when exposed to the air. The popular statement, therefore, that a grain of musk will scent a room for years supplies but another example of the contrast between text-book information and laboratory experience. The power of a smell to cling to a substance seems to depend neither on the intensity of the smell nor on the ease with which it travels through a closed space. Musk has but a faint smell, but the recollection of the greeting of a rich Oriental survives many washings of the hands. The smell of rose leaves, again, is but faint, and it travels very slowly through air in a tube; and yet the experiments on its propagation in the glass vacuum apparatus were rendered extremely troublesome, by the difficulty experienced in removing the traces of the smell from the glass between the successive tests. Rubbing its surface was quite ineffectual, and even the mercury had to be occasionally shaken up with alcohol to free it from the remanant smell. In fact we found, as Moore put it:

> You may break, you may shatter the vase if you will,
> But the scent of the roses will cling to it still.

This absorption of scents by glass, and the ease with which I found that jasmine flowers could be distinguished from woodruff leaves, even when each was enclosed in a series of three envelopes specially prepared from glazed paper, and when many precautions were taken to prevent an odour being given to any of the envelopes in the operation of

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closing, as well as to prevent its diffusion through the joins in the paper, led me to try whether an actual transpiration through glass could be detected with the nose. For this object a number of extremely thin glass bulbs were blown from soda and from lead glass, so thin that they exhibited colours like a soap bubble, and felt, when gently touched, like very thin oiled silk, and after a little ammoniated lavender, amyl nitrite, ethyl sulphide, mercaptan, solution of musk, oil of peppermint, and popylamine had been introduced into them respectively, they were hermetically sealed, and placed separately in glass stoppered bottles. In some cases, on removing the stopper from a bottle after many hours, a faint odour could be detected, but so, generally, could a minute flaw after much searching; the crack, however, being so slight that in did not allow sufficient passage of the air to prevent the bulb subsequently breaking, presumably from changes of atmospheric pressure. And in those cases where a smell was detected without any flaw being found in the glass, the subsequent breaking of the bulb put an end to furthur testing. The question, therefore, remains unanswered.

In presenting this brief introduction to the physics of smell, I have aimed at indicating the vast territory that waits to be explored. That it will be found to contain mines of theoretical wealth there can be no doubt, while it is probable that a luxuriant growth of technical application would spring up later on. Already, for example, Mrs. Ayrton unintentionally picks out inferior glass by the repugnance she shows at drinking water out of certain cheap tumblers. To conclude, I may say that one of my fondest hopes is that an enquiry into the physics of smell may add another to the list of wide regions of knowledge opened up by the theoretical physicist in his search for answers to the questions of the technical man.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE III.

(Continued from page 303.)

Physical and Mechanical Properties.

The physical and mechanical properties of guttapercha depend chiefly on its chemical composition—*i.e.*, upon the relative proportion of gutta and resin—or ratio, $\frac{G}{R}$; but as far as the specific gravity is concerned, the constitution of the resin, and probably that of the gutta also, asserts itself. The specific gravity of guttapercha of average composition is practically the same as that of water; but the individual brands differ somewhat from each other, some being lighter and others heavier than water. In this bottle I have a number of small spheres of different kinds of guttapercha immersed in distilled water, and you observe that most of them float; but a few have sunk to the bottom. Table X. gives the specific gravities of 12 different sorts, including an average material, obtained by mixing different brands in the masticator after they had been cleaned. The table also gives the specific gravity of guttapercha obtained from leaves by my process, as well as those of balata and Para-caoutchouc, for comparison. It will be seen that, disregarding caoutchouc, by far the lowest specific gravity is that of the material obtained from leaves, the "soondie" following next, then the "genuine" and "mixed," and finally the "white"; the "mixed white" being by far the heaviest. The guttapercha used for these determinations was in the form of sheet 2·2mm. thick, and the air was completely removed from the strip under the receiver of an air-pump before the final weighing was taken. The temperature of the water was accurately adjusted to 15deg. C., and the specific gravities given in the table are those compared with water of that temperature. The table further gives the ratio $\frac{G}{R}$ for each material. The complete analysis, including a determination of the ashes, was given in the Appendix.

Table X.—Specific Gravity of Cleaned Guttapercha (2·2 m./m. Sheet at 15deg. C.).

Group	Description of material.	Spec. grav.	Ratio $\frac{G}{R}$
I. Genuine.	Pahang	0·9858	3·9
	Banjer red	0·9868	4·0
	Bulongan red	0·9911	3·4
	Mean	0·9879	3·8
II. Soondie.	Bagan	0·9709	1·44
	Kotaringin (Goolie red)	0·9729	1·30
	Serapong	0·9767	1 38
	Mean	0 9735	1·37
III. White.	Bulongan	1·0093	1·57
	Mixed	1·0186	1·14
	Padang	0 9911	1·40
	Mean	1·0063	1·37
IV. Mixed.	Padang reboiled	0 9960	1·18
	Salawak mixed	0·9912	1·20
	Mixed after cleaning	1·0022	1 75
	Mean	0·9965	1·38
V. Various.	Balata	0 9731	1·16
	G.P. from leaves	0·9625	5·19
	Para-caoutchouc	0·9275	—

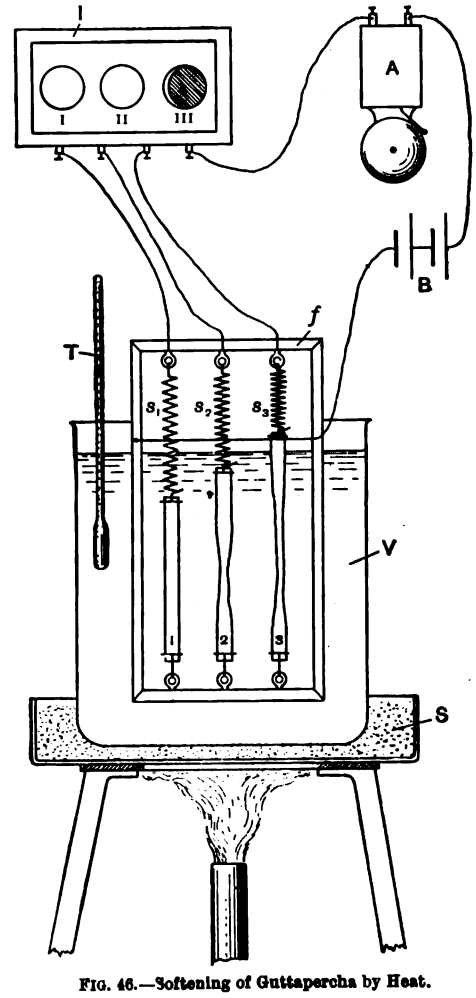

Fig. 46.—Softening of Guttapercha by Heat.

The same description of sheets was used for determining the absorption of water after prolonged immersion, the experiment extending over 18 weeks. The area of each strip exposed to the water was approximately one square decimeter, and its weight about 10 grm. The results were plotted in diagrams, from which it was observed that the materials belonging to each group behave much alike, which shows that there is really a kind of relationship between them, and we shall find this similarity between the members of a group in other respects also. The reduction to pure gutta is based on the assumption that it is the hydrocarbon which chiefly absorbs the water,* the resin being practically impervious to it. It is interesting to observe that after reduction to pure gutta, the best kinds of material are still the most pervious, but the guttapercha from leaves is now the least; whereas if the materials be directly compared with each other, the "white" sorts show the least absorption.

* Cantor Lectures delivered before the Society of Arts.

* As the materials all contain over 1 per cent. of water before immersion, the dirt contained in them must have been completely saturated beforehand, so that practically no further absorption of water by it can take place.

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Pure Para-caoutchouc possesses, as is well known, a very much greater absorptive power for water than guttapercha, and this is still the case after reduction to pure gutta, as the curves show.

Similar experiments, in which sea water was used in place of the water from the Kent Water Company, gave very curious results, which are likewise recorded in an Appendix.

Another physical property of guttapercha of some practical importance is the temperature at which it becomes plastic, and this depends almost entirely upon the relative proportion of gutta and resin, as I should like to demonstrate to you by an experiment.

I have here a little apparatus (Fig. 46), consisting of a rectangular frame, in which three narrow strips (1, 2, 3) of guttapercha are each held under the tension of a spring, it being so arranged that an electric contact is established and an alarum sounded as soon as one of the strips becomes soft enough to allow the spring to pull it apart. The three materials contain 2½, 38, and 60 per cent. of resin respectively, the one with the

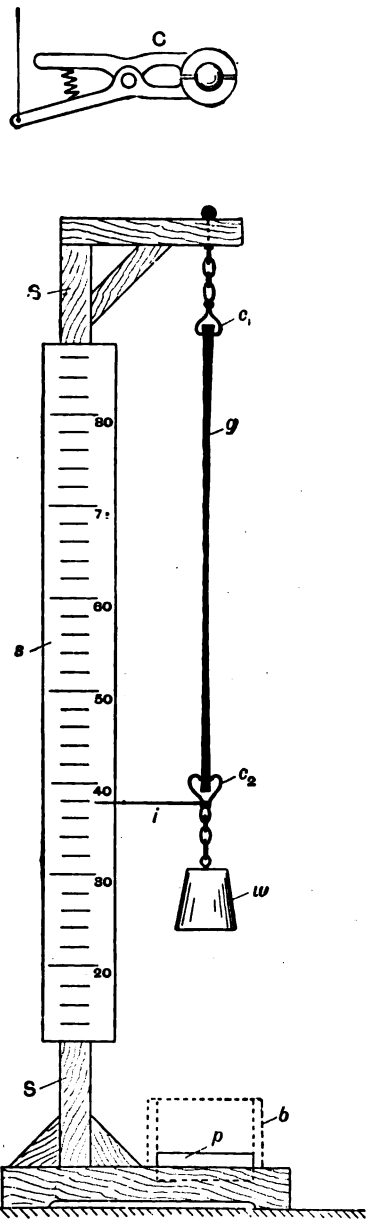

FIG. 47.—Apparatus for Testing Golf Balls.
(Shown in Use for Stretching Test).

low percentage having been artificially produced, The frame with the strips is immersed in water contained in a large beaker, which is being slowly heated on a sand bath. The temperature of the water is now about 40deg. C. and nothing has as yet occurred. On reaching 42deg. C. the bell sounds for the first time and shutter No. 3 of the indicator drops, which shows that the material containing 60 per cent. of resin has sufficiently softened to give way to the spring; now the bell rings a second time and shutter No. 2 drops. I find the temperature of the water to be 48deg. C. A rather long time elapses before the bell rings a third time and No. 1 shutter drops; however, you hear it now, and the temperature at which the strip with 2½ per cent. of resin softens I find to be about 55deg. C.*

* These figures are only of relative value, depending on the conditions of the experiment. They are not comparable with those given in the tables which follow; this also applies to other figures obtained during the lecture.

A third physical property—viz., the time required by a material to harden again on cooling, after having previously been softened in hot water—also depends chiefly on the relative percentage of gutta and resin, as you will see from some tables to be given later on; but time will not permit me to enter more fully into this subject, and I must now consider the mechanical properties.

The principal mechanical property with which we have to deal is the tensile strength. When guttapercha is stretched it becomes much stronger, as you observe when I pull this thin strip apart by hand. At first it gives way easily; but after it has stretched to a certain extent it becomes so strong that I cannot further lengthen it. I can show you this more distinctly with the large apparatus (Fig. 47) which I have here. You observe the thin rod of guttapercha with the thickened ends, technically called a "gut," *g*, suspended from the bracket at the top of the stand, S. I apply a weight, *w*, of 4lb. to it and you see it stretches at once to a certain point on the scale, *s*, but it does not break, even if I apply twice that weight, although the gut has become considerably thinner than at first. To accelerate matters, I now load it with 21lb.; it stretches still further, and now breaks. If the experiment had been carefully made, and the breaking strain per square inch of original area taken, as is usual, it would have worked out to be something between 2,000lb. and 3,000lb. for that particular material; but, if instead of the original area, the final sectional area at breaking had been taken, the strain would have been found to be about 12,000lb. per square inch. I have other guts here made of materials having different percentages of resin. If I were to test them in the same way, you would see that their tensile strength depended largely on these percentages. Here, for instance, is a material having about 45 per cent. of gutta and 55 per cent. of resin, which breaks at about 770lb. to the square inch; here is another gut of the same material, after most of the resin has been extracted with petroleum spirit, and for this nearly twice that breaking strain would be required.

The elongation—*i.e.*, the extent to which a gut stretches

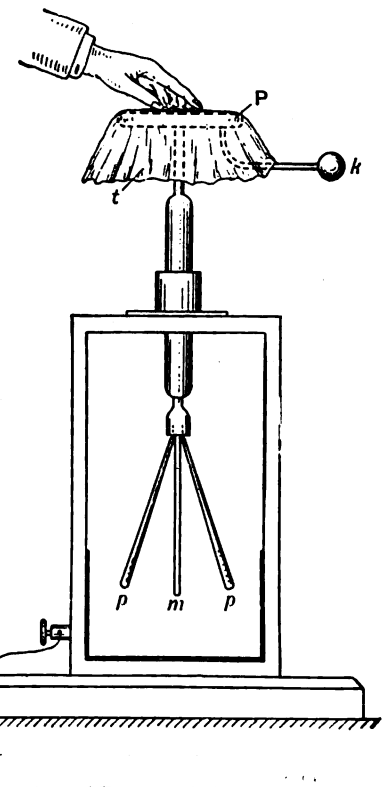

FIG. 48.—Insulation and Electrostatic Capacity of Guttapercha.

before it breaks, is similarly affected by the percentage of resin, being in the last two cases, for instance, 460 and 500 per cent. respectively, but it also depends on the nature of the gutta.

There are other properties besides, such as the degree of hardness at ordinary temperatures, the resistance to pressure, or to a blow, or to shearing, which are all greatly affected by the percentage of resin; however, I can only call attention to these in passing and we must now consider the more important electrical properties.

Electrical Properties.

These depend chiefly on the nature of the gutta, and to a lesser extent on that of the resin, but only very slightly on the relative proportion of these two components. They also depend upon the nature and amount of the impurities and on the water. We shall see later on that the electrical properties—*i.e.*, the insulation resistance and inductive capacity—are very little affected by the extraction of the resin, unlike the physical and

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TABLE XI.—Electrical Properties of Guttapercha and Some Other Materials.

Description of material.	Insulation resistance (megohms). Per cube knot.	Per knot $\left(\log \frac{D}{d} = 1.\right)$	Source.	Inductive capacity (microfarads). Air = 1.	Per cube knot.	Per knot $\left(\log \frac{D}{d} = 1.\right)$	Source.
Guttapercha:							
Cleaned commercial, highest	139,300	51,050	(1)	4 496	0·0801	0·2184	(1)
,, ,, lowest	382	140	(1)	2·619	0·0466	0·1272	(1)
Willoughby Smith's special	955	350	(4)	3·122	0 0556	0·1515	(4)
From leaves, Sérullas	57,980	21,260	(2)	2·950	0·0525	0·1433	(2)
,, ,, ,,	120,700	44,260	(2)	3·120	0·0555	0·1515	(2)
,, ,, Obach's	48,630	17,830	(1)	2·707	0·0482	0·1315	(1)
Balata	2,145	786	(1)	2·724	0·0485	0·1323	(1)
Caoutchouc:							
Pure vulcanised	130,000	47,660	(1)	2·662	0·0474	0·1293	(1)
Mixed vulcanised	81,700	29,950	(1)	3·405	0·0606	0·1654	(1)
Pure unvulcanised	15,440	5,659	(1)	2·505	0·0446	0·1217	(1)
Submarine cable	37,100	13,600	(1)	3·561	0·0634	0·1730	(1)
Overland telegraph cable	61,770	22,650	(1)	3·405	0·0606	0·1654	(1)
Ebonite	16 540	6,061	(1)	3·160	0·0562	0·1534	(6)
Paraffin Wax	34 230	12,550	(1)	2·310	0·0411	0·1122	(6)
Sulphur	21 180	7,764	(5)	3·825	0·0681	0·1858	(6)
Resin:							
Colophony	21,700	7,952	(1)	2·550	0·0454	0·1239	(6)
Extracted from guttapercha	14,360	5,264	(1)	3·270	0·0582	0·1587	(1)
Water	—	—		75·700	1·3480	3·6770	(7)

(1) Our own determinations. (2) Lord Kelvin's report to the Gutta Percha Corporation. (3) Dr. Hopkinson's report to the Gutta Percha Corporation. (4) Clark and Sabine's "Electrical Tables and Formulæ." (5) Foussereau (1888) tested at 69deg. C. (6) Boltzmann. (7) E. B Rosa.

mechanical properties. The insulating property of guttapercha was first observed, as far as I know, by Dr. Werner von Siemens in the year 1846. Faraday also noticed this property somewhat later, and recommended guttapercha for insulating purposes in March, 1848.

I wish to show you the two principal electrical qualities of guttapercha by an experiment. I have here an electroscope (Fig. 48), with a flat brass disc, P, at the top, and below it two pith rods, *p*, suspended on either side of a fixed strip of brass, *m*, which throw their shadow on to a screen in front of the instrument. I spread a thin piece of guttapercha tissue, *t*, over the brass disc like a tablecloth, and now charge the electroscope by means of the brass knob, *k*, at the side. You observe the pith rods diverge and now remain stationary. I lay my fingers on the top of the disc, so that they are separated from it by the tissue, and you observe the rods slightly converge and then remain stationary. On withdrawing my hand they again take up their former position. Now, this simple experiment demonstrates the two electrical properties of guttapercha at the same time. The fact that I could hold my hand, which through my body was connected to earth, on the upper side of the thin tissue for a considerable time, without discharging the electroscope, shows its excellent insulating quality; and the binding of the electrical charge of the disc of the electroscope, indicated by the temporary partial collapse of the pith rods, whilst my hand rested on the tissue, showed the inductive capacity of the material.

The insulation should be as high as possible, and the inductive capacity, generally, as low as possible; but, whereas the latter is mostly associated with other good qualities of the material, such is not always the case with a high insulation.

Faraday, it appears, had some difficulty in 1848 in obtaining guttapercha with a sufficiently good insulation for his purposes, and he found that this was due to an excessive amount of water contained in the commercial material. This is rather an important matter, and I should therefore like to show you some experiments on the effect of water in guttapercha on its insulating property. I have here some strips containing about 15, 10, 5, and 2½ per cent. respectively, and I charge the electroscope again, as you see from the divergence of the pith rods. I now touch the brass knob with the strip containing 15 per cent. of water, pressing my finger against the other side of the same, and you observe the pith rods gradually converge; but as they do not regain their former position when I remove the strip it shows that the charge has been dissipated by contact with the guttapercha. I repeat the experiment with the next strip containing 10 per cent., and you observe how much more slowly the charge disappears. I take the one with 5 per cent. and find it to be a good insulator, in fact, practically equal to that containing 2½ per cent. water; but I must mention that different kinds of guttapercha behave differently in that respect. We shall recur to the influence of water on the electrical properties presently, when I shall give you some exact figures; but I should first like to call your attention to Table XI., which gives the specific insulation and inductive capacity of various specimens of guttapercha* in comparison with other materials, such as paraffin wax, colophony, ebonite, etc., known to be good electrical insulators. I also give these particulars for an average sample of the resin extracted from guttapercha by means of petroleum spirit. The insulation in megohms at 75deg. F. is given per cube knot of the material and also per knot of a cylindrical layer or tube, whose outside diameter, D, and inside diameter, *d*, are in the ration 10 : 1, so that $\log. \frac{D}{d} = 1$, which is a convenient way of expressing it for the cable manufacturer. The specific inductance capacity in microfarads is likewise given per cube knot and for a tube with $\log. \frac{D}{d} = 1$; it is also compared with that of air as a standard, the usual way of expressing specific inductive capacity in text-books.

The figures show how greatly these electrical data vary for different specimens of guttapercha. Take, for instance, the insulation per cube knot, which is only 382 megohms in the case of the lowest material, otherwise of very good description, and as much as 139,300 megohms—*i.e.*, 365 times the former amount, in the case of the highest, otherwise inferior material.

As regards the guttapercha from leaves, Lord Kelvin and Dr. Hopkinson found a higher insulation for Sérullas's material than we ourselves obtained for mine in this particular instance; but we have also occasionally observed equally high insulations in guttapercha extracted from leaves by my process. Paraffin wax, colophony, ebonite, etc., are intermediate between the maximum and minimum found for guttapercha; but pure vulcanised caoutchouc has a very high insulation, approaching the maximum observed for guttapercha. The specific inductive capacity also shows notable variations, the lowest figure per cube knot being 0·0466 and the highest 0·0801. In this respect the gutta obtained from leaves by extraction with petroleum spirit compares favourably with that of the best sorts of ordinary guttapercha. The inductive capacity of pure vulcanised caoutchouc—viz., microfarad 0·0474—lies between the lowest figure and that of the gutta from leaves. Paraffin wax, a hydro-carbon like pure gutta and caoutchouc, has the lowest inductive capacity of all the materials recorded in Table XI.—viz., 0·0411; water, on the other hand, has the highest known of any substance—*i.e.*, 1·348 microfarad per cube knot. The significance of this will be seen on consideration of a table, which gives the insulation and inductive capacity of several brands of guttapercha, each with a high and low percentage of water. The decrease of insulating power with high percentages of water is unmistakable; although, perhaps, it is not so great as one might expect. On the other hand, the effect of a larger percentage of water on the inductive capacity is very marked, particularly in the case of "Banjer white" and "Bulongan white," but also in "Pahang" and "Bagan."

A third electrical property, which has recently come into prominence, is what is called the dielectric strength or resistance to piercing by high voltages. Table XIII. gives the dielectric strength of various guttapercha-covered wires (cores), and the corresponding thickness of the insulating material or dielectric; it also gives for comparison the dielectric strength of caoutchouc-covered wires and of ebonite. You observe that a thickness of a little over ½in. of guttapercha breaks down with 40,000 volts, and one of about 1-10in. with 28,000 volts.

* The electrical and mechanical tests were, if not otherwise stated, all made in the core testing department of Messrs. Siemens Bros. and Co.'s works at Woolwich, under the superintendence of Mr. Paul Estler.

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TABLE XIII.—Dielectric Strength of Guttapercha in Comparison with Other Materials.

Description of Dielectric.			Thickness of dielectric. Inch.	Voltage at which dielectric broke down.*
Guttapercha:	Copper per knot.	G.P. per knot.		
Cores of various sizes, from submarine cables	500lb.	320lb.	0·127	40 000
	450lb.	280lb.	0 109	28 000
	107lb.	150lb,	0·0925	18,000
	107lb.	130lb.	0·0825	15,000
	130lb.	130lb.	0·0805	14,000
Test cores made from...	Pahang		0·051	19,000
	Banjer red		0 058	20,000
	Bulongan red		0 048	19,000
	Bagan soondie		0·049	15,000
	Serapong soondie		0 054	18,000
	G.P from leaves		0·047	17,000
Caoutchouc:				
Core of overland telegraph cable			0·102	20,000
Core of submarine cable			0·078	19 000
Ebonite (sheet)			0 130	38,000

* A comparatively low voltage was first applied; this was raised by 1,000 volts about every 10 minutes, until the dielectric broke down.

The author also gives a most complete table to show the chemical composition and the physical, mechanical, and electrical properties for the different grades of each of the 12 brands of guttapercha with which we have become acquainted, each row of figures being the average of the results obtained from a certain number of individual lots, as stated in the table. The figures given are most interesting and instructive, and clearly show how largely the physical and mechanical properties of guttapercha depend upon its chemical composition—*i.e.*, the relative proportion of gutta and resin, or ratio $\frac{G}{R}$. It almost looks as if the specific insulation and induction also followed this rule, inasmuch as both mostly increase with an increasing amount of resin; but, as I have pointed out before, this connection is only an apparent one, the electrical properties being in reality only slightly affected by the removal of the resin, whereas the physical and mechanical properties are entirely changed thereby.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

96. How would air space reluctance be calculated when designing a dynamo with toothed armature core discs? How would the length of the magnetic path through such an armature be determined?—A. H. A.

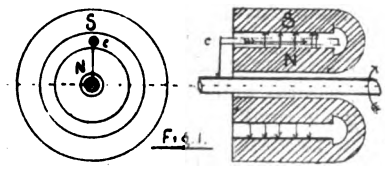
97. Describe the best method of varying the speed of a motor-driven feed pump.—W. B.

ANSWERS.

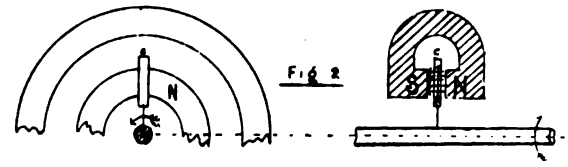
Question No. 90.—Can the unipolar or homo-polar direct-current dynamo be made to give a high voltage, say 200 volts. If not, why not?

Best Answer to No. 90 (*awarded* 10*s.*).—Unipolar dynamos may for all practical purposes be looked upon as dynamos whose armatures are wound with but one coil of wire, which cuts the lines of force continuously in the same direction. Since the E.M.F. of a machine depends upon the number of convolutions of wire upon the armature, and upon the speed of rotation, it would naturally be expected that with but one coil of wire the speed would have to be very excessive, even if the length of conductor were great, to produce a moderate voltage at the terminals.

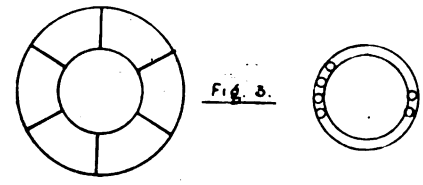
In Figs. 1 and 2 a single conductor is shown rotating between tubular pole-pieces, and a little consideration will make it clear that an E.M.F. will in each case be generated along the length of the conductor and always in the same direction, and also that the E.M.F. will last so long as the conductor is moving through the field. If the circuit be completed by joining the ends of the conductor by means of rubbing contacts to an external resistance, the uni-polar dynamo will urge an uni-directional F.M.F. and current through the external and armature circuits. Fig. 1 shows the conductor rotating parallel with the axis, and Fig. 2 shows the conductor at right angles to the axis of rotation. In each of the two cases a considerable current will be obtained, but the voltage will be small, not more than five



volts. If a number of conductors be arranged symmetrically round the axis of rotation, a larger current will be obtained, but the voltage will remain the same when they are coupled in parallel. If the conductors be increased in number until finally a solid cylinder or a solid disc of metal is obtained (Fig. 3), their action will be precisely the same as if a single conductor only had been employed. To increase the E.M.F. it will be necessary to place two or more of the conductors in series in order to add their E.M.F.'s together. If this is done in the usual way, a little consideration will show that the connecting pieces will act as inductors and connectors, forming loops round which the E.M.F. and current alternate, thus destroying the characteristic feature of the type of



machine under consideration. If the rotating armatures shown at Fig. 3, in each of which insulated conductors are arranged either on a disc or on a cylinder, be connected by wires so that the end of one conductor is connected to the opposite end of another conductor, the connecting wires will then rotate with the conductors, and must of necessity cut the lines of induction at exactly the same rate and in the same direction as the conductors proper. The connectors thus virtually become conductors, and will induce an E.M.F. which is in an opposite direction to that in the conductors proper, the resultant E.M.F. being nil. From this it is evident that if the armature rotates, the connecting pieces must be stationary so as not to cut the field, and therefore the current must be taken into and out of them by means of sliding or rubbing



contacts. It would thus appear that there is no winding which can be applied to uni-polar armatures if they are to give a uni-directional E.M.F.

The best that can be done is to increase the E.M.F. by making use of the sliding contacts for connecting the conductors in series, but such a method, owing to the multiplication of contacts, causes the arrangement to become unworkable through the immense difficulties and trouble introduced with their use. Sometimes two distinct machines mounted upon the same spindle are coupled in series, but the difficulty of collecting the heavy currents generated, together with their two-fold nature, prove formidable obstacles to their adoption.

A uni-polar dynamo has been built to produce a current

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of 5,000 amperes and an E.M.F. of two volts when run at a speed of 2,000 revolutions per minute. Prof. Forbes, the inventor, calculated that an armature 4ft. in length and 4ft. in diameter, would give an E.M.F. of 60 volts and a current of 320,000 amperes when run at a speed of 1,000 revolutions per minute. The horse-power required to drive it would be about 30,000. Such a large current would cause excessive heating of the metal in the armature, and this, together with the high speed for such a heavy mass and huge power, puts the scheme out of the question.

To summarise, uni-polar dynamos cannot as yet be made to give a higher voltage than about 20 volts, for the following reasons: (1) excessive speed at which the machine would have to be driven; (2) the length of conductor cutting through the field being limited by the size of the armature, and this latter having practically but one coil, it would have to be of a prohibitive size; (3) impossibility of greatly increasing the range of voltage owing to the abnormal electrical and mechanical difficulties in the way of coupling the conductors in series; (4) the difficulty of collecting the resultant and excessive current at the periphery of the machines.—F. STOTT.

Answer to No. 90 (*awarded* 5*s.*).—The homo-polar direct-current dynamo up to the present has not been made commercially successful for any other than large currents at comparately low voltages, say, 2 to 10 volts. Above this pressure it is necessary to employ such a number of sliding contacts, etc., that the primary advantage of the homo-polar machine are entirely lost. The reasons are these: The essential feature of a homo-polar machine is that any inductor must only cut lines of force in one direction, and one of the simplest forms conceivable is that shown in

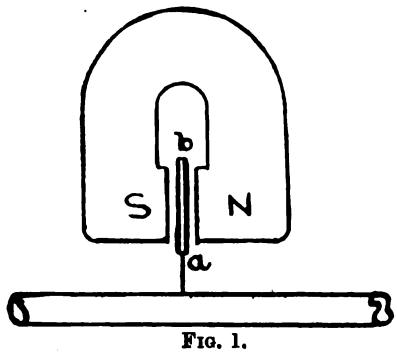


FIG. 1.

Fig. 1, in which a circular magnet, N S, envelopes a radial inductor, *a l*, which is capable of being rotated on its spindle. Now, if this magnet, S N, is completely circular, with no break in it, then the E.M.F. generated in *a l* will be continuous and in one direction. A number of inductors can be arranged symmetrically round the spindle, and can be placed in parallel so as to carry a larger current, the E.M.F. still remaining the same, until finally we arrive at a solid circular disc identical with Faraday's early dynamo. Now the E.M.F. obtained from such a machine—say, with a disc 12in. diameter, a normal flux in the gap space of 4,000 lines per square centimetre, and a speed of 1,000 revolutions per minute—would be roughly

$$E = \frac{N\,n\,c}{10^8},$$

when N = total flow of lines, n = revolutions per minute, and c = number of inductors.

$$\therefore E = \frac{20^6 \times 1{,}000 \times 1}{10^8}$$
$$= 20 \text{ volts.}$$

Now to increase this figure, one of the three factors—N, n, c—must be increased. But both the flux density and the speed have, as a rule, been carried to their practical limits, so that the only available quantity to alter is the number of inductors on the armature.

Looking at Fig. 2, we see that the E.M.F. in each conductor is in the same direction—viz., from periphery to centre—so that to place them in series the inner end of one conductor must be joined to the outer of the next by means of a rotating connector, and since this is cutting lines at the same rate as the inductor, there will be an E.M.F. induced in it in an opposite direction to that in the inductor itself, and the total E.M.F. of the combination will be nil. To obviate this difficulty, presuming the armature is the rotating part of the machine, the connectors must be stationary, so as not to have an E.M.F. induced in them, but this involves such a multiplicity of sliding contacts, etc., as to render the whole unworkable.

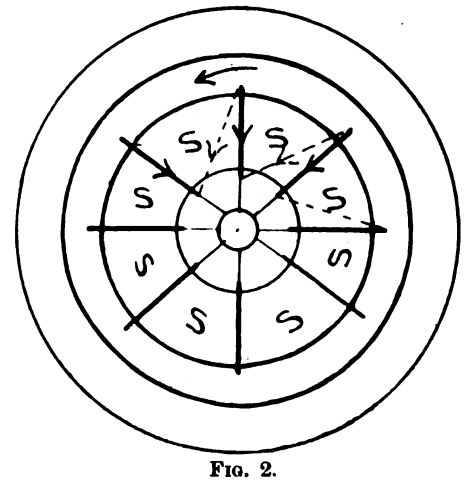


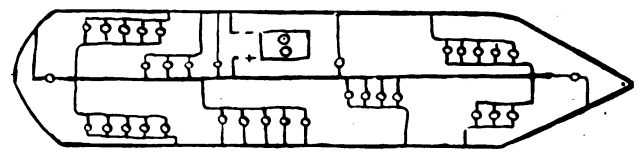
FIG. 2.

One partial solution of the difficulty is by placing two armatures on the same spindle and putting them in series, but even by this means the voltage that can be obtained is limited, while the first cost is necessarily heavy in proportion to the output. It is possible by arranging the winding of the armature to convert the homo-polar machine into an alternator, and in this case it can be designed to give voltages as high as those of ordinary hetero-polar alternators, but this hardly comes within the sphere of this question.—H. BELL.

Question No. 91.—Describe the single-wire system of ship-lighting and its advantages or disadvantages. Which pole of the dynamo should be connected to the ship.

Best Answer to No. 91 (*awarded* 10*s.*).—The single-wiring system of lighting ships perhaps would be easier described by giving a small diagrammatic sketch of same. The negative pole of dynamo is always connected to the hull of vessel; the positive pole in most cases being run by single cables from single-pole switches and fuses off main switchboard, through the different sub-circuits, to the grouping of lamps at different parts of the installation. The return leads from the lamps are run to the nearest ironwork which is in direct communication with the hull of the vessel; here they are put in contact with the hull by clamping down with a brass set bolt and washer.

As regards the advantages of the single-wire system, it has nothing to recommend it beyond its economy in cost of material and, perhaps, the fitting, the cost of which may be taken as about £50 cheaper than the ordinary two-wire system, when applied to an ordinary fair-sized vessel.



The disadvantages are as follows: (1) in the single-wire system there is twice the chance of a breakdown, on account of there being only one thickness of insulation between the positive pole and hull of vessel, which forms the negative pole; (2) more danger of fire through bad contact with the hull, and exposed wire eaten away by the salt water; (3) the electrolytic action at point of contact with brass set bolt, which is often situated in a damp place, sometimes causing the breaking of small wires through corrosion, or even a wasting away of the hull of the vessel at this point; (4) the serious effect upon the compass, which it is impossible to screen efficiently.

Now, with regard to the advantages and disadvantanges of a single-wire system as opposed to a double-wire system, it is well known that if a wire conveying a current runs parallel to a magnetic needle, the current passing will make

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the needle set itself perpendicular to the current. Supposing a main cable for lighting a ship ran fore and aft, and supposing the ship was sailing northward along the magnetic north, the current being then parallel to the needle, the tendency would be to turn the needle at right angles—that is, athwart the ship. When a single wire conveyed a current in the neighbourhood of the needle, it would tend to deflect it; but if the ship was wired with double wires laid alongside one another, the two currents to and from the lamps would neutralise each other, and the effect upon the compass would be nil. If the ship was lighted with an alternating current there could be no effect on the compass; but with a continuous current and the single-wire system the needle might be affected to a considerable extent. There is a formula by which the amount of the deflection could be calculated:

$$E = \frac{\cdot 2\ C}{H \times D} \times 57\cdot 3.$$

E being the error in degrees, C the current in amperes, H the earth's horizontal force at the place, and D the distance in centimetres from the wire to the needle. Of course, the effect on the compass depends entirely on the course the ship is steering, because the current tends to set the needle perpendicular to the wire carrying the current. If the ship was on such a course that the needle was already at right angles to the wire, the effect would be nothing. The formula gives the greatest effect possible.

I may mention that there is a firm of shipbuilders in Scotland who did their own electric lighting, and preferred lighting with single wires mainly on account of economy, but in designing the arrangements they always worked out by the formula given the effect on the compass, and if they found the error would be appreciable laid double wires, and by this means prevented any error to the compass arising from the electric light installation.—J. J. SMITH.

Answer to No. 91 (*awarded* 5*s.*).—The single-wire system of electric lighting as applied to ships whose hulls are built of metal consists of running one insulated wire from the dynamo to the lamps and connecting the other terminal of the lamp by means of a short length of insulated wire to the nearest metal work which is in direct and permanent connection with the metal skin of the ship. This latter is then used as the return wire in place of an insulated wire, the free terminal of the dynamo being also connected to the metal skin of the ship. The system is thus one in which the consuming devices are supplied with current in the usual way, but in which the return to the dynamo is through the metal of the hull, which is itself the return wire. The distinctive feature of the system is the earthed return, which some maintain is an advantage, as any leak must necessarily take place from conductor to ship's skin, and therefore the circuits are completely protected from over-heating by the cut-outs, and fire guarded against. On the other hand, some maintain that this absolute security does not exist, and that the permanent earth puts a continual strain on both conductor and dynamo alike, to meet which better and more expensive insulation has to be provided, thus increasing the cost of installing.

Advantages of Single Wiring—(1) Cheaper to instal than double wiring, as a much smaller quantity of wire is used, though where the system is properly carried out, the difference in cost is not great; (2) more easily fitted than double wiring; (3) the resistance is only about one-half that of double wiring.

Disadvantages—(1) In single wiring, if a fault occurs, there is no opportunity for discovering and remedying it until the fault has developed into a breakdown (2) Insulation resistance can only be measured when the whole of the lamps have been removed. (3) Corrosion takes place at the juncture of the lamp wire with the metal of the ship, introducing extra resistance and leading to failure of the light. (4) All wiring in the vicinity of compasses must be carried out with a parallel insulated return, close to the outgoing wire, as a single wire carrying current would seriously affect the compass readings; even when this is done, as the ship's hull is then connected as a shunt to the insulated return, unequal currents flow in the two wires and a small variation is caused in the compass reading; this error may also be caused in double wiring, should a leak develop between the dynamo and compass and another one beyond the compass, but this state of affairs is rarely met with. (5) As a rule faults cannot be remedied when the dynamo is running.

When the conductor is provided with a sheath of iron wire uninsulated, several of the above objections fall to the ground if the iron wire be used as the return, but, as the iron wire is rapidly eaten away by salt water, very little is to be gained by using such a system.

The best system for ship-lighting is the multiple main switchboard system, in which two conductors are taken from the dynamo to the main switchboard, whence the current is conveyed by sub-mains to distribution boards, and from the latter the current passes directly to circuits containing but a small number of lamps. In this way joints are considerably reduced in number, the cut-outs are collected on the boards and are therefore accessible, greater durability and efficiency are obtained, whilst the enhanced cost is not more than 15 per cent. at the most. The navy has abandoned the single-wire system as unsatisfactory. The negative pole of the dynamo should be connected to the skin of the ship.—F. STOTT.

Answer to No. 91 (*awarded* 5*s.*).—The negative wire of the dynamo is bolted to the ship's frame, or the insulating washer may be removed from the negative brush-holder—the former is the best method. The positive lead runs to all lamps, the return is taken from the lamp to the nearest "earth." This system is rapidly going out of use in the better class of shipwork, wiring on the double or concentric systems taking its place. Its advantages, as compared with these two, consist almost entirely in the cheaper cost of wiring. The advantage of fewer holes to be drilled through iron bulkheads is compensated for by having to drill and tap the same for "earths" at every lamp or group of lamps. The greater ease of locating and repairing faults is also balanced by the greater liability to develop them. The principal disadvantage is the risk of interfering with the accuracy of the ship's compasses. Also the increased chance of a simple earth becoming a dead short, and of shocks to weak persons from fittings, which the prevalence of salty moisture in the atmosphere renders easy. The single-wire system is not advisable for search-lights or cargo-motors.—J. H. C. B.

NEWCASTLE-UPON-TYNE TRAMWAYS.

The following is the last report issued by the late Dr. John Hopkinson, which is dated July 15, 1898:

I have made a careful examination of a map of Newcastle, which shows the proposed route for the tramways and the grades upon the route. The plan also shows a number of possible sites for the generating station. I have also been over almost the whole of the tramway route with the borough engineer—certainly all parts presenting any interest. I have inspected most of the possible sites for the generating station—all of those which are at all likely—and have very carefully inspected the site which I shall recommend. Before discussing the detailed estimates appended as schedules to this report, it may be convenient that I should deal with the general questions.

Newcastle presents steeper and more difficult gradients than most English towns. In Westgate-road we have a long gradient of 1 in 22 and upwards, extending over considerably more than half a mile; and the middle of this gradient is as steep as 1 in 13·5. I have carefully considered these gradients, and am certain that they will give us no difficulty in ascending if we arrange the plant, as we should do, expressly for the purpose. I have seen, in Montreal, much steeper gradients worked without difficulty. There are there several gradients on the roads running square with the River St. Lawrence steeper than 1 in 13, and in one case even as steep as 1 in 8. These are handled without difficulty. It so happens in Newcastle that on the lines in which there would probably be a great holiday traffic, the gradients are not difficult. I should, therefore, suggest that if electric traction be adopted, the use of trailing cars should be restricted to these lines. It is just where the holiday traffic is great that trailers can be advantageously employed, inasmuch as holiday traffic involves as a rule a large number of persons to be carried with few stops. The absence of trailers on the steep grades will, of course, render the handling of these grades easier than it might otherwise be. The gradients, of course, have to be descended as well as

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ascended, and the question arises whether they are of such difficulty that there will be danger from the cars getting the better of their brakes. It has been suggested that slipper brakes should be employed; this I do not think would be advantageous, inasmuch as the employment of a slipper brake involves skidding between the slipper and the rails, and when brakes skid their stopping power is diminished. If skidding can be avoided there is no difficulty in applying adequate brake power to the cars to stop them upon anything. Skidding is to be avoided by keeping the rails clean, that is, free from such material as the pitch which oozes out from the setts, and by adequate sanding. If these points are carefully attended to, there will be no difficulty in descending these grades with electric cars.

While speaking of the gradients in Westgate-street, I may, perhaps, refer to the place on the road a little further out than the hill where the road divides, and one portion goes at a higher level, the other at a lower one. After meeting the committee when in Newcastle, I walked out and inspected this point again. I am inclined to think that as convenient a method of dealing with this point as any would probably be to take the rails returning to Newcastle on the lower level as well as those going out, but to bring them close up to the retaining wall of the higher level road, keeping this road as narrow as practicable. If done in this way the cost would be insignificant, and I think the arrangement would accord with the Board of Trade regulations; it would certainly have the additional advantage of avoiding another steep gradient on the road.

There is no doubt that for general convenience the best form of electric traction is that with the overhead trolley wire, and a trolley running approximately centrally over the car. There are in Newcastle a considerable number of streets of a width suitable for the use of central poles with a bracket on either side to carry the trolley wire. This arrangement certainly looks extremely well, and from the point of convenience leaves nothing to be desired. There are other parts where the roads are too narrow, or the ordinary street traffic is not convenient for this arrangement. In such cases the best course will be to put up poles on either side of the road, or in lieu thereof attachments to the houses, and to carry the trolley wire on span wires stretched across the road. I am not prepared to say exactly in which streets the one plan or the other should be adopted, as this would be a matter upon which the Tramway Committee of Newcastle would have much to say; but I am clear that something like one-half of the distance could be appropriately done with centre poles and one-half with span wires. It is possible that there may be a short length of street through the heart of Newcastle in which the committee might think that trolley wires and centre poles, or span wires to carry them, would be objectionable. Certainly if this were so, the lengths in question would be small. There are many ways in which the difficulty could be overcome. The conduit plan, in which two conductors are placed in a conduit under the roadway to which access is obtained through a slot is one. The use of any slot in the roadway is objectionable, probably in Newcastle as objectionable as the overhead trolley, and although a tramway can be made perfectly successful in this way, I would not recommend it for the reason stated. Another plan is to make use of what is known as the surface-contact system. According to this system the current is conveyed to the cars by means of metallic knobs placed in the streets slightly rising above the setts. The current is only conveyed to these knobs at the time when a car is over them, and as soon as the car leaves them they cease to have any electrical activity whatever.

Various systems of accomplishing this have been proposed, and one of them is at present at work in Paris. On the whole, if in any limited parts of the town the trolley wire is objected to, I should suggest that the simplest expedient would be to provide accumulators upon cars prepared to run upon the rails, and to arrange for a car entering upon the route without trolley wires to simply pick up one of these small accumulators cars which would furnish it with a supply of power until the length of tramway in question was passed. The motor or passenger car would then drop the accumulator car, which would be charged whilst standing from the overhead conductor, and be ready to serve another car on the return journey. If this plan were adopted, there would be no need to have anything whatever in the streets in question; there would be no slot, there would be no overhead wire, and the tramway would be just like any horse tramway. The accumulators, though involving a certain additional cost both for power and in capital outlay, would be actually a very small matter indeed, because they would be absolutely confined to the length of tramway upon which they were required, and there would be no necessity for hauling the additional weight of the accumulator over other parts of the system. I suggest this, however, simply for the purpose of indicating how I would meet an objection which may possibly never be raised at all. If practicable I would, of course, prefer to take the trolley wires over the whole of the tramways.

There are in Newcastle at least two very long bridges. On these bridges it would not be convenient, in my opinion, to run either a single track or two tracks near to each other in the centre of the road. I would suggest that on these bridges two tracks should be used, and that one should be taken as near as practicable to one of the kerbs, the other to the other kerb. In this way there would be in the centre of the road ample room for any ordinary vehicle to either get out of the way of a tramcar or to pass it, and, the distance being short, the delay to the tramway traffic by carts crossing the bridge would be infinitesimal. There would be no objection to the tramway being near the causeway, inasmuch as there would be on these bridges no question of frontagers objecting on the ground that the tramway would interfere with the standing room for carts.

Coming now to the question of car-sheds, it will be found that I make no recommendation regarding their position, and for this reason: It is not a matter of very great moment precisely where they are placed, and therefore the convenience of obtaining land at a reasonable price is the consideration which will determine their position. I should, however, say that in my opinion the car-sheds are better distributed over different parts of the tramlines, and preferably on the outer parts of the line remote from the town, than centered in a single very large car-shed, inasmuch as less time is wasted in getting out the cars to the districts they have to work and in bringing them in again in the evening. Of course, one of the car-sheds only would be fitted up for the purpose of repairs.

The station at which the current driving the cars is generated ought, on the ground of economy, to be as near the centre of the district supplied as can be conveniently arranged. Fortunately this, in the case of Newcastle, is very easily accomplished; there is a piece of vacant land, which I understand now belongs to the Corporation, near to the Manors Station and fronting on to Melbourne-street. This site is as central as can be desired; it has the advantages of abundant area, of the faculty of obtaining a siding from the railway for bringing in coal, and also the probability that condenser water can be obtained by laying cast-iron pipes in the sewer which goes beneath the land straight to the river. If, however, in this or any other plan of obtaining water we find difficulty, it would be quite practicable to get rid of the steam by means of water coolers, which are now very generally used. In my estimates, then, I have assumed, that the site near the Manors Station will be the site on which the generating station is placed. No more convenient place could possibly be found.

The power required to propel the Leeds cars, which carry 51 passengers each, is somewhat less than a Board of Trade unit per car mile. The Newcastle cars, carrying 42 passengers, will take less. In my estimates, I have assumed a Board of Trade unit per car mile. At eight miles an hour the cars will on this assumption take eight Board of Trade units per hour, or 10⅔ h.p. each, or to drive the 120 cars at one time on the line the average power must be 1,280 h.p. delivered to the conductors. In order to meet the losses by friction, resistance, etc., and for variation in the power required, and to provide current for lighting, I take a unit of 875 i.h.p., provide three such units, two working at once and one spare. It may not be inappropriate at this point if I briefly notice some of the special advantages obtained by the Corporation propelling their tramcars electrically. The facility for extending the working into other districts or altering the line of track is very great, inasmuch as all that has to be done is to bond the rails and to put up the overhead trolley wire. This can be done, of course, with extremely little disturbance of the streets and very expeditiously. Furthermore, it lends itself very readily to extensions into districts where the traffic is comparatively small; for example, running outside the borough to neighbourhoods where workmen's dwellings can be erected cheaply, having regard to the cost of land. To put it shortly, the electrical method of propulsion is extremely flexible. If the Corporation were manufacturing current for the purpose of their tramways they would certainly use the supply for other purposes as well; for example, I understand that there are a large number of cranes along the wharfs on the river. These cranes can be driven with the greatest possible facility by simply connecting electric motors upon them with the same source of supply of current as serves for the tramways. From the estimates given later on it will be seen that the cost of this supply will be exceedingly small, and hence the cranes would be worked at very great economy in this manner. Again, arc lighting can very readily be done by the same source of power; it is already being done in Leeds, and in this case the supply is taken directly from the overhead trolley wire. Here it works well, though I am bound to admit that before it was put up I regarded it as an experiment, as I was not certain how far it might be disturbed by the passing of the tramcars. The lamps at Leeds are placed upon the same poles which carry the trolley wires. In the case of arc lighting, again, the cost for the supply of current is very small on account of the cheapness with which it is generated. No electric lighting supply company at present in existence would be persuaded to supply current at the price at which the corporation would be able to produce it for themselves. The arc lamps would be of the continuous-current type, which is

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much more satisfactory both in its working and in the distribution of its light than are alternate-current arcs.

Before proceeding to the estimates, it may be convenient to refer to one or two objections which are occasionally raised by partially informed people to electricity as applied to driving tramways. There is some fear on the part of the public that there is danger from shock from the wires. If the work is carefully carried out by experienced people there should be no possibility of receiving any shocks at all. With regard to the shock experienced from such circuits as are used for tramways, I may say I have often myself had shocks of the pressure employed—namely, 500 volts—and have never suffered the slightest injury from them. This is precisely the experience of most others. For one shock received by the public there must be scores received by the people who have to handle the apparatus, and with impunity. Horses have been killed by such a pressure, but a horse appears to be an animal peculiarly sensitive to electric shock. It has also been suggested that the return current destroys water-pipes and gas-pipes by electrolysis. This undoubtedly has been the fact to a very considerable extent in America. The reason is not far to seek. In the early days of tramway working the rails were very insufficiently bonded, and the arrangements for conveying the current back to the generating station by feeders were extremely imperfect. All this is now over. We know what bonding to employ and how to bring our currents back, with the result that the currents returning through the earth are harmless. The Board of Trade lay down regulations on this point which their authorities consider will be ample for securing the public safety, and it is easy to obtain much better results than those demanded by the Board of Trade. On the whole, then, I say with confidence that the electrical system of traction is at least as safe from every point of view as any other system of street traction.

I have already alluded to the convenience of the overhead trolley system in comparison with the electric conduit and slot. Its use avoids the existence of the slot with its surface of iron on either side; it avoids the considerable disturbance of the streets in excavating for the conduit, and the difficulty of securing effective drainage.

We now come to a short explanation of the schedules of costs appended to this report; these comprise three estimates. The first is an estimate of the capital outlay required for the 40 miles of single track proposed, the second is an estimate of the cost of working per car mile, the third sets forth the actual costs in pounds sterling of the various items put forward in the estimate per car mile, and the fourth shows the allowance per car mile for the maintenance of the track, machinery, and rolling-stock.

Referring to Schedule I., the first item—the trolley wire—is for a wire 0·4in. diameter similar to that already erected at Leeds, and to that which is now about to be put up at Liverpool. The price given for this item is that at which the contract was actually taken in the case of Liverpool. The poles are assumed to be of a design similar to those employed in Leeds, and the price at which they are taken is the same as was expended at Leeds. The bonding of the rails is for material only—the small amount of labour needed being assumed to be included in the cost of laying the track. This material is assumed to be the same in price as in Liverpool. The cables are small in amount owing to the fact that the station is placed in an admirably situated situation. The distances to which the tramways go from this station are comparatively small, and the size of the overhead conductor is substantially 50 per cent. greater in area than is usual in tramways. The cost is based upon the actual cost in Leeds. The cars are assumed to be similar to those which are now in use in Leeds, and the price given is that which was actually paid there. The tenders just received for additional cars for Leeds similar to those now in use, show that we may expect to obtain such cars at about £90 per car lower than is quoted in my schedule. The boilers, condensing engines, dynamos, and cranes are all based on actual experience in Manchester electric lighting station. A recent tender I have received for extensions in Leeds would have justified a somewhat lower estimate for engines and dynamos. The switchboard and instruments are my own estimate. The 40 miles of track at £5,000 per mile is the figure given to me by your borough engineer. The rails at the car shed are based on my experience at Liverpool, the cost of the car-sheds upon the experience in Liverpool, and the cost of the engine-house, boiler-house, economiser, and chimney are based upon experience at Manchester. As it may not be known to all members of your committee, I may mention that I was personally responsible for the work in Manchester until they engaged their present able electrical engineer, and that I am personally responsible for the work at Leeds and Liverpool; hence the figures are thoroughly known to me from every point of view.

The total amount of the expenditure for the tramways amounts to £358,877. 14s. 6d. This amount is exclusive of anything for land; this I have intentionally omitted because I am in nothing like so good a position to form an opinion on this point as are those resident in Newcastle. Excluding the land I think the amount includes everything requisite, and barring the inevitable changes by the hardening of prices or the reverse, should be fairly accurate.

The second schedule shows the cost per car mile of operating. To this I have given very careful consideration, as the resulting figure is a low one—as low as anything of which we have experience up to date. But I cannot see where any of the items deviate in the direction of being too low. The result is no doubt in large part due to the fact that the tramways proposed in Newcastle are on a substantial scale; that the price of coal is low; that the wages—in comparison with American wages, at all events—are lower; that the car miles are high, owing to the 2½ minutes' service throughout the system; and that the cost of management is bound to be low as there are no heavy directors' fees to pay, nor specially expensive offices to be maintained. I have assumed in working out these estimates that the cost of coal is 6s. per ton. I understood, when in Newcastle, that coal could be obtained at even a lower rate than this. I have also assumed that the engine-room is worked by two shifts of men. For the cost of wages of drivers, the experience in Leeds is a good precedent, though that experience would not be a good precedent for any other item, inasmuch as the tramway there is much smaller than is proposed for Newcastle, for the purpose of this report; the service at Leeds is very much less frequent, and the work there has only just begun. But in regard to the wages of drivers and conductors, these, of course, will be simply proportional to the work done. The allowance for depreciation, renewals, and repairs, errs, I think, in the direction of being too high; still it is well to be on the safe side. In the fourth schedule is shown the allowance I make per car mile for repairs and depreciation in comparison with the actual figures for repairs on the tramway of Zurich in 1894; the excess of my figures is to be accounted for in part by depreciation as distinguished from actual repairs, and in part by the liberality of the estimated rates. The allowance for legal expenses, insurance, rates, and taxes, is, I think, adequate to meet these charges. On the whole, then, I am of opinion that if the number of car miles run per week is that which I have indicated—namely, 112,320—which has been calculated on the basis of running 18 hours a day for six days, and half a day on Sunday, or 6½ days in all, I am of opinion that the tramways will be worked at a cost of less than 5d. per car mile. If the number of car miles run is less than this, the cost will undoubtedly be slightly increased, as many of the charges will not vary proportionally with the number of car miles run. The charge, however, for drivers and conductors will, as already stated, be practically proportional to the car miles, and this charge is the largest item in the whole account.

The third schedule, of course, gives just the same information as the preceding, but it gives it in another form more convenient to judge whether the sums allowed are adequate.

(Signed) J. HOPKINSON.

NEWCASTLE UPON-TYNE TRAMWAYS.

Schedule No. I.

Trolley wire—40 miles erected complete with insulators	£7,593	0	6
Poles for two trolley wires—20 miles	14,582	7	0
Bonding rails—40 miles	3,713	0	0
Cables—six miles of 0·34 square inch section	3 300	0	0
*Cars—132 at £560 per car (12 being spare), and two spare trucks with motors complete	74,600	0	0
Boilers—seven, each of 400 h.p., with mechanical stokers, steam-pipes, and economiser	8,958	0	0
Engines—three condensing, each of 875 h.p.	12,075	0	0
Dynamos—three	5,715	0	0
Cranes—two	446	0	0
Switchboards and instruments	1,000	0	0
Track—40 miles at £5,000 per mile	200,000	0	0
Rails at two car-sheds, complete with bonds	2,100	0	0
Car-sheds—area 5,554 square yards	18,050	10	0
Engine-house, boiler-house, economiser, and chimney—area = 1,603 square yards	6,744	17	0
Total	£358,877	14	6

* This price is for a 51 passenger car (22 inside and 29 outside). If a 42 passenger car is used the price would be slightly lower.

Schedule No. II.

COST OF WORKING PER CAR MILE.

Number of car miles run per week = 120 × 6·5 × 8 × 18 = 112,320.

	d.
Electric car-sheds—wages of attendants, materials, etc.	0·100
Generating station—coal, 0 128d.; oil, waste, etc., 0 032d.; wages, 0·036d.	0·196
Management and office, engineers' salaries	0·150
Wages of car drivers and conductors	1·840
	2·286
Depreciation or renewals, being 10 per cent. on total capital outlay, except rolling-stock, which is taken at 12½ per cent., 1·551d.; interest on total capital outlay at 3 per cent., 0·442d.	1·993
	4·279

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Legal expenses, insurance, rates, taxes, and contingencies, 10 per cent. on combined totals—*i.e.*, on 4·279d.	0·427
Total	4·706

Schedule No. III.

COST OF WORKING PER ANNUM.

Number of Car Miles Run Per Annum, 5,840,640.

Electric car sheds		£2 433·600
Generating station		4,769 856
Management and office—engineers' salaries		3,650·400
Wages of drivers and conductors		44,778·240
		55,632·096
Depreciation or renewals and repairs	£37,745·136	
Interest	10,766·331	
		48,511·467
Legal expenses, insurance, rates, taxes, and contingencies		10,415·808
Total		£114,559·371

Schedule No. IV.

COST OF MAINTENANCE PER CAR MILE.

Maintenance of	Newcastle. d.	Zurich. d.
Track	0·845	0.263
Engines, boilers, and dynamos	0·110	0·054
Rolling-stock	0·382	0·213

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: J. B. Braithwaite, jun., M.I.E.E. (chairman), Arthur Ayres, M.I.C.E., John S. Raworth, M.I.C.E., Aymor H. Sanderson, Colonel Frederick George Steuart, B. H. van Tromp, Edward Woods (past-president Institution of Civil Engineers). Consulting engineer: John S. Raworth, M.I.C.E.; general manager: R. Percy Sellon, M.I.E.E.

Ninth annual report to be presented to the shareholders at the general meeting of the Company, to be held at Cannon-street Hotel, E.C., on Monday, Sept. 12, 1898, at 12 noon.

The profit and loss account shows an available gross profit of £52,825. 9s. 6d. After deducting maintenance, general charges, interest on debenture stock, and interim dividend on preference shares for the half-year ended Dec. 31 last, there remains a balance of net profit of £21,538. 10s. 2d. The directors recommend that this sum be applied as follows:

	£	s.	d.
Dividend at the rate of 6 per cent. on preference shares for half-year ended June 30, making 6 per cent. paid for the year	5,400	0	0
Dividend at the rate of 3 per cent. on ordinary shares for the year	5,400	0	0
Bonus payable to employés under profit-sharing scheme	1,620	0	0
Workmen's Compensation Act Insurance Fund	1,000	0	0
Reserve fund	5,000	0	0
Balance carried forward	3,118	10	2
	£21,538	10	2

The results of the year's working show a steady improvement in the Company's business. The increasing development of electric traction and electrical power distribution in Great Britain should have favourable consequences for the industry. Of the redeemable second debenture stock, £26,770 has been redeemed during the year, leaving a sum of £50,000 outstanding. Capital expenditure to the extent of £21,693. 8s. 10d. has been incurred during the year on extensions of buildings and plant at Loughborough, and additional freehold land, adjoining the works, has been purchased to afford facilities for the development of the Company's manufacturing operations. Further extensions of the works are now in progress which will entail additional capital expenditure during the current year. In the present uncertainty attending the effect of the Workmen's Compensation Act passed last session, the directors have set aside a sum of £1,000 out of the profits of the year to form an insurance fund, to which regular addition, proportional to wages paid, is being made. The rates at present demanded by the leading insurance companies appear to the Board unduly heavy in the light of the Company's very small accident record in past years. During the year numerous important contracts have been executed, involving the manufacture of engines, generators, and motors for electric lighting and traction purposes, and rolling-stock for a number of electric and other tramway and railway lines at home and abroad. The result of the year's trading enables a further sum of £1,620 to be paid to the Company's employés under the profit-sharing scheme, which in the opinion of the Directors continues to operate beneficially in the Company's interests. Mr. Arthur Ayres and Mr. Edward Woods are the Directors who retire by rotation, and being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, and offer themselves for re-election.

Dr. BALANCE-SHEET, JUNE 30, 1898.

			£	s.	d.
Authorised Capital:					
150,000 6 per cent. preference shares of £2 each			300,000	0	0
180,000 ordinary shares at £2 each			360,000	0	0
			660,000	0	0
Capital issued:					
90,000 6 per cent. preference shares of £2 each			180,000	0	0
90,000 ordinary shares of £2 each			180,000	0	0
			360,000	0	0
4½ per cent. perpetual first debenture stock, secured by debentures charged on the undertaking			125,000	0	0
4½ per cent. redeemable second debenture stock, part of £105,000 secured by debentures charged on the undertaking, £76,770; less amount redeemed during year, £26,770			50,000	0	0
Sundry creditors: head office, £37,178. 16s. 8d.; Australian branch at April 30, 1898, £540. 17s. 3d.	37,719	13 11			
Bills payable—head office, £3,847. 1s. 11d.; Australian branch at April 30, 1898, £59. 10s. 8d.	3,906	12 7			
			41,626	6	6
To reserve			5,000	0	0
To profit and loss account: balance of profit and loss account, £26,938. 10s. 2d.; less interim dividend paid on preference shares for the half-year ending Dec. 31, 1897, £5,400			21,538	10	2
			£603,164	16	8

Note: Liability on shares in other companies, £14,455.

Cr.			£	s.	d.
Property—Freehold and leasehold factories at Loughborough and Lambeth, including plant and machinery, as per last account			100,195	5	8
Additions during the year, less property sold			17,569	4	5
			117,764	10	1
Patents and goodwill, as per last account			181,397	8	9
Goods in hand, in process of manufacture, work in progress, and materials at Loughborough and other places	£91,918	16 5			
Australian branch at April 30, 1898	9,955	12 8			
			101,874	9	1
Sundry debtors: Head office	104,656	6 2			
Australian branch at April 30, 1898	4,202	14 5			
Ditto balance of items in transit and invoices rendered, less cash received from April 30 to June 30, 1898	1,503	4 5			
	110,362	5 0			
Bills receivable, head office	2,198	11 9			
			112,560	16	9
Loan against security, at short notice			26,661	15	0
Cash at bankers and in hand:					
Head office	8,330	5 4			
Australian branch at April 30, 1898	638	9 2			
			8,968	14	6
Shares and debentures held at or below cost price			48,937	2	6
Reserve invested in consols, Queensland 4 per cent. bonds and American Railroad Gold Bonds			5,000	0	0
			£603,164	16	8

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1898.

Dr.	£	s.	d.
General charges—viz.:			
Directors' fees (exclusive of consulting engineer's fees)	1 000	0	0
Auditors' fee	105	0	0
Salaries	5,830	4	6
Law charges	92	14	6
Insurance	722	17	10
Postage, stationery, and printing	748	1	7
Rent, rates, and taxes	1,025	14	5
Advertising and London office expenses	1,543	13	0
Debenture stock trustees' fees and expenses	208	3	11
	11,276	9	9
Reduction of capital expenses	283	10	9
Further cost of head office removal	76	18	6
Maintenance of buildings and plant	4 296	3	2
Ditto, of patents	253	8	10
Interest on first debenture stock to June 30, 1898	5,625	0	0
Interest on second debenture stock to June 30, 1898	2,551	3	3
One-half of cost of redeeming £26 770 second debenture stock	611	15	1
Income tax	101	0	7
Bad and doubtful debts	811	9	5
Balance, profit carried to balance-sheet	26,938	10	2
	£52,825	9	6

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Cr.	£	s.	d.
Balance brought forward from last account	3,011	18	5
Gross profit on trading, including profit realised on securities sold, interest account, and dividends on securities held	49,647	13	7
Transfer fees	165	17	6
	£52,825	9	6

LIGHT RAILWAYS.

The Dundee Town Council by a majority of two have decided to object to the construction of the Dundee and Broughty Ferry light railway. The principal objection seems to be that the Council and the company intend to lay lines along the same ground, the former as a tramway and the latter as a light railway. The resolution agreed to contains nearly 600 words, but the portion here given indicates the position the Council have taken up, and is as follows: "That the Council resolves, with regard to the proposed order under the Light Railways Act, 1896, for authorising the construction of light railways in the county of the city of Dundee and the county of Forfar by a company, a stranger to and having no interests in the district, as follows—viz.: (1) that it has always been, and is still, the intention of the Town Council to construct tramways within the city whenever and wherever they may be or may become necessary, and that it would be inexpedient and disadvantageous to allow a third party to acquire any rights or control over the highways of the city; (2) that the proposed railway No. 1 is proposed to be constructed in the same line and on the same ground as the proposed extension by the Commissioners of the tramways, and that the said railway would injuriously affect and interfere with the tramway system of the Council, and their rights and powers in and over and their management of the streets and roads within the burgh; (3) that the promoters of the said order be requested to abandon the same as regards railway No. 1, and also as regards railway No. 2, unless an amicable arrangement to the mutual satisfaction of both parties is come to and before the hearing, and that failing any agreement the Council attend at the enquiry by the Light Railway Commissioners and oppose the proposed order on all competent grounds; (4) that the Council declare that as at present advised they would provide an extension of their tramway system *vid* Broughty Ferry-road to the boundaries of the burgh, and would not object to any light railway beyond the boundaries of the burgh if laid on proper lines, nor to communication with their proposed lines of tramways at the boundaries of the burgh on proper clauses and provisions applicable to any such junctions being adjusted to their satisfaction, and on the works of the junctions being carried out at the instance of the promoters, and at the sight and to the satisfaction of the burgh engineer. Further, that the Council ask the clerk to notify the promoters to ask the Light Railway Commissioners to adjourn the proposed enquiry for a few weeks to enable parties to meet and adjust terms in consistence with the foregoing resolutions."

A representative of a firm of light railway and electric motor contractors has paid a visit to Southport and Lytham, and made a rough survey of the route of the proposed tramway between the Southport promenade and Lytham (across the Ribble), projected by Mr. Stewart Speddy, of Southport. His report was that the plan was quite feasible, but that the work would be costly. The tramway, which would not be more than six miles long, would certainly shorten very considerably the distance between Liverpool and Southport on the one side, and Lytham, Blackpool, Fleetwood, and Morecambe on the other.

The Board of Trade has recently confirmed an order authorising the construction of a light railway in the parish of Pewsey in the county of Wiltshire.

The Light Railway Commissioners have submitted to the Board of Trade for their approval the order for the Airdrie and Coatbridge tramway scheme.

In consequence of the objections which had been raised to the original draft order for the proposed light railway from Middleton through Castleton to Rochdale, the Light Railway Commissioners have drafted a new order, and the Castleton District Council met the other evening to consider whether the clauses for the protection of the interests of Castleton were inserted in the new order. For various reasons, the Council decided to oppose the confirmation of the draft order.

The Westmorland County Council have agreed to the recommendation of the Light Railways Committee, which reported that the advisability of constructing a light railway from Kendal to Arkholme had been considered by the committee and the Kendal Corporation, and which recommended the Council to vote £100 towards the cost of a survey of the district, Kendal Corporation contributing a like sum. At the Council meeting, it was stated that the cost of the railway would be about £100,000. It would take about 150 acres of land, and would touch several important industrial centres on the route. It was estimated that the earnings would amount to £12 per mile per week; assuming that the proposed line did earn that amount, that would mean £11,000 per annum. The cost of working it would be about £4,000 per annum, leaving £7,000 for dividend, etc. The council of the Kendal Chamber of Commerce have passed a resolution approving of the scheme.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bury St. Edmunds.—The Corporation invite tenders for the erection of buildings for their electric lighting station. Tenders by Sept. 10.

Thrybergh (Rotherham).—Tenders are required for lighting Thrybergh Colliery by electricity. For particulars and permission to inspect apply to Mr. W. Hargreaves, agent, Rothwell Haigh, Leeds. Tenders to be addressed to Messrs. J. and J. Charlesworth, Limited, colliery proprietors, Milnes House, Wakefield, by Sept. 26.

Aberdeen.—The Corporation invite tenders for the supply for one year of electricity supply meters, house fuse boxes and service cables. Booklet of specifications and conditions of contract may be obtained on application to Mr. J. Alex. Bell, city electrical engineer, accompanied by a deposit of 10s., which amount will be refunded on receipt of a bona fide tender for any one of the above classes of goods. Tenders are due by Sept. 17.

Belfast.—The Harbour Commissioners invite tenders for the supply of 50 electric light masts (tubular), in strict accordance with the outline specification and blue print, which may be obtained from the harbour engineer, Mr. G. F. L. Giles. Sealed tenders, on the special forms provided for the purpose, to be addressed to Mr. W. A. Currie, secretary, Harbour Office, Belfast, endorsed "Tender for Electric Masts," and sent in by Sept. 12.

Torquay.—The Electricity Committee invite tenders for the supply and delivery of (1) meters, (2) arc lamp carbons, for a period of 12 months from Oct. 1, 1898. Further particulars and form of tender may be obtained from Mr. P. Storey, the borough electrical engineer. Sealed tenders, endorsed "Meters" or "Arc Lamp Carbons," as the case may be, to be sent in to the Town Clerk, Fredk. S. Hex, Esq., Torquay, not later than 2 p.m. on Sept. 19.

Leeds.—The City Council invite tenders for the supply of (a) poles, (b) trolley wire and attachments, in connection with the extension of their electric tramway systems. Tenders must be sent in by noon on Sept. 20. Plans may be seen and forms of tender obtained on payment of a deposit of £5, which will be returned on receipt of a bona fide tender, from the City Engineer, Municipal Buildings, Leeds, or from 5, Victoria-street, Westminster, S.W.

Gloucester.—The Corporation require tenders for new buildings for electricity works. Plans and specification may be seen at the office of Mr. Harry A. Dancey, 26, Clarence-street, Gloucester, between 10 a.m. and 5 p.m. The quantities are being prepared by Mr. Dancey, and may be obtained from him on payment of a charge of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Electricity Works," to be delivered at the Town Clerk's Office, Guildhall, Gloucester, before 11 a.m. on Sept. 19.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Hull.—The Electric Lighting Committee invite tenders for the supply of the following cars, etc.—viz, 45 electric motorcars, 20 trail cars, 2 sprinkler cars, 2 traversing platforms. Specifications and forms of tender may be obtained of Mr. A. E White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Rolling-Stock," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 30.

Bexhill.—The Bexhill Urban District Council invite tenders for the following work in connection with their electric lighting station: (Section A) water-tube boilers; (B) steam dynamos and balancer; (C) switchboards; (D) storage battery; (E) underground cables and pipes, arc lamps and posts. Copies of the specifications, with form of tender and general conditions, can be obtained at the office of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster, S.W. Applications for any or all of above must be accompanied by a cheque for £5. 5s., which will be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting, Tender for Section —," must be delivered at the offices of Mr. Fred. A. Langham, clerk, Council Office, Bexhill, by 10 a.m. on Sept. 28.

Bangor.—The Corporation invite tenders for the supply and erection of the following plant: (Contract No. I.) two water-tube boilers, economiser, brickwork, and flues; (II.) steam, exhaust, and other pipes, steam pumps, and feed-water heater; (III.) two 60-kw. steam dynamos, balancer, boosters, and 5-ton overhead travelling crane; (IV.) switchboard and instruments; (V.) accumulators; (VI.) mains. General conditions, specifications, forms of tender, etc., may be obtained from Mr. F. Hastings Medhurst, B.Sc., M.I.E.E, the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., on payment of a deposit of £3. 3s. for each section, which will be returned on

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receipt of a bona fide tender. Sealed tenders, endorsed "Electricity Works, Contract No. —," must be delivered to Mr. R. Hughes Pritchard, town clerk, Bangor, North Wales, by Sept. 10.

Rathmines.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pumps, ejector, economiser, electric motor; (B) engine-house plant—high speed steam dynamos and accessories; (C) condensing plant and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) underground work—trenching, cables, etc.; (H) posts for incandescent street-lighting; (I) lanterns and incandescent lamps for same; (J) meters. Tenderers are at liberty to tender for any section, but not part of a section, and applicants must state for which section they wish to tender, in order that the requisite drawings may be forwarded. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, 64, Victoria-street, London, S.W., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders, sealed and marked "Tender for Electricity Works," must be addressed to Mr. F. P. Fawcett, secretary to the Township Commissioners, at the Town Hall, Rathmines, co. Dublin, and be delivered on or before Oct. 5.

RESULTS OF TENDERS.

Birmingham.—The tender of the Walsall Electrical Company has been accepted, at £430, for wiring St. Martin's Church.

Brighton.—The Council have accepted the tender of Banfield and Co. for the supply of Annesley coal to the electricity works at 18s. 10d. per ton.

Liverpool.—The Lighting Committee have accepted the tender of Messrs. Waring and Sons, at £2,635, to erect an electric substation in Lodge-lane.

Shipley.—The tender of Messrs. Cole, Marchent, and Morley has been accepted by the Council for supplying an engine, dynamo, motors, and pumps at the sewage works, at £1,225. 10s.

Shoreditch.—The Vestry have received the following tenders for boilers for the electricity works:

R. Taylor and Sons (accepted)	£3,410
E. Danks and Co.	3,900
J. Fraser and Son	4,236
Fleming and Ferguson, Limited	4,400
Tinkers, Limited	4 750
S. Hodge and Sons, Limited	5,150
Davey, Paxman, and Co.	5,173
J. Jones and Sons	5,300

The following tenders have also been received for the supply of transformers:

General Electric Company	£2,010
Electric Construction Company (accepted)	2,747
Thos. Parker, Limited	2,800
Fuller-Westrom Electric Manufacturing Company	2,805

BUSINESS NOTES.

Brighton.—A main is being laid in Preston Drove at a cost of £260.

Dover.—The regatta week's takings on the tramways formed a record.

Whitstable.—The Council have resolved to apply for an electric lighting provisional order.

Accrington.—A local paper states that rumours of electric tramways for the town are in the air.

Bo'ness.—The new arc lighting installation at the docks is completed. There are some 20 arcs in use.

Western and Brazilian Telegraph Company.—The receipts of this Company for the past week were £2,857.

Reigate.—The Electric Lighting Committee are considering the purchase of a site for the proposed electricity works.

Commercial Cable Company.—The Board announces the usual quarterly dividend of 1¾ per cent. on the capital stock.

Balmoral.—The work of lighting Balmoral Castle by electricity is completed, and when the Queen arrived there were 600 lamps in use.

Eastbourne.—The electric light company have been requested to defer works of extension in several streets until the close of the holiday season.

Teignmouth.—The borough surveyor has been instructed to prepare particulars preparatory to applying for an electric lighting provisional order.

Babcock and Wilcox.—The directors recommend a dividend for the half-year ended June 30 of 25s. per share, free of tax, on the ordinary shares.

Callender's Cable and Construction Company.—The certificates for the new preference shares are now ready to be exchanged against banker's receipts.

Spennymoor.—A committee has recommended that the clerk ascertain the cost of obtaining a provisional order authorising the supply of electricity by the Council.

Norwood.—The works incidental to the extension of the electric light from Croydon to Norwood are proceeding rapidly, and already a considerable distance has been covered.

Salford.—The Local Government Board's sanction has been given to the application made last July by the Corporation to raise a further £33,000 on electric lighting account.

Swinton.—The Council have adopted the recommendation of the Water, Lighting, and Sanitary Committee that the necessary steps be taken to obtain a provisional order for electric lighting.

Bury St. Edmunds.—The *Bury Free Press* states that there is a rumour in the town that the application of the Council for the loan of £20,000 has been refused by the Local Government Board.

Rochdale.—The Town Council have decided to make application to the Local Government Board for its sanction to the borrowing of £30,000 for the purpose of the Rochdale Electric Lighting Order, 1898.

Appointment.—Mr. J. G. Griffin, of the Great Eastern Railway electric light station, has been appointed assistant electrical engineer at the new lighting station of the Llandudno District Council.

Cambe: well.—The General Purposes Committee has received statutory notice from the London Electric Supply Corporation of its intention to lay distributing mains in George street and Waterloo street.

Redditch.—An official enquiry has been held into the Council's application to borrow £11,000 to carry out an electric lighting scheme. The amount mentioned is exclusive of the cost of the site for the generating station.

Cromer.—A committee of the Council recently reported as to the electric lighting question, and the Council has decided to instruct the surveyor to prepare the necessary plans and scheme, and report to a future meeting.

House-to-House Electric Light Supply Company.—The Stock Exchange Committee has ordered a further issue of 2,000 7 per cent. cumulative preference shares of £5 each fully paid, Nos. 68,001 to 70,000, to be quoted in the official list.

Lyon's Patent Electric Refrigerator Syndicate, Limited.—This Company has been registered with a capital of £1,600 in £1 shares. The object is sufficiently indicated by the title. The registered office is at 175, Hope-street, Glasgow.

Ilkeston.—The Tramways and Electricity Committee's recommendation has been adopted—viz., that the tramways be constructed on a gauge of 3ft. 6in., and that no engine or carriage used on the tramways should exceed 6ft. in width.

Dundee.—The Gas Committee recommend the Council to extend the electric light plant at a cost of some £3,000. A sub-committee has resolved that the price of electricity should be 4d. per unit up to and including 1,000 units, and above that that it be reduced to 3d. per unit.

Tunbridge Wells.—According to a local paper the Electric Lighting Committee, and indirectly all the consumers, are receiving unfair treatment in the attempt which its states is being made to divert the profits of the electric light undertaking to the relief of other committees.

Halifax.—The Tramways Committee have recommended that in the new extensions double lines be laid along Skircoat-road and Heath-road to Salterhebble and Skircoat-green, also along Market-street and Union-street (where the width of the streets will allow), and North Bridge.

Airdrie.—The town clerk has been instructed to meet the engineer of the Scottish House-to-House Electricity Company with reference to a letter from the manager enclosing a print of the proposed agreement for lighting the streets of the burgh, together with relative plan, etc.

Bristol.—All street work in connection with the extensions of the street lighting will be stopped while the British Association meetings are in progress, so as not to cause any inconvenience to visitors. The Electrical Committee of the Town Council have decided to recommend a reduction of the price charged to private consumers. The new price will be 5d. per unit.

Maidstone.—Messrs. Burstall and Monkhouse have been appointed to act for the Council as consulting engineers, and prepare and furnish a preliminary report and estimate of a scheme for carrying out electric lighting for a fee of 30 guineas, such fee to be merged into a commission of 5 per cent. on the cost of the undertaking should they be engaged to carry out the scheme.

Fenton.—The Council have received a communication from Messrs. Barker, Leese, and Co., intimating that if Fenton did not apply for a provisional order the Board of Trade would grant the order to the Potteries Electric Traction Company upon their application. The clerk has been instructed to get further information upon the subject, and call a special meeting of the Council.

Derby.—We hear that it is not at all unlikely that the question of the purchase of the town tramways will at no very distant date receive the serious consideration of the Corporation. It is stated that in the event of the purchase taking place it is probable that the transfer of the property will be followed in the course of time by the application of electricity for the purpose of driving the trams.

Leeds.—Regular stopping places for the cars appear to be in vogue now. Considering that this is a new departure, it works well. The cars are able to ply with greater regularity. Such is the improvement in this respect that the five minutes' service to and from Harehills-road, on the Roundhay section, can be maintained with one car less than was found requisite under the old arrangement.

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Willans and Robinson.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to a further issue of 3,000 ordinary shares of £1 each fully paid, Nos. 27,001 to 30,000, and 3,000 6 per cent. cumulative preference shares of £1 each fully paid, Nos. 57,001 to 60,000.

Manchester.—A meeting of property owners and ratepayers was held on Tuesday, and authorised the Corporation to promote in the next session of Parliament a Bill to make arrangements with the out-townships of Manchester to work the tramlines within their districts; among other things, to authorise the electric equipment and supply of electricity by the Corporation for working tramways outside the city.

Durban (Africa).—At a recent meeting of the Town Council a letter was read from Mr. A. K. Murray offering to take over all the tramways, including the purchase of the Borough Tramway Company's property, at the prices arranged by the Corporation, to adopt electric traction, to reduce the fares to 1½d. per mile, and to pay the Corporation £2,000 per annum for the right. The letter was referred to a committee.

Suffolk Electric Supply Company.—We understand that applications for shares have exceeded the present capital issue, and that letters of allotment and regret will be sent out at once. The first applicants for shares include well-known county and business men, and under the practical management of Mr. Napier Prentice, who started the electric light in Stowmarket, the company bids fair to be highly successful.

Cork.—At the last meeting of the Corporation a letter was read from Mr. Merz, secretary to the Cork Electric Tramways Company, Limited, stating that within 48 hours of that notice the company intended to commence to supply electric energy through their mains for general lighting. The notice was formal, as the company already electrically supplied 101 houses. The Corporation have decided to commence the public lighting on Oct. 1.

Barnton.—The Parish Council have received a letter from the secretary of the electric lighting company on the question of lighting the village. It stated that it would not pay the company to extend the cable to Barnton unless they were guaranteed an income of between £250 and £300 per annum. To produce this it would be necessary to instal 400 lamps of 16 c.p., or 800 of 8 c.p. This the Council cannot do, and have decided not to light the place at all for the present.

Eccles.—Mr. Clirehugh attended the last meeting of the Town Council, and reported that the various contracts were progressing favourably, and that he considered the Electric Lighting Committee would be in a position to supply electrical energy about the third week in September. The committee have resolved that Mr. Leonard Harvey Combe, who has been acting under Mr. Clirehugh as clerk of works of the Eccles electric lighting contracts, be appointed electrical engineer to the Corporation at a salary of £150 per annum.

Ravensthorpe.—A representative of the Electrical Power Distribution Company has interviewed the Council in respect of an application of his company for the Council's sanction to powers to put down a plant for generating electricity within the district of the Council. He has promised to submit the company's offer in writing in the course of a few days, when the Council will consider it. A letter received from the Electric Traction Company states that one of the company's representatives will shortly wait upon the Council.

Swansea.—The following somewhat drastic resolution bearing on the new tramway works which are being laid down by the British Electric Traction Company has been passed by the Corporation with but one dissentient: "That the borough surveyor be instructed to move such portion of any passing place constructed by the company which exceeds the old limits allowed by the road authority, and to stop by force, if necessary, the extension of any such passing place until the consent of the road authority is obtained for such work."

Copper Stocks.—Messrs. H. R. Merton and Co.'s statistics of copper show that during August the deliveries, although the lowest recorded in the past 12 months, were yet 1,464 tons in excess of the supplies, which were only 15,202 tons, compared with 19,973 tons last month and 19,659 tons a year ago. The stock now stands at 28,397 tons, against 29,861 tons at the end of July and 33,267 tons at the end of August last year. A further advance in the price of G.M.B.'s has been made, the quotation now being £51. 15s., compared with £50. 2s. 6d. a month ago and £49. 2s. 6d. a year ago.

Edinburgh.—The Electric Lighting Committee on Tuesday reconsidered their estimates for the current year, and resolved in consequence of the greatly increased private demands for the light to fix their estimate of revenue for the year at £54,000, instead of £51,000. It was further understood that of the expected £3,000 of increased revenue £1,000 should be placed to reserve, and £2,000 transferred to the burgh assessment account for the relief of the rates. The committee also decided that the minimum charge for the private consumption of the light should be £1 per annum, instead of 13s. 4d. per quarter as heretofore.

Hull.—The new electric lighting station at Sculcoates has been at work over a fortnight. The station will in all probability be completed by the end of the month. The new electric power station, which is about to be erected in Osborne-street for the purpose of working the trams, will soon be commenced, as far as bricklaying is concerned. It is confidently expected that the building will be ready by the time the tramlines are completed. The contract for the new station will be decided about the 23rd inst., and at the same time the Works Committee will consider tenders for steel roofs and sundry iron and steel work for the tramway power station. The work includes nine plain trusses, 44ft. span, and nine 63ft. span.

Weston-super-Mare.—The electric lighting scheme has received a check through the Council by a majority of one objecting to the town yard site, in spite of the fact that Mr. Hawtayne saw not the least likelihood of the works proving a nuisance. The proposal of a combined refuse destructor and electric generating station seems to have quite upset one councillor, for when Shoreditch was instanced he politely declared that that London district was not a sweet-smelling place at any time, and therefore the smell from a destructor would not be likely to be considered a nuisance. Last evening a special meeting of the Council was held for the purpose of discussing a motion that all resolutions standing upon the books with regard to the adoption of an electric lighting scheme be rescinded.

Paisley.—The *Glasgow Herald* is informed that a private conference was held on Friday night between members of the Town Council and representatives of the British Electric Traction Company regarding the proposal of the traction company to take over the tramways of the burgh. It is understood that the company, in the event of a satisfactory arrangement being come to in their favour, are prepared to put down a double line and have their service of electric cars running in Paisley in the course of next year. As has been already stated, there is likewise a proposal before the Paisley authorities for the managing of their tramway system by the Glasgow Corporation, and it is stated that in connection with the subject a conference between representatives of both bodies is to be held.

Appointments Vacant.—The Aberdeen Corporation want an assistant electrical engineer, who must have a knowledge of Babcock boilers, Willans engines, continuous-current dynamos, and batteries. Wages 40s. per week.—The Bradford Corporation require a competent linesman, to act as linesman and inspector. Candidates must have had previous experience in electric traction work, and the wages will be 35s. per week. For further particulars of these and other vacancies see our advertisement columns.—An engineer-in-charge is also required at the Barrow-in-Furness electric lighting station (salary £90 per annum), and a switchboard attendant at Eccles (salary £62). Applications for the former, endorsed "Engineer in-charge," to be sent in by Sept. 19; for the latter, endorsed "Switchboard Attendant," by Sept. 20.

Bradford.—On Tuesday the Tramways Committee discussed at length various proposals for the extension of tramway facilities in Bradford. The committee decided to adopt the scheme at once in regard to the construction of lines from Forster-square, up Kirkgate, to Whetley hill; from Morley-street, along Thornton-road, to Lister Hills and Legrams lane; and from Park-avenue to Little Horton-lane, and along Southfield-lane to join the Great Horton line. The consideration of other proposals will be deferred until the boundaries of Greater Bradford have been determined. The receipts on the Great Horton electric tramway on Saturday were £64. 17s. 4d., and on the Bolton-road line £25. 9s. 6d., making a total of £90. 6s. 10d. The cars on these lines the committee recommend should be fitted with slipper brakes for use in cases of emergency only.

Peterborough.—The Town Council has met with an unfortunate dilemma, which has led to the abandonment of the works in Albert-place Meadow, in connection with the electric light undertaking. It appears that the Great Northern Railway require the site for the improvement of their station. A speaker at the Council meeting said that it would be a great inconvenience and loss to the town to part with such a valuable site, as they would have had the privilege of using water from the river for condensing purposes, and also they would be alongside the railway for getting their coal. These were advantages that they would not find attaching to any other site in the town. Elsewhere, in all probability, they might have no chance of using condensing engines, which would make a difference of something like a third in the consumption of coal.

Fulham.—At the Vestry meeting on Wednesday, the Electric Lighting, etc., Committee presented a report from the electrical engineer, stating that, in accordance with instructions, he had prepared plans and specifications for the combined dust destructor and steam raising plant, and that he had sent copies to the Horsfall Company, Messrs. Beaman and Deas, and Messrs. Manlove, Alliott, and Co., as he considered it would be wise to ask for three tenders rather than to limit the competition by only requesting two firms to tender. He also had requested a representative of each of these firms to attend before the committee on the 15th inst., when the tenders are to be received and opened. The committee approved the action of Mr. Medhurst, the consulting engineer, and, having considered the specification prepared by that gentleman, recommended that it be approved.

Birkenhead.—On Wednesday the Corporation considered certain matters in connection with extensions at the electricity works. Reporting on this, Mr. W. Bates (the electrical engineer) suggested that tenders for the supply and erection of a further 150-unit steam dynamo should be asked for at the earliest possible date. As to the proposed extension, provision was made to meet all demands for the next two years at a cost of £13,343. A list of 32 streets was given for the laying of distributing mains, and it was recommended that provision should be made for service cables, etc., for 150 fresh consumers. The borrowing powers of the Corporation for electricity supply were £41,500. At present there was an excess over that authorised outlay on the cost of the existing works of £1,512. 2s. 9d. In order to cover the excess and carry

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out the proposed extension, the Electrical Committee had resolved to apply to the Local Government Board for power to borrow a sum of £15,000.

Hendon.—The Council have received a letter from the Finchley Council stating that the Highways Committee of that authority had interviewed representatives of the North London Electricity Company, who proposed to apply for a provisional order authorising them to supply electricity to Finchley, Southgate, Edmonton, Enfield, Tottenham, Hendon (rural and urban), Hornsey, Wood Green, Barnet, Friern Barnet, East Barnet, Chipping Barnet, and New Barnet. In view of the many districts involved in the proposed scheme, Finchley suggested that it would be desirable to hold a conference to discuss the subject, and they accordingly invited two members of the Hendon Urban Authority to attend a representative meeting at the Guildhall on the 13th inst. Though the Hendon Council intend to apply for its own provisional order, nothing it is thought will be lost by the Council being represented at the conference, and accordingly two members have been appointed to attend the same.

Dewsbury.—The Gas, Electricity, and Water Committee have passed the following resolutions: (1) that for the purpose of relieving the present overloaded condition of the existing feeding mains and distributors, the principle of increasing the voltage from 220 to 440 volts, be adopted in preference to that of duplicating the mains, the estimated cost of such increase being £2,232. 2s.; (2) that the extension of the mains into Oxford-road, West Park-street, James-street, and Park-road, be proceeded with, and that the electrical engineer do obtain tenders for the supply of the necessary cable and laying down of the same; (3) that the town clerk do apply to the Local Government Board for their sanction to the borrowing of £2,500 in respect of the cost of the extension of mains into such streets. The Council have decided to oppose any application by the British Electric Traction Company for powers to lay down tramways in Dewsbury, and have instructed the Borough electrical engineer to prepare a report upon a scheme for municipal tramways.

Leeds.—With rogard to the proposed transfer of the undertaking of the Yorkshire House to-House Electricity Company, Limited, to the Leeds Corporation, the City Council at its meeting on Wednesday resolved to appoint Alderman Wigram and Councillor Wilson to attend the meetings of the directors of the company, in accordance with the invitation of the directors, pending the completion of the proposed arrangements for taking possession of the undertaking, and to empower them to direct the payment by the Finance Committee (by signing the usual schedules) of such expenditure, both on capital and revenue, as they shall agree to be proper. The following resolution was also carried: "That so much of the resolution passed by the Council on July 6, 1898, approving the acceptance of tenders by the Highways Committee as relates to the conditional acceptance of the tender of Messrs. Dick, Kerr, and Co., for the supply of electrical tramcars, be rescinded, and that the tender of the British Thomson-Houston Company, Limited, for the supply of 50 electrical tramcars, at the sum of £26,573. 15s., be accepted."

Glasgow.—The Corporation have passed the following resolution: "That, as it is desirable that the Corporation and the citizens should, before finally settling what tramway motor is to be adopted, have an opportunity of considering all other motors, it be remitted to the Tramways Committee to invite those who may desire to submit gas, oil, air, or other motors, to submit those offers, and show by experiment, at such time, place, and on such terms as may be agreed on, so that an adequate comparison with the overhead motor may be obtained." With regard to the proposed extension of the tramways outside the municipal boundaries, a sub-committee have recommended, *inter alia*, that "the Corporation cannot agree to have any divided authority as to the equipping and managing of the tramways, but they will deal with the tramways in the county as regards motive power, and work them in the same way as in the case of the particular city lines of which the extensions in the county form a continuation, reserving power to adopt any special construction which may be found advisable in the central part of the city."

Southport.—For upwards of 12 months the British Electric Traction Company have been negotiating for the purchase of the two tramway systems at Southport, and terms are now arranged. The two tramway-owning bodies of Southport are the Southport Tramways Company and the Birkdale and Southport Tramways Company. In respect to the first undertaking, which is at present paying 3 per cent., the London company have agreed to pay £8 for each £5 share. The Birkdale and Southport Company have been approached directly to sell the whole of their concern, and last week the contract was signed for the sale, at a price which will yield £7. 10s. for every £5 share The London company have undertaken these negotiations with the knowledge that the Southport Town Council have recently made application for a provisional order for the construction of a system of electric tramways which will compete with the present lines. In the case of the Birkdale and Southport trams the Corporation will have a two months' option of purchase at the price offered by the London company, but it is not intended to exert their powers in this respect.

Societe Internationale de Construct'on D'Automobiles, Limited.—This Company has been registered, with a capital of £50,000 in 5 000 £1 shares and £11,250 £4 shares, in order to acquire either solely or jointly with other persons or companies in France and elsewhere, patents, licenses, and other rights and privileges concerning the manufacture, the sale, the exportation, and the importation of motors, motor carriages, tricycles, and all other accessories relating to the industry of mechanical and electrical engineers, metal founders, wheelwrights, blacksmiths, carriage builders, wood turners, upholsterers, and lamp manufacturers; with a view to the above object, to adopt and carry out, with or without modifications, an agreement dated July 11, and expressed to be made between Messrs. Tauzon et Cie. of the one part and M. P. E. Moyse, as trustee for and on behalf of this Company, of the other part; and, further, to act as mechanical and electrical engineers, motor manufacturers, carriage builders, painters, company promoters, financial agents, etc.; to buy and sell stocks, shares, and other securities; as manufacturers of motors, motor carriages, bicycles, carriage builders, etc.

Blackpool.—The General Purposes Committee's meeting was practically unanimous in accepting the recommendation that the transformation of the tramway from the conduit to the overhead system should be made. Mr. Quin and Mr. Lancaster attended, and the former stated that the adoption of overhead traction would mean a saving of at least £1 500 a year in upkeep alone, while the latter estimated that the greater reliability and efficiency of the improved system would allow the line to earn not less than £2,000 a year more than it was at present capable of. The difference between the two methods of traction, therefore, was estimated to amount to at least £3,500 a year in favour of the ratepayers.—At Tuesday's meeting of the Town Council, Councillor Brodie moved the adoption of the Electric Lighting and Tramway Committee's minutes, and said the new system would mean a saving of £1,500 a year. He could also tell the Council that they had decided to commence with the penny fares in October, and, with the exception of Easter and Whitsuntide, they intended to continue them until next June. They had further decided to grant contract tickets at £8 per annum. The minutes were passed.

Denton.—The Tramways Committee have received a letter from the Ashton-under-Lyne Corporation asking if, in the event of their deciding to promote a Bill in Parliament authorising them to supply electricity outside the borough, the Denton Council would at the same time apply for the usual provisional order under the Electric Lighting Act, and on the necessary powers being obtained, if they would be willing to enter into an arrangement for being supplied with electricity by the Ashton Corporation. The clerk has been instructed to communicate with the Ashton Corporation as to their terms and also with the Levenshulme Council with regard to the report recently made to them on the question of lighting their district by electricity. A letter has also been sent from the Board of Trade stating that they had extended the time for the completion of the Oldham, Ashton, and Hyde electric tramways, and that the company had made out a case for a single "decker" car. It has been resolved that whilst having no further observation to offer on the subject, the committee are of opinion that cars with outside seats are best adapted for the requirements of the district, and the clerk is to ask the Hyde Corporation, the Ashton Corporation, and the Audenshaw District Council what action they are taking.

Liverpool.—At the meeting of the Town Council on Wednesday the Tramway Committee recommended that they should be authorised to take steps to have plans, sections, and estimates prepared to continue the overhead electric traction tramways from the termination of the experimental line at the Dingle to the end of Aigburth-road, and also for an extension of the experimental line from the Prince's Park gates along Croxteth road to Lodge-lane, in accordance with the lines as authorised by the tramway provisional order of this session. At the meeting of the Lighting Committee it was decided to accept the tender of Messrs. Waring and Sons, West Derby, to erect an electric sub-station in Lodge-lane, at a cost of £2,635. The Tramway Committee requested the committee to try to utilise the poles which are being erected in connection with the electrical tramway system for the purpose of lighting the streets. The matter was referred to Mr. Holmes, electrical engineer, and Mr. Bellamy, chief superintendent of street-lighting, for report. It was reported that the extension of mains in Upper Parliament-street had cost £169, and in Devonshire-road and Admiral-street £127. The committee having had many applications for electric light from the Prince's Park and Sefton Park districts, it was decided to lay additional mains in thoroughfares there at a cost of £239.

London Provincial Electric Company.—A winding-up order was recently made against the London Provincial Electric Company, Limited, and the statutory meetings of creditors and shareholders were held this week before Mr. A. S. Cully at the London Bankruptcy Court. The Chairman said that the statement of affairs had not yet been lodged. The Company was registered in June, 1897, with a nominal capital of £60,000, to acquire the business of Messrs. Ridings, Codd, and Co., electrical engineers, Birmingham, including certain patents, and was promoted by Mr. J. H. Crawford. The price to be paid was £30,000, of which £10,000 was payable in cash, £10,000 in shares, and £10,000 in cash or shares, at the option of the directors. The price Mr. Crawford was to pay for the business sold by him to the Company for £30,000 was £3,000, of which £1,500 was payable in cash and the balance in shares. On April 18 last debentures for £10,000, charging the whole of the Company's assets, was issued as security for the cash portion of the purchase price, and on Aug. 10 a receiver was appointed on behalf of the debenture-holder. The liabilities were estimated at £3,800, of which £3,100 was in respect of money advanced by Mr. Crawford, and the assets consisted of certain patents and a dynamo. The meetings were adjourned to the 13 h inst.

Dublin.—The work of the electric equipment of the Dublin tramways is progressing as rapidly as the intricate nature of the operations will permit. The *Dublin Evening Mail* states that hundreds of working-men and scores of experts are daily—some-

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times nightly—engaged in pushing forward this great revolution in tramway locomotion in the Irish metropolis and suburbs, but as ordinary traffic must be impeded as little as possible the completion of the new system will not be attained for several months. Some of the lines, however, will be in working order within a short period. The Dollymount service has been in full operation since early summer, and the line to Dalkey has been worked from D'Olier-street for over a month, and it is expected the impediment to the entire run from Nelson's Pillar will be removed within a few days. The line from Rathmines to Ballsbridge has been completed in every respect, except the electric equipment, and this, when the power station at Ringsend is finished, will be simply a matter of carrying out details. Horse cars have been running over the new line for the past fortnight, and are extensively patronised. The newly reconstructed line along the northern quays to the Phœnix Park is also being utilised for horse cars pending the introduction of the electric current, for which all the poles and overhead wires are in their places. The work of replacing the rails and laying the conduits on other routes is going on with expedition.

Edison-Gower Bell Telephone Company of Europe, Limited.—This Company has been registered, with a capital of £75,000 in 2s. 6d. shares (113,600 preference and 486,400 ordinary), in order to adopt an agreement bearing date July 7, 1898, and expressed to be made between the Edison-Gower Bell Telephone Company of Europe, Limited, of the one part and Sir A. Armstrong, as trustee for and on behalf of this Company, of the other part, and a second agreement bearing same date, and expressed to be made between the Consolidated Telephone Construction and Manufacturing Company, Limited, of the one part and C. L. W. Fitzgerald, as trustee for and on behalf of this company, of the other part, and, generally, to carry on the business of a telephone and telegraph company, and, in particular, to establish, work, and regulate telephone exchanges and other conveniences, and to transmit and facilitate telephonic and telegraphic communications and messages; to carry on any other businesses connected with the supply or employment of electricity, and in particular the business of an electric heat, light, and power supply company; to erect, maintain, lay down, carry out, buy, sell, take, and let on hire and deal in telephones and all apparatus, works, and things connected with the above objects. The first directors—of whom there shall be not less than three nor more than four—are Sir A. Armstrong, A. H. Baker, C. L. W. Fitzgerald, and H Grewing. Qualification not specified. Remuneration to be fixed by the Company.

Salisbury.—The Council at the monthly meeting had before them schemes for improved public lighting of the city. The gas company offered to supply gas, light, extinguish, clean, repair, glaze, paint, and efficiently maintain 216 No. 2 and 75 No. 4 New Welsbach burners, giving 50 c.p. and 100 c.p. respectively, with lanterns, all accessories, etc., for the inclusive sum of £574 per year of 3,700 hours' lighting. The electric light company were prepared to undertake to light the city throughout by means of incandescent electric lamps of such power as would light the streets considerably better than they were lit at present, for all-night lamps running all the year, for the sum of £925. 17s. 6d. The latter company also proposed an alternative scheme as follows: 16 half-night arc lamps of 1,000 c.p. each, and 32 half-night incandescent lamps of 12 c.p. each, including carbons, trimming, cleaning, lighting, repairs and maintenance, at £20 per lamp per annum, £320; 245 incandescent lamps of 25 c.p., including renewals, cleaning, lighting, repairs and maintenance, at £2. 17s. 6d., £704. 7s. 6d.—total, £1,024. 7s. 6d. After considerable discussion the gas company's proposals were accepted, a peculiar fact of the voting being that about half the Council were debarred from doing so because of their interest in one or other of the rival companies. Through the competition of the electric light the gas company's charge for the current year is £574, as against £915 odd last year, or a difference of £341!

Belfast.—According to Councillor Andrews, electric traction in Belfast will not arrive before 1907. This gentleman states that the directors of the Belfast Street Tramways Company practically put the entire onus of the delay in the introduction of electric traction on the Corporation. He challenges the statement, and distinctly says that the delay has been partly caused by the Corporation, but that a very large portion of the delay has undoubtedly been due to the tactics of the tramway company, who seem to be imbued with the idea that the Corporation will buy out their undertaking at any price they choose to put upon it, and so get rid of the question. It appears that the directors are not willing in any circumstances to agree that the cost of the electrical power proposed to be supplied by the Corporation should be fixed yearly by an electrical engineer. They also wish to be informed at what price the Corporation propose to supply the electrical power. Upon receipt of fuller details in relation to the Corporation's proposals generally, and especially in regard to the two important points mentioned, the directors will be prepared to resume their consideration of the matter. As a reply, the Corporation have passed the following: "That the tramway company be requested to state whether they accept the principle involved in the proposals of the Corporation as a basis of settlement before entering into the details of the proposed scheme." Also: "That the sub-committee already charged with the negotiations be requested to consider and report as to the desirability of appointing an expert to advise the committees on the financial aspect of the position as regards the sums to be charged in respect of the outlay connected with the installation and depreciation should the proposals referred to become the basis of negotiation, and such other matters as the committee may require assistance in, and the gentleman whom they would recommend as consultant."

Bury (Lancs.).—A report by the borough engineer and the electrical engineer was submitted with the minutes of the Electric Lighting Committee to the Council yesterday week. The subject of the report was the extension of plant at the electrical works, and in it was stated the fact that "the necessity for an extension demanded the immediate attention of the committee." A table of the monthly rate of progress was given, and showed that whilst in March, 1897, 41 consumers used 2,481 lamps, in August, 1898, 101 consumers used 6,788 lamps. To this would have to be added a further 1,725, for which applications had already been received, making a total of 8,513, leaving only a balance of 1,487 to make up the full complement of 10,000 8-c.p. lamps, which is the estimated total capacity of the present plant. The report stated that "at the present rate of progress it will be seen that by the new year the full capacity of the plant will be arrived at. To make preparations for the autumn of 1899, it is necessary that extensions should be completed by midsummer next, and, as is well known, the engineering firms are so fully employed that deliveries will not be guaranteed under nine months. In addition to the necessity of coming to a decision on account of the time involved in getting orders executed, there is a further question of increased voltage. . . . In the present engine and dynamo house there is ample room for extensions for many years. Mr. Watson has gone very carefully into the size of the engine and dynamo that would be advisable, which is equal to an output of 250 kw., or 350 h.p. The estimate for such a plant, including additional boiler and all accessories, is £3,800, whilst the altering of the present plant to allow of the increased voltage would cost an additional £1,450, making a total expenditure of £5,250. This expenditure is absolutely required to meet the demands for the winter of 1899-1900. The following year probably a similar increase will be required, and it may be economy to obtain tenders for double this plant, making arrangements for the supply of one portion next summer, and the other portion the following summer. The present borrowing powers (£30,000) are almost exhausted, as there has been expended up to the end of July last over £28,000, whilst authority has been given to spend another £4,000 on mains, which will make the expenditure exceed the borrowing powers by £2 000. Steps should therefore be at once taken to apply for further borrowing powers." The minutes further stated that the committee had resolved that plans and estimates for an extension of the plant at the electricity works be prepared, and that the town clerk make application to the Local Government Board for power to borrow the sum of £20,000 to carry out the necessary works. It was reported that the Lighting Committee had approved a scheme for substituting arc lamps for the present gas lamps in several streets, and it was resolved that the works be carried out. The Council adopted the report and minutes, with the exception of a small detail.

PROVISIONAL PATENTS, 1898.

AUGUST 29.

18163. Improvements in electric incandescent lamps and other articles which require to be hermetically sealed. Frederick James Satchmell, Jesmond Dene, Lightfoot-road, Hornsey, London.

18475. Electric meters. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Thomas Alva Edison, United States.) (Complete specification.)

18485. Improvements in the distribution of electrical energy for railways and tramways. John Smith Raworth, 46, Lincoln's-inn-fields, London.

AUGUST 30.

18522. An improved electrolytic apparatus for the production of alkali. William Thomson, Baron Kelvin of Largs, 154, St. Vincent-street, Glasgow.

18531. Improvements in electric railway switches. Rollin Alger Baldwin and Heavlon Rowland, 70, Market-street, Manchester. (Complete specification.)

18549. Improvements in or relating to electrically-driven dental engines. Orlando William Frederick Hill, 78, Fleet-street, London.

18566. An improved electric light fitting. Gerard Nuttall, 45, Southampton-buildings, Chancery-lane, London.

18582. Improvements in induction motors. Reginald Belfield, 322, High Holborn, London. (Benjamin Garver Lamme, United States.)

28583. Improvements in systems for converting the energy of alternating-electric currents into mechanical energy by means of inductien motors. Reginald Belfield, 322, High Holborn, London. (Benjamin Garver Lamme, United States.)

18584. Improvement in controllers for electric motors. Harry Phillips Davis, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Section 103, April 25, 1898, being date of application in United States.)

18613. Improvements in telephonic systems and apparatus. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

AUGUST 31.

18639. A means of making an electrical contact by pulling a cord or wire. Wilford Wyatt Martin, Avenue Villa, Coventry-street, Kidderminster.

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18639. Improvements in couplings for connecting together the electric wires as used on railway trains for electrical communication and the like. Alexander Shiels, 100, Wellington-street, Glasgow.

18649. Improvements in guide ropes and solenoid cores of arc lamps. John Miles Moffat, 448, Merton-road, Wandsworth, London.

SEPTEMBER 1.

18702. Improvements in electricity accumulators. Alexander Schanschieff and Albert Edward Hodgson, Penny Bank-chambers, Halifax.

18722. Improvements in clips for attaching to telephone or other cables when drawing the same into pipes or conduits. John George Brien, 72, Canton-street, Burdett-road, London.

18725. Improvements in phonographs. Joseph Chania, 15, Took's-court, London.

18740. Improvements in safety fuse apparatus for electrical installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Aktien Gesellschaft, Germany.) (Complete specification.)

18742. Improvements relating to the extraction of chromium by electrolysis. Julius Franz Ludwig Moeller and Ernest Auguste George Street, 45, Southampton-buildings, Chancery-lane, London.

18750. An improved coin-feed electric machine. Robert Loignion, 1, Broad-street-buildings, Liverpool-street, London.

18754. Improvements in electric tramways and railways. John Charles Love, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 2.

18806. Improvements in telephonic apparatus. Alfred Graham, 46, Lincoln's-inn-fields, London.

18807. Improvements in electric sparkers for explosive engines. Alexander Winton 46, Lincoln's-inn fields, London. (Complete specification.)

18820. Improvements in or relating to electrically illuminated signs or advertisements. George Bennett Bowell, 322, High Holborn, London.

SEPTEMBER 3.

18847. Improvements in electric batteries. Manes Ephraim Fuld, 6, Finkle-street, Stockton-on-Tees. (Complete specification.)

18854. Improvements in electrically igniting charges of internal combustion engines. Arthur Frederick Evans, 56, Ludgate-hill, London.

SPECIFICATIONS PUBLISHED.

1897.

11575. Syntonised telegraphy without line wires. Lodge.

18796. Secondary or storage batteries. McDougall.

18941. Electric alarm and registering apparatus. Junge. (Vester.)

19995. Means for effecting magnetic transmissions. Engisch and König.

20,669. Automatic brakes for electrically-driven machines. Blackburn and Spence.

21109. Bobbins and cores of solenoids for enclosed electric arc lamps. Davy and Thomas-Davies.

21669. Insulators for telegraph and like wires. Ashby.

22610. Compound or material applicable for electrical or heat non-conducting or insulating purposes. Brown, Schmidt, and Mackenzie.

22852. Phase adjusting and regulating methods and means for alternating-current apparatus. Belfield. (Tingler and Shallenberger.)

23442. Electrolytical current-directing devices and transformers. Johnson. (Pollak.)

23470. Electric incandescence lamps and apparatus or appliances in connection therewith. Nernst.

26026. Covers or domes of the switches of electrical glow lamps, which improvements are also applicable to other electrical switches. Evered.

28721. Manufacture of electrical resistances of metal foil. Helberger.

1898.

8805. Electrical switch apparatus. Minshall.

8438. Apparatus for electrically illuminating or displaying letters, figures, designs, pictures, signals, and their like, principally adapted for advertising purposes. Gent.

13258. System of electrical communication for use in telephony, telegraphy, and the like. Brown.

13793. Electric generators. Edwards. (Emanuel.)

14107. Prepayment electricity meters. Long and Schattner.

14800. Electrical heaters, rheostats, and the like, having comminuted resistance for the electric current. Sill.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending.	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for current half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway Company	Sept. 3	3,827	3,538	+ 289	—	—
Blackpool and Fleetwood Tramroad	,, 3	978	—	—	7,805	—
Bristol Tramways and Carriage	,, 2	3,181	2,543	+ 637	—	—
City and South London Railway	,, 4	916	875	+ 41	9,612	9,028
Dover Tramways	,, 3	248	—	—	5,320	—
Dublin S.D. Electric Tramways	,, 2	1,057	706	+ 350	10,303	7,763
Halifax Corporation Tramways	Aug. 24	297	—	—	—	—
Liverpool Overhead Railway Company	Sept. 4	1,617	1,382	+ 235	—	—
South Staffordshire Tramways	,, 2	629	639	- 10	21,918*	2,1566*
* Receipts since	Jan. 1.					

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	13½-14½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9⅞-10¼
—— 4½ per cent. Cum. Pref	10	10⅞-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16¼-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (issued at £2. 10s. premium, all paid)	10	13-14
Brush Company, Ordinary	2	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2¼
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9⅞-10⅛
——	6	5⅞ 6⅛
—— Pref. Half-Shares	1	1⅛-1⅜
—— ,, ,,	5	4¼-4½
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24½-25½
—— 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	16¼-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	2⅞-3⅛
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— ,, ,, ,,	6	8½-9½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	1⅞ 2⅛
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ordinary Shares, 1-17,400	5	5-5⅛
Electric Construction, Limited	2	2⅛-2⅛
—— 7 per cent. Cumulative Pref.	2	2⅜-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅝-¾
Elmore's Wire Company	2	1⅛-1⅜
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½ xd
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½ xd
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3⅞-4⅛
Metropolitan Electric Supply, Limited, Ordinary	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-190
National Telephone, Ordinary	5	5⅞-6⅛
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	7⅛-8
—— £4½ shares	4	6½-7
Royal Electrical Company of Montreal	1⅛	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2⅛-2⅜
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	38-42
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	125-131
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

Candia.—During the recent troubles the telegraphists have bravely stuck to their posts—an act of gallantry which can, perhaps, be only appreciated by those who have been in a "row in the East."

German Manœuvres.—Motorcars are being tried in the autumn manœuvres by the German army. Should they prove efficient, a number will be manufactured by the Government and one or two attached to each regiment.

Wonderful!—We have referred in another note to a discussion in America on storage batteries, and make this a separate note because it seems to deserve it. Mr. Scott, in this discussion, said "he was assured positively" that a storage battery had not been charged for 13 months, and that "it gave full two volts to every cell, and that with a half-dozen lights burning."

Institution of Junior Engineers.—On Saturday, Sept. 24, this institution will pay a visit to Sir David Salomons's interesting workshops and laboratories, etc., at Broomhill, Tunbridge Wells. Those wishing to attend must catch the train leaving Cannon-street at 1.35 p.m. Tickets may be obtained from the secretary of the institution at 47, Fentiman-road, S.W.

Swiney Lectures on Geology.—Under the direction of the directors of the British Museum, this course of 12 lectures will be delivered by R. H. Traquair, M.D., LL D., F.R.S., on "Palæontology of Great Britain" at the South Kensington Museum on Mondays, Wednesdays, and Fridays at 5 p.m.; beginning Oct. 3, ending Oct. 28. Each lecture will be illustrated by means of lantern slides and limelight. Admission to the course is free.

The Electro-Harmonic Society.—The programme of the Electro-Harmonic Society for the coming season announces that the concerts will be six in number, and will take place on the evenings of the following dates, all of which are Fridays: Sept. 30, 1898, smoking concert; Oct. 21, 1898, smoking concert; Nov. 25, 1898, ladies' night; Jan. 27, 1899, smoking concert; Feb. 24, 1899, ladies' night; March 24, 1899, smoking concert. We may remind our readers that the annual subscription to the society is 10s. 6d.

The Late Dr. John Hopkinson.—The Stafford Town Council at their last meeting passed the following resolution unanimously: "That this Council deplores the lamentable accident which has befallen their consulting electrical engineer (Dr. John Hopkinson), and desires to place on record their appreciation of the exceptional ability displayed by him in all work he has carried out for the Corporation, and at the same time to express their deepest sympathy with the widow and family at the irreparable loss they have sustained."

Field Telegraphy.—There is, perhaps, nothing new to be said on the subject of the telegraphic connection between Cairo and Khartoum, or, rather, near to Khartoum. Few incidents have been chronicled so quickly and so correctly connected with warlike operations on the confines of civilisation as have been those of the advance up the Nile. With but slight intervals the Sirdar has always been within touch of the home authorities, and this speaks much for the excellence of the work and the forethought taken to establish telegraphic communication.

Electric Trams in Lisbon.—It is reported that the Companhia Carris de Ferro de Lisbon has at length obtained a concession from the Government and the local authorities for the introduction of electric traction on the Lisbon tramways. The concession is for 99 years, and the local authorities have reserved the right of requiring alterations in the system of working at the expiration of 20 years. It is further said that the Allgemeine Elektricitäts-Gesellschaft of Berlin, and Messrs. Wernher, Beit, and Co., of London, are jointly interested in carrying out the work.

Machine Drawing.—We have received from the authors, Messrs. T. and T. G. Jones, an excellent little book published by John Heywood, of Manchester, on this subject. This part forms Part I. of Book II. The drawings given as specimens are very good and very clear; the description is concise, and the formula explicit. A feature of great use is that the letterpress description is on the left-hand page, the drawing on the right-hand, so that there is a minimum of turning leaves to get corresponding information. The examples are well chosen, and a careful student should revel in the little book.

Sunderland Tramways.—An exhaustive report of the deputation of the Tramways Committee of Sunderland has been sent us. It consists of about 120 quarto pages with several maps, and a number of excellent illustrations. The deputation visited Hamburg, Brussels, Dover, and Leeds, and the report describes the installations and organisation at these places very fully. Elsewhere we give the conclusions of the borough electrical engineer, Mr. J. F. Snell, which will be followed by those of the borough engineer, Mr. R. S. Rounthwaite, and the comparative estimates by these two gentlemen.

Dover.—The authorities at Dover are to be congratulated at the success of the first year's working of their electric tramways. The borough engineer, Mr. Stilgoe, upon whose shoulders much of the responsibility falls, deserves the highest praise for the care and attention he has devoted to the work. It is stated that over a million and three-quarters of passengers have been carried during the year at the fare of 1d. per head. The profit on the year's working is some £1,300. Such news should put heart of grace into those authorities which have been hanging back till they have seen how the business turned out in other places.

Cane Lamps.—The latest electric plaything is an electric cane lamp. The handle of the cane contains an incandescent lamp, the two poles of which are connected with the plates of a battery. Below this is a small chamber to carry the battery fluid. When it is desired to use the lamp the cap is taken off and the cane inclined, so that the liquid it contains comes in contact with the electrodes. A current is thus produced that will, it is asserted, keep the light going for an hour, which ought to be a sufficient allowance of time for the sometimes somewhat difficult search for the keyhole, provided that the lamp works. Burglars and nightouters, please note!

New Line Proposed.—The difficulty of getting from the suburbs north of Hyde Park to those south, and *vice versâ*, without undue loss of time, has always been the source of just complaint. It appears that steps will be taken to remedy this annoyance, and place London more on a level with other towns as far as street communication is concerned. A Bill will be introduced next session to obtain the right of constructing a railway from Cricklewood, through Kilburn and under Hyde Park, to Victoria. Such a railway would greatly relieve the traffic along the Edgware-road and Park-lane, besides allowing one to get from Victoria to Westbourne-grove without having to travel three times the necessary distance.

Telephones in Cape Colony.—Consul-General Stowe, writing from Cape Town to the United States, explains that the telephone service of Cape Colony is under the

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control of the Colonial Government. On April 9, 1898, there were 1,535 instruments in use, and the revenue for 1897 amounted to £13,225. There are 869 miles of wire and 780 subscribers. Seven exchanges in the colony work on the single-wire system, but arrangements are being made to have all lines duplicated, and in future no exchange will be established except on the metallic-circuit system. In the course of the next few months the underground cable system in Cape Town will be completed and exchanges established in the suburbs. We are indebted to the *Scientific American* for the above details.

Clifton College Soiree.—On Thursday, Sept. 8, a large number of members of the British Association attended a soirée at Clifton College, and were received by the Headmaster of Clifton College (Rev. Canon E. G. Glazebrook) and Mrs. Glazebrook, and Dr. Percival (Bishop of Hereford. Light entertainment was provided by the Bristol Royal Orpheus Glee Society, whilst those more interested in recent scientific advances were provided with a lecture by Prof. H. H. Turner, F.R.S., on the total eclipse of last January, whilst Prof. Ramsay, F.R.S., and Dr. Morris W. Travers exhibited the spectra of Neon, Krypton, and the latest new gas (not of American origin), Xenon. Refreshment tents were open throughout the evening, whilst a band played at intervals in the close. This soirée will probably be remembered by many as one of the most enjoyable events of the Bristol meeting.

The Institution of Mining Engineers.—The annual meeting of the members of the Institution of Mining Engineers opened on Tuesday last at Mason College, Birmingham. Mr. G. Lewis (Derby) occupied the chair, and, in addition to Prof. H. Louis, the attendance, which was large, included representatives of leading collieries throughout the country. The Secretary announced that Mr. J. A. Longdon (Chesterfield Institution) had that morning been elected by the council president of the institution. The first paper, the joint production of Mr. E. B. Marten and Mr. E. Howe, dealt with the South Staffordshire mines' drainage scheme, with special regard to electric power pumping. Other papers dealt with timbering in the iron ore mines of Cumberland and Furness, the automatic manipulation of coal and coke, etc. In the evening the annual dinner was held.

The Tunbridge Wells Profits.—The fact that the electric lighting undertaking has made a profit at Tunbridge Wells is not pleasing to the gas interests in the town. When, however, it is proposed to prevent the profit growing by reducing the price of electric energy the displeasure turns to clamour. These critics demand a paper readjustment of the balance-sheet so that the profits may be made to appear less than they really are. The opponents of the electric light, while advocating this readjustment to relieve the general district rate, know it would indirectly secure the further result of lessening the competition of the electric light with gas, as the cheaper the power is the more people will use it, and the more profitable will be the turnover to the municipality. It is suggested that the rent of the site used by the electric lighting undertaking ought to be raised, and that many more establishment charges should be added. We trust that a broad-minded policy will prevail.

Hydrometers of Total Immersion.—In a preliminary statement made by Mr. A. W. Warrington, M.Sc., to Section A of the British Association, he describes a series of experiments made with the object of showing that the hydrometer becomes an instrument of scientific precision if it is modified so that when used it is totally immersed in the liquid. Small ring-shaped platinum weights are slipped over the ungraduated neck of a glass hydrometer until the latter has nearly attained the specific gravity of the liquid to be tested. The temperature of the liquid is then slowly altered until the hydrometer and the liquid have exactly the same specific gravity. With proper precautions this method gives results accurate to one in a million for temperatures from 0deg. to 40deg. C. A change in the volume of the hydrometer as small as 0 00015 of a cubic centimetre can be detected, and this leads the writer to hope that with a properly modified Nicholson hydrometer the specific gravities of solids, of from 200 gr. to 100 gr. in weight, can be determined at about one in a hundred thousand.

American Practice.—This is the story of the unfortunate error of the sparrows of Kansas City, as related in the sprightly fashion by the *Star* of that place: "It's the birds," exclaimed the unhappy electrician to the superintendent. For the fiftieth time a department of the great Swift packing-house had been plunged into darkness by the failure of the electric lights, and for the tenth time the superintendent had called the electrician, Mr. Kobell, to time. "Birds—bosh!" retorted the superintendent. "It's a fact!" protested the electrician. "The confounded birds take the fuses between the binding posts for threads and try to grab them off for their nests. Every time they pounce on a wire they break the current." "Bosh!" repeated the superintendent. The electrician rushed out and returned with two limp sparrows. "Look at the blisters on this one's feet," he cried, "and this one's bill is melted off." Sure enough, the sparrows were burned and blistered. Under the eaves of the building the thin lead fuses had proved a charnel place for birds. At length it was decided that fuse covers have their advantages.

Estimates v. Reality.—The other day we happened to be on board ship with a number of well-known engineers as well as a general cargo of passengers. One of the general cargo let everyone around him know he was an electrical engineer. We have in our time met many electrical engineers, but had never previously seen to our knowledge this particular specimen, nor do we ever wish to see him again. Some of the engineers aboard were closely connected with electrical undertakings, and naturally questions were asked—and answered by the specimen. Now, practical men always harp on the question of cost, so it was news to some of us to hear the specimen emphatically assert and reiterate again and again that the total cost of generation per unit could not be much less than 6d. Under exceptional circumstances it might be reduced to 4d. The moral is this—do not talk with strangers on subjects you know very little about. As one gentleman remarked, "I knew a good deal more than he imagined, and so could not believe anything he said." The best of it was, the specimen quoted chapter and verse for his statements, and the singularity of his proofs was that they always concerned installations by "Lord This" and "Sir Somebody" that.

Electric Canal Haulage.—We learn from the *Street Railway Review* that, in accordance with an Act passed at the last session of the Ohio Legislature, Mr. W. G. Wagenhals, who was until very recently general manager of the Cincinnati and Miami Valley Traction Company, has been granted the privilege of experimenting with electric traction on the Miami and Erie Canal. If the experiments are successful, Mr. Wagenhals is to receive the exclusive right to operate boats by electric power for 25 years. Mr. Wagenhals saw the opportunities of this application of electric power when he went to Dayton, two years ago, and made some preliminary trials which convinced him of the practicability of the plan. An ordinary motorcar towed two boats loaded with 80 tons each at a speed of 10 miles per hour, with an expenditure

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of 20 amperes. This proved to be too high a speed, as a wave 3ft. high was thrown ahead of the boats and forced the water over the banks. Six miles per hour was entirely practicable, however. The canal is 250 miles long, connecting Lake Erie with the Ohio. It is 60ft. wide and 4ft. deep. The towing wagon of latest design is to weigh 20 tons and to be only 6ft. in height over all. The outcome of the further trials will be watched with interest.

Magnetism and Temperature.—Mr. J. R. Ashworth, B.Sc., in a paper read before the British Association, "On the Construction of Magnets of Constant Intensity under Changes of Temperature," describes experiments on a remarkable property of drawn steel wires. Magnets made of such wires, after a series of heatings and coolings, reach a cyclic state in which, contrary to general experience, an increase of temperature produces an increase of magnetic moment, and decrease of temperature a decrease of magnetic moment. It is easy, by several processes which are described, to change this abnormal effect to the normal one, in which higher and lower temperatures produce lower and higher magnetic moments respectively. In passing from the abnormal to the normal state by any of these processes, a stage is reached at which change of temperature neither increases nor decreases the magnetic moment, and for changes within the atmospheric range of temperature, the intensity of such a magnet remains constant. An account is given of the behaviour at different times of magnets of constant intensity which have been tested at intervals during 18 months. In conclusion, experiments on the cause of the abnormal thermo-magnetic effects are described.

The Bristol Symposium.—On Friday last the local scientific societies of Bristol gave a smoking concert (or symposium) in the Merchant Venturers' Hall in honour of Sir W. Crookes. A most lively entertainment was provided, and most liberal hospitality in the matter of smokes, etc. The souvenir programme had a good portrait of the president, the "Crookes tube" on it represented as a pipe. The verses on the programme read as follows:

Puff, puff, puff, O C———!
At briar and clay, O C———!
And I would that my tongue could utter
Such thoughts as occur to me.

Oh! well that Edie and Swan
Your radiometer knew,
And well for the Röntgen ray
That the vacuum bulb you blew.

Your works are a record of skill
Our jaded hopes to inspire;
But, oh, for a mode of rechanging change!
And a message by wireless wire!

Pump, pump, pump,
At table and bulb, O C———!
Tho' you'll never make them quite so void
As the heads in the west countree.

Storage Batteries.—In the discussion on a paper by Mr. Appleton on this subject in Philadelphia, a few statements were made which possess some interest. Mr. Salom stated that 12 electric hansoms and one electric brougham had covered about 50,000 miles in 14 months; this gives an average of nearly 4,000 miles each. Unfortunately, Mr. Salom does not give any information about repairs or renewals, but leaves us to infer that this work has all been done with the original batteries—a wonderful performance, if that is so. He does, however, give figures to show that a good deal more common sense exists in New York on this subject than on this side. Here, according to our competitions, we seem to think one of these vehicles ought to run 150 or 200 miles at a stretch without a refresher; there they are satisfied with a capacity to run 25 miles. He said, "If they can go 25 miles per day on one charge, which they are doing now, we think all the requirements of cab service will be thoroughly covered and met. . . The actual amount of power required for a 25-mile drive is about 12 horse-power hours." [To us this seems extremely low.—ED. *E. E.*]. . . "In other words, you can ride 25 miles for 36 cents' worth of power," that is, for about eighteen pence, or about three farthings per mile. Subsequently Mr. Gibbs gave the weight of battery required as about 100lb. per horse-power hour.

Presentation to Mr. J. E. Stewart.—The impending retirement of Mr. Stewart from the position of electrical engineer-in-chief of the Corporation electricity supply works, Derby, with which he has been connected from its very inception, was received with much regret by the whole of the staff employed under him. It was felt by all that this was a fitting opportunity for showing their esteem and appreciation of the many kindnesses received from Mr. Stewart during his tenure of the office of engineer and manager of the works. As a result, a walnut cabinet of dessert knives and forks was in the name of the whole of the staff presented to him on Friday afternoon Sept. 9. The knives and forks are ivory hafted, of very chaste workmanship, with silver mounts, and the cabinet bears the following inscription: "Presented to J. E. Stewart, Esq., borough electrical engineer, by the officials and workmen of the Corporation Electric Lighting Department on his leaving Derby, September, 1898." Mr. Stewart, who was deeply moved, thanked his fellow-workers on behalf of Mrs. Stewart and himself, and said that both of them, whilst highly valuing the gift, would especially value the thought which prompted them in giving it. He only hoped that the same kindly feeling would exist between his successor and the men as had so happily been the case with themselves. Mr. Stewart is shortly starting for America, where he is taking up an important post with the St. Lawrence Power Transmission Company.

Etherion.—At the American Association for the Advancement of Science, recently held in Boston, a communication was received from Mr. Charles F. Brush as to the discovery of a new gas or series of gases, to which the name Etherion has been provisionally given. We are informed that Mr. Brush made his "discovery" some year and a half ago, while experimenting on the occlusion of gases by glass. Reference was made by Mr. Brush to the conductivity of various known gases "at a pressure of a few millionths of an atmosphere," although how such a low pressure could be obtained or measured must for the present remain a puzzle to scientists. When further we try to determine on what grounds Mr. Brush relies in ascribing such properties as a density of only a thousandth of that of hydrogen, a specific heat 6,000 times that of hydrogen, etc., we find that the heat conductivity of the new gas is apparently the only constant which has been determined. When it is remembered that of all physical constants the heat conductivities of gases are at once the most difficult to determine and the most unreliable when obtained, we are lost in admiration of Mr. Brush's assurance. Most scientists would have experimented on the density of a supposed new gas, would have observed and tabulated its spectrum, and investigated the ratio of its specific heats, etc., and would then only have felt themselves justified in assuming that they had not lighted on a mare's nest. But Americans are nothing if not go-ahead. Finally, Mr. Brush points out that such a gas could not be confined to the earth, and from this he reasons that it must be distributed through interstellar space. He is not even sure that he has not isolated "the

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ether." Mr. Brush may be right, but his announcement will to many irresistibly suggest the advent of the gigantic gooseberry and the sea serpent with the silly season.

The Dissipation of Energy in the Dielectric of a Condenser.—Messrs. Edward B. Rosa and Arthur W. Smith read a paper on the above subject before Section A of the British Association at Bristol this week. In their experiments the heating effect of an alternating E.M.F. upon the dielectric of a condenser is measured by a wattmeter, using a coil of wire in series with the condenser to give resonance and raise the voltage upon the condenser. The wattmeter measures the energy expended upon coil and condenser, the current being nearly in phase with the E.M.F. The coil loss is then deducted from the total to give the net energy expended upon the condenser. This is then divided by the energy stored to give the net loss, in per cent., and hence the efficiency. The efficiency is defined as follows: $\eta = \frac{\text{Energy stored—Energy dissipated}}{\text{Energy stored}}$ and η is proved to be $1 - \pi \cot \phi$, where ϕ is the angle between the current and E.M.F. for the condenser. In a second series of experiments the condensers were placed in a calorimeter, especially designed for the purpose, and the heat measured while they are subjected to a measured E.M.F. at a known frequency. This gives the efficiency, which agrees with the previous work, though by a totally different method. It is found that the percentage of loss in paraffin paper condensers is relatively small, varying with the temperature and condition of the paper before paraffining it. In beeswax and resin condensers the energy lost is much greater, and increases as the temperature rises up to a maximum value and then decreases as the temperature rises further, until the dielectric begins to soften, then it increases rapidly. Exact numerical values are given for the losses in the full paper.

Telephone Time Records.—Mr. Henry Abbott, in our New York namesake, makes some interesting remarks respecting the relative merits of the different methods of timing calls in telephone exchanges in the United States. He states that, as far as his experience has gone, there are more telephone exchanges where the operations are overloaded beyond the point of giving efficient service than those in which the error is on the other side. He points out that a considerable revenue is lost by telephone companies from this cause alone, due to operators being too busily employed to accurately observe and write down the time occupied by a particular person. It is pointed out that where only one or two large clocks are used persons situated in different parts of the room will read the time differently, on account of the distance between the clock dial and the hands. It may easily be seen, however (though Mr. Abbott seems to have overlooked the fact), that no great error can result from this if a particular interval is thus read by a single operator who remains stationary and reads only from one clock, provided the interval does not approximate too closely to half an hour. Both the beginning and end of a small interval of time will be read inaccurately, either too fast or too slow, as the case may be, by about the same amount. He, however, records a case where six operators were watched, and it was found that 6·6 per cent. of the total value of the business done during a certain time was lost to the company owing to the intervals occupied having been wrongly recorded. The use of stop-watches, time-stamps, etc., are also discussed. Preference is finally given to the use of the calculagraph, an instrument which automatically stamps on a ticket the interval occupied by a particular message. The operator has nothing further to do than to insert a ticket and pull a lever at the beginning and end of a message. It is stated that the companies who have adopted this device have expressed their conviction that they save thereby; further, it must be a satisfaction to know that fair and just tolls are being charged.

Power Distribution.—The importance of this question is seen in the number of papers read upon it at the late meeting of the British Association. It will be remembered that some time ago Mr. H. A. Mavor read a paper on the subject before the Institute of Engineers and Shipbuilders in Scotland, and the institute has just issued that part of its *Transactions* containing the discussion on this paper. Mr. Biggart admitted that "no doubt there was a large field for electric driving. His firm, many years ago, adopted it in special work, and found it to be of great advantage." He contended, however, that a good deal of trouble was given by using gas in gas-engines with the gas made on the premises, owing to variations of load, that for economy the gas supply should be constant, otherwise the economy would be a fleeting quantity. Mr. Sayers, speaking afterwards, combated these views, and said Mr. Biggart said that the Dowson gas plant would work very well if the load were constant, but troubles arose on a variable load. He knew of a Dowson gas plant which had been in operation for some years, and which was used exclusively for electric lighting, and there could be no doubt that the load was a most variable one. The plant he referred to consisted of two 250-h.p. sets. During the first year or two the cost of fuel per electrical unit delivered was ·2d. During the period from June, 1896, to July, 1897, the cost was ·13d. per unit delivered, which was pretty low. An electrical unit was equal to 1,000 watts, as compared with 746 watts for 1 h.p., therefore, when allowing an efficiency of only 75 per cent. for the electric motor, it might be considered that ·13d. represented the cost per horse-power. The power obtained from a given quantity of steam was very variable, depending on the engine used; whereas, if an electric motor wasted more than, say, 25 per cent., it would probably burn out. Usually only 10 or 15 per cent. would be wasted, except in very small motors. Using coal gas, in the engines he had referred to, at 2s. 3d. per 1,000 cubic feet, the cost per unit delivered was 1·2d.

Birmingham to London Underground.—The cable now being laid by the Post Office between Birmingham and London is being rapidly pushed forward. The *Birmingham Daily Post* gives the following details of the enterprise, which is of great importance to Birmingham. In the early months of last year the work of laying this subterranean telegraph cable was commenced, and there appears every prospect that it will be carried through within the next twelvemonth. The effect will be to very largely increase and improve the means of communication between the Midlands and the Metropolis, and there are aspects of the undertaking which give it a general interest. First, it should be explained that the length of the line will be about 105 miles, the route traversed between St. Martin's-le-Grand and the General Post Office, Birmingham, being through Cricklewood, Hendon, Edgware, Watford, Hemel Hempstead, Leighton Buzzard, and Fenny Stratford, thence by the Old Watling-street road to Weedon, branching off through Southam, Leamington, and Warwick, and passing by way of Hockley Heath and the Stratford-road to the vast building at the top of New-street. The growing volume of the telegraphic work between London and Birmingham rendered it necessary to enlarge the means of communication, and the new cable is to supplement, and not to supplant, the existing service It may, however, be found desirable to utilise the present open-wire system to a great extent for telephone purposes,

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transferring the telegraphic work to the underground cable. The precaution is also being taken to construct the new cable on the twin-wire principle, so that the 76 single telegraph wires can be converted into 38 metallic telephone circuits. But the remodelling of the telephone system is not the object in view, the primary end being to extend the telegraphic communication with London to a point commensurate with the growing needs of the public, and at the same time to safeguard the service from the liability to breakdown which attends the open-wire system. It is said that nothing short of a first-class earthquake will seriously disturb the underground cable. The gangs of workmen who are engaged in laying the cable have now approached to within 30 miles of Birmingham, having reached Southam. For a distance of about 45 miles from London the work has been actually completed, and the next link, reaching from Fenny Stratford to Leamington, is now being added; six gangs, numbering about 30 men each, being employed on detached sections. Special endeavours are being put forth to expedite the work in every possible way, and the third and last link in the chain—that from Leamington to Birmingham—will soon be in hand.

The Jacques Carbon Battery.—Mr. John W. Langley contributes to the *Journal* of the Franklin Institute for September, 1898, an interesting paper on the above subject, founded on the work of Messrs. H. S. Rosewater and W. H. Oldham, two students in the Case School of Applied Science, Cleveland, O. It will be remembered that Dr. W. H. Jacques, of Boston, recently patented a cell in which electrical energy is obtained directly from the consumption of coal, the efficiency of the process being equal to 32 per cent. instead of the ordinary value of 6 or 8 per cent. In the arrangement used by Dr. Jacques a rod of compressed coal dust, which forms one electrode of the battery, is supported in a vessel containing fused caustic alkali, through which oxygen is blown. The electric energy obtained is ascribed by Dr. Jacques to oxidation of the coal, just as zinc is oxidised in a Daniell cell. On the other hand, Mr. Reed considers the effect to be a purely thermoelectric one. Considering that we might distinguish between these two theories by forcing nitrogen through the cell, it is difficult to see why the subject has not been brought to a definite issue. Reed has passed coal gas through the fused alkali, and found the resulting E.M.F. equal to that when oxygen was used. Messrs. Rosewater and Oldham used an iron cell, which virtually formed one terminal of the battery, the other terminal being composed in turn of copper, iron, and carbon. The pot was then filled with caustic alkali, which was kept fused, whilst a current of air was blown through it. Curves were obtained showing the relation between the temperature of the pot, the E.M.F. produced, the amount of air admitted, the nature of the electrode, etc. Mr. Langley concludes that there can be no doubt that the current produced is of thermoelectric origin. In the first place, the general appearance of the curve plotted is characteristic of a thermoelectric curve, showing sudden changes in magnitude and direction. Then the maximum voltage occurs when the difference of temperature is greatest. Further, blowing air containing oxygen through the pot ought to increase the potential between the electrodes; this was found not to be the case. The addition of sodium nitrate to the fused alkali was found to reduce the P.D. between the electrodes. The E.M.F. found by Messrs. Rosewater and Oldham was much smaller than that given by Dr. Jacques. They ascribe this to the smaller size of their pot, together with the very gradual and even heat employed, which tended to lessen the difference of temperature between the electrodes. The subject is, however, by no means settled as yet. There can be little doubt that the passage of an electric current through fused caustic alkali is accompanied by electrolytic decomposition, and it is difficult to imagine the generation of a sufficient pressure by thermoelectric means to effect this decomposition. Anyway, electrolysis must be taken into account, and any theory which neglects this side of the question can hardly hope for ultimate acceptance.

The Paris 1900 Exhibition.—The following are extracts from the rules of the exhibition, which we regret to have to take from an American paper—the *Western Electrician*. Our English authorities are moving most slowly in making arrangements, and are giving practically no information to the electrical traders. Under the rules it is provided that exhibits shall be divided into 18 groups. Machinery and processes of mechanism are included in Group IV, but a separate classification of electricity is made in Group V. as follows: Class 23 (Machines and Appliances for Producing and Utilising Electricity). — Dynamos of direct and alternating currents: constant or varying quantity; transmission of electrical energy—electric motors: direct constant current, alternating currents; transportation by electricity: electric engines, electric tramways; regulation of the electric currents: dynamos for alternating currents; appliances of electricity in mechanics: elevators, cranes, windlasses, capstans, magnetic warping, swingbridges, trolleys, etc.; safety and registering machines. Class 24 (Electro-chemistry).—Electric batteries; accumulators; general processes of electro-plating—electro-metallic preparations; refining of metals and their alloys; appliances of electricity to industrial chemistry: bleaching, disinfection of drains, manufacture of soda, chlorine, chlorate of potash, etc. Class 25 (Electric Lighting).—Systems of direct and alternating currents; arc lamps; indicators; carbons; incandescent lamps; fittings for private houses, studios, factories, and public buildings; general depôts of electricity; appliances for lighthouses, military purposes, navigation, public works; safety appliances and registering meters; photometry—apparatus for determining power and distribution of electric light; material for ornamental electric lighting with chandeliers, etc. Class 26 (Electric Telegraphy and Telephones).—Telegraph apparatus—transmitting and receiving apparatus; various apparatus and appliances; apparatus for simultaneous transmission; special devices; lightning conductors; transmission of words; telephones and microphones; appliances and apparatus used in central offices; switchboards; simultaneous telegraphic and telephonic communications; telegraph and telephone conduits; open-air, underground, and submarine cables. Class 27 (Various Applications of Electricity).—Scientific apparatus and instruments for measuring; electricity in surgery, dentistry, and therapeutics; electric clocks; application of electricity to railways, mines, and public works; electric signals; electricity in the ignition of explosives; long-distance indicators and registering appliances for phenomena of various descriptions; electric heating furnaces; electricity for soldering iron, etc; apparatus and appliances for heating by electricity. Electrical appliances are also included in Group VI. under "Equipment for Mercantile Navigation," where "special apparatus for producing and using electricity" may be entered. Submarine navigation naturally includes similar apparatus. In Metallurgy, Group XI., and Chemical Industries, Group XIV., electricity forms an important feature. Group XVIII., which comprises "Military and Naval" exhibits, has special departments for electricity and its applications in warfare. The telegraph and telephone are particularly mentioned.

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TRANSMISSION OF POWER BY ELECTRICITY.*

BY ALEXANDER SIEMENS, M.I.C.E., M.I.E E.

The greatest achievement of the century which now approaches its close is the intimate connection that has been established between science and practice, the effects of which are noticeable in every feature of modern civilisation, and in none more than in electrical engineering. A little over 30 years ago the dynamo-electric machine was invented, which made electrical engineering of practical utility; but long before that time the laws of nature had been discovered by scientific research which govern the flow and the distribution of electric currents, Ohm's and Kirchhoff's laws, and which permit of the accurate measurement of the same, Weber's, Ampère's, and last but not least Faraday's researches. In no other domain of human activity has it ever been possible to attempt the solution of problems with an equal certainty of being able to criticise the proposed methods by the light of well-established scientific rules, and of avoiding unnecessary trouble and expense when these rules showed an error in the reasoning. In other words, science teaches us what not to attempt. If a process is shown to be possible scientifically it has still to be proved to be commercially, but any device which science shows to be wrong in principle should be dropped at once. This facility of verifying results accounts for the rapidity of the progress of electrical engineering, and for the variety of purposes to which electricity is nowadays applied. Among these, transmission of power promises to become one of the most important, and it may not be uninteresting to study its development a little more in detail.

Although telegraph instruments and indicators generally belong, strictly speaking, to this branch of the subject, the term "transmission of power" is usually only applied to cases where electric motors are employed to convert electrical energy into mechanical motion. The first important development took place in connection with electric tramways starting from the small circular line exhibited in Berlin by Dr. Werner Siemens in 1879. With our present experience there is no need to dwell on the advantages of electric traction in the streets of towns and their suburbs, and there is little doubt that in the near future horse and steam tramways will disappear everywhere. Up to now cable traction has held its own in all cases where exceptionally heavy gradients have to be dealt with, but means are devised to overcome such gradients with the help of electric motors, and in this field the ultimate triumph of electricity is also assured. This great success on tramways has naturally led to attempts to move the trains on the railways by means of electric locomotives, and it is well known that even the heaviest goods trains can be drawn by electric motors as well as by steam locomotives. It would be a fallacy, however, to deduce from this fact the conclusion that it would be advantageous to replace the locomotives on all existing railways by electric motors, as the feasibility of such changes depends ultimately only on economical considerations. The changes may be technically possible, but an alteration can only be introduced if a saving in expense is thereby effected. This principle governs not only electric traction, but the whole field of human progress, which proves the necessity of investigating the economical aspects of a problem after its scientific features have been examined and found to be based on sound reasoning.

In the case of transmission of power there are three factors common to all systems which determine the cost of the motive power at the place where it is utilised, and thereby indicate what is the proper system to use. The first factor is the source of the energy that is to be distributed; the second is the means of transmitting; and the third the apparatus for utilising the energy. With regard to the first point, the electric system is hampered by the fact that the available mechanical energy, however produced, has to be converted into electrical energy, and such a transformation always involves losses, which are avoided where the mechanical energy can be applied direct to the means of transmission. As the cost of generating electricity decreases it is desirable so to arrange the whole system that the units of the generating machinery can be constructed large enough to give the most economical results, and so to choose the site of the generating station that all the necessary supplies can be obtained in the cheapest manner. In spite of the drawback mentioned above, electric transmission of power is applicable in a great many cases on account of the unquestionable superiority of the means of distributing electricity over the means of dealing with any other form up to a certain point with the increase in size of the dynamos, of energy. The ease with which the current can be carried over a long distance, the certainty with which the losses can be determined beforehand, and the flexibility of the conductors, constitute advantages which no other system presents, while the inevitable loss of the double conversion, added to the losses in the conductor, militate against the application of electricity in cases where the source of power and the apparatus for utilising the same can be brought close together.

As the efficiency of electric motors has been accurately determined, there is no difficulty in predicting how much of the mechanical energy produced by the original source of power is available for useful purposes, and it is easy to ascertain from time to time that the desired electrical conditions are maintained. It is well known that over 84 per cent. of the indicated horse-power of a steam-engine is available at the terminals of the dynamo in the form of electrical energy, and that electric motors will produce over 90 per cent. of the electrical energy supplied to them in the shape of mechanical power. These high efficiencies were obtained at a comparatively early period, and it was, therefore, obvious that the main advancement in the electric system must be sought in diminishing the cost of the conductors without increasing the loss of energy during transmission. Guided by the teaching of science, nearly all inventors have attacked this problem by suggesting an increase in the pressure of the current in one form or another. Under the impulse of this tendency the art of insulating electric conductors has steadily improved, and while it was not long ago considered impracticable to work with currents of more than 2,000 volts pressure, there are now a number of successful electric systems employing currents of 10,000 volts pressure, and insulated conductors for even higher pressures can easily be obtained in the market. More serious difficulties appeared when attempts were made to construct dynamos and motors for high-pressure currents, and many ingenious devices have been suggested to overcome or to avoid them. In the case of alternate currents the employment of transformers permits the use of low-pressure generators and motors, while high-pressure currents transmit the energy through the conductors, but this advantage is obtained by introducing another loss through the double transformation. Without much explanation it is easy to understand that the advantage of such a system is the greater the further the source of power, and the motors are distant from each other. Another advantage of this system is that the transformers have no moving parts, so that they require next to no supervision, and that they do not occupy much space. If an equally reliable alternate-current motor had been invented there is little doubt that this system of transmitting power would be the dominating one at the present time, but unfortunately alternate-current motors up to now refuse to start without being first synchronised by external means. They are liable to stop abruptly when they are overloaded, and their speed cannot be varied.

A great step towards the solution of the problem was made when the possibility was discovered of combining three alternating currents in such a way that return wires can be dispensed with. This result is brought about by employing three alternate currents with their phases differing by 120deg., so that their sum is at every moment zero. At the same time a revolving magnetic field is produced in the field of the motor, so that its armature can start revolving without being first synchronised. In certain cases it is not even necessary to supply currents to the armature, in which the currents will be induced by the revolving magnetic field, so that all difficulties of making contact with the revolving part of the motor are avoided. As in the case of single-phase

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alternate currents, stationary transformers can be used with three-phase currents, which therefore present very conspicuous advantages for transmitting power. On the other hand, a continuous-current system is decidedly simpler, and consequently cheaper in first cost and cheaper in maintenance, provided the dynamos and motors can be well enough insulated to permit the use of high-tension currents. The transformation losses are avoided, and the motors can be made extremely efficient for large differences in their load, and their speed can be varied without much trouble, both qualities in which the three-phase motors are deficient.

As there are continuous-current generators regularly supplying currents at more than 2,000 volts pressure, it is evident that this system can be applied in all cases where the distance between generator and motor is not excessive, and indeed, in most cases where electricity is employed to distribute power in factories, continuous currents are preferred. Such an installation—viz., the electric plant at the works of Siemens Bros. and Co., at Charlton—was described by the author in December, 1894, before the North of England Institute of Mining and Mechancial Engineers, at Newcastle-on-Tyne, and since that time very valuable experience has been gained there with regard to the suitability of electric motors for driving machinery. Six years' work has shown that the system is perfectly reliable, and that the expected great saving in the cost of attending to the motive power has been fully realised. During the year 1897, the output of the generating station was 1,178,286 B.T.U., or a load factor of ·18. In May and June this year some tests were carried out to determine the consumption of coal and water per Board of Trade unit, and the output in one week was found to be during daytime 21,283 B.T.U., or a load factor of ·35, and during night-time 6,047 B.T.U., or a load factor of just under ·10. During these trials Yorkshire hard coal was used, having an evaporative power of 13·8lb. of water, as compared with Welsh coal 14·5lb.; in daytime 5·13lb. of coal were consumed per B.T.U., and at night 10·42lb., showing the immense influence of the load factor, while the average consumption was 6·55lb. of Yorkshire coal per B.T.U. Allowing for the difference in heating value, the 1,178,286 B.T.U. in 1897 were produced by the burning of 3,282 tons of Welsh coal, while the boilers of the central station consumed altogether 6,154 tons. It is therefore fair to charge half the actual expenses connected with the boilers to the generating of the electric current, while the other half falls on heating the works and driving some steam-engines which have not been replaced by electric motors. The actual expenses during 1897 in connection with the boilers, pumps, and condensers were £8,746, and include coal, carting the same and the ashes, trimming coal and stoking boilers, washing, cleaning, and attending boilers, condensers, and economisers, supervision, repairs, gas, sundry stores, 10 per cent. depreciation and 5 per cent. interest. The present staff to work five return-tube and two Babcock and Wilcox boilers consists of one chief stoker, five stokers, one trimmer, and one boy. For the engine department the total expenses were £1,648, comprising the wages of the engine-room staff and of occasional help from the yard department, supervision, repairs, stores, 10 per cent. depreciation and 5 per cent. interest. The engine-room staff consists of three engine drivers, two dynamo attendants, and three electrical assistants, whose time is not wholly taken up with central-station work. In these charges no account is taken of the water, most of which is used in the indiarubber department before it is transferred to the boilers. The total amount spent on such water was £234 for the year 1897, and one-third, or £78, should be charged against electricity. According to these figures the actual cost of electricity was, in 1897:

Expenses in boiler department	£4,373
,, engine ,,	1,648
,, for water	78
Rent, taxes, insurance, and salaries	220
1,178,286 B.T.U., total cost	£6,319

or 1·287d. per B.T.U., or 0·96d. per electrical horse-power hour at the switchboard of the station. For the maintenance of the cables no expenses at all were incurred, but for depreciation and interest 7½ per cent. should be charged on the capital outlay, which was in round figures £3,000. In connection with the motors the expenses were £2,063, comprising repairs, stores, labour, 10 per cent. depreciation, and 5 per cent. interest. As the capital charge for motors is over £10,000, a large proportion of this sum (over £1,500) is due to interest and depreciation. A further charge on the motive power is the 5 per cent. loss in the conductors, and 10 per cent. loss in conversion from electrical into mechanical energy. Taking all these figures together, we arrive at the total cost of motive power during the year 1897—viz., £9,900, or 2d. per B.T.U. used by the motor and 1·71 per brake horse-power hour exerted by the motors.

It is not pretended that these results are the best obtainable; they may, however, be utilised for drawing some general conclusions which apply to transmission of power by electricity generally. For this purpose the total of £9,900 has to be sub-divided under the heads: (A) *Standing Charges.*—Depreciation, interest, payment of rates and taxes, rent, general charges, and loss in conductors and conversion. (B) *Fuel.*—Coal and carting the same. (C) *Labour and Supervision.*—Actual wages paid in connection with boilers, engines, and motors, also part of foreman's wages. (D) *Stores.*—Mainly oil and waste, also water; the charge for the latter is, however, exceptionally low, as explained above. (E) *Repairs.*—The charges of the fitters and other departments for work done. Arranged under these heads the total charges for the brake horse-power given out by the electric motors are:

(A) Standing charges	£4,869	49·1	per cent.
(B) Fuel	2,654	26·8	,,
(C) Labour	1,183	12·0	,,
(D) Stores	595	6·0	,,
(E) Repairs	599	6·1	,,
Total	£9,900	100·0	,,

This shows that, roughly speaking, the standing charges account for half the expense, fuel for a quarter, labour for one-eighth, and repairs for one-twentieth, the stores making up the total. In addition, it should not be overlooked that the cost of conductors and the loss of energy in them is naturally low, as the motors are comparatively close to the central station. Wherever they are far apart the standing charges would preponderate still more. Of the 49·1 per cent. charged as standing charges, 36·1 per cent. are unvarying, while 13 per cent. represent loss in leads and in conversion, and these will increase with an increasing output. For instance, if the output of this particular plant were doubled so that the load factor would be ·38, the expenses would be for, say, 2,400,000 B.T.U.:

Standing charges	£6,162	= 38·00	per cent.
Fuel	5,308	= 32·65	,,
Labour	2,365	= 14·60	,,
Stores	1,190	= 7·35	,,
Repairs	1,198	= 7·40	,,
Total	£16,224	100	,,

This is equal to 1·62d. per B.T.U. at the terminals of the switchboard, or just under 1·4d. per brake horse-power hour given out by the motors. Of the standing charges 22 per cent. represent depreciation and interest, while 16 per cent. cover the losses in leads and in conversion.

A comparison between these two results shows again the importance of increasing the load factor to diminish the expense per unit of work done, or, in other words, if power is to be transmitted by electricity, it is, above all things, necessary to use it as constantly as possible. Conversely, if in any particular instance power is wanted only at intervals and for short periods, it can safely be assumed that no economy can be effected by introducing transmission of power by electricity. Similar considerations determine for the workshop whether it is more advantageous to drive a particular machine by its own electric motor, or whether it is more economical to group a number of machines together, driving them by belts from a shaft to which an electrical motor is attached. Bearing in mind the property of electric motors of not absorbing more current than the load at each moment demands, and their high efficiency even at one-quarter of the full load, it will in most cases be possible to group machines together, especially smaller ones, as the cost of a countershaft and belting is in such cases less

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than the difference in the cost of one large motor and several smaller ones with all their accessories. The most useful field for electric motors in workshops is without doubt their application to movable machinery, such as cranes, travellers, and drilling tools; a description of which need not be entered into.

Next to the importance of having constant work for the plant is the question of fuel consumption. Besides using the most economical boilers and engines, the site of the power plant should be selected so as to secure the fuel at the lowest possible cost. Whether water power would be cheaper than steam, cannot be decided for all cases, as the answer depends on the amount of capital outlay required to secure an adequate supply of water at all seasons of the year; further, on the price of coal and other well-known considerations. At any rate, it is very remarkable how very few localities can be found where a sufficient water supply may be depended upon all the year round.

An obvious solution of the problem, how to obtain cheap fuel, is evidently to erect the plant for generating electricity close to a coal mine, and to distribute power to the various works which usually are found in the neighbourhood. Such an installation has been erected at Brakpan, in the Transvaal, and the electricity is conveyed from there along the Witwatersrand to various mines and railway stations up to Johannesburg, which is about 30 km. (19 statute miles) distant from Brakpan. The generating plant was erected near a small lake, so as to secure water for condensing purposes all the year round, about 3 km. (two statute miles) from a coal mine, with which it is connected by a private railway line, and all the latest improvements in the shape of mechanical conveyors and stokers were adopted to reduce the price of the fuel and the cost of labour. Besides a separate plant for supplying all the auxiliary motive power and the station lighting, the works contain four main steam dynamos of 1,000 h.p. each, which deliver three-phase currents at 750 volts to transformers, which raise the pressure to 10,000 volts. The current then enters the overhead main line of conductors, which is altogether about 40 km. (25 statute miles) long and has branches to the various mines, as circumstances require. Each conductor consists of two bare strands of copper wire, each 70 square millimetres in section, and elaborate precautions have been adopted to prevent these six strands from falling to the ground and from coming in contact with other wires crossing the main line. Some trouble was experienced to protect the system against lightning, and it has been necessary to construct special apparatus before this difficulty could be overcome. At the various mines transformers reduce the pressure of the current according to the purposes for which it is to be used, and they employ motors varying in size from 1·5 h.p. to 250 h.p. In the month of July, 1895, the works at Brakpan were commenced, and on Jan. 27, 1898, the first steam dynamo commenced working. Since then the works have steadily been added to, but the data as to cost can obviously not be taken as a guide for other cases, as the regular working of the full plant has not yet settled down properly.

A somewhat similar system of distributing power over a district has been in operation near Waldenburg, in Silesia, for the last two years. In this case the generating plant has been erected at the pit mouth, and it consisted at first of four steam dynamos, each of 300 h.p., two of which produced three-phase currents; the third continuous currents to work a tramline about 22 km. (14 statute miles) long, while the fourth steam-engine is coupled to one three-phase and one continuous-current dynamo, serving as a stand-by for both systems. For a radius of 4 km. (2½ statute miles) the three-phase current is distributed at a pressure of 3,000 volts, at which it is generated, but for greater distances the current is transformed up to 10,000 volts. Owing to the success of the enterprise, two large three-phase generators of 1,000 h.p. are to be added as soon as they can be completed, and six more of the same size will be taken in hand in the near future. The charge to the public for electricity is in the district receiving current at 3,000 volts—for lighting purposes, 50pfg. (= 6d.) per B.T.U., and for motive power and heating, 15pfg. (= 1·8d.) per B.T.U. In the places supplied by the 10,000-volt currents the charges are 20 per cent. higher, but large consumers receive a discount, according to the amount of current they use, amounting to 35 per cent. in cases where the value of current taken exceeds 10,000 mk. (£500) per year. At these prices the 1,200,000 B.T.U. used in 1897 in Siemens Bros.' works at Charlton would have cost about £7,000, even if the higher prices of the 10,000-volt district had been paid.

It is characteristic for this country that these examples of transmission of power by electricty over a large district had to be taken from foreign practice. However enterprising and progressive the individual Englishman is, when a novelty can be introduced only by the co-operation of a municipality, of a county council, or, worst of all, of Parliament, everybody appears to consider it a patriotic duty to throw obstacles in its way, and in most cases it is quite impossible to find out who benefits by such action. After a while the public discovers that the introduction of the novelty would be a great convenience, and an agitation is set on foot to remove the obstacles which were, in many cases, introduced only to satisfy prejudices. Let us hope that a similar fate will not befall the transmission of power by electricity.

THE APPLICATION OF THE ELECTRIC MOTOR TO SMALL INDUSTRIAL PURPOSES AND ITS EFFECTS ON TRADE AND ON THE COMMUNITY GENERALLY.*

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The electric motor is rapidly becoming the most favoured medium for the transformation and transmission of energy for all industrial operations whether on a large or small scale. This is due to the paramount advantages it possesses over any other method of utilising potential energy. These advantages are well known to electrical engineers, but indifferently appreciated by a large number of mechanical engineers, and almost unknown by the general manufacturer and tradesman. To the last of these three, the general manufacturer and tradesman who is using machinery driven at present by steam or water power, the electric motor must in the days to come prove of exceptional value; and yet, strangely enough, very little effort has hitherto been made either by the motor maker or by the managers of electricity supply undertakings to open up this very wide and lucrative field of enterprise. There is no necessity to enumerate here the many excellent and distinctive features which the electric motor possesses. The intention in this paper is rather to consider the reasons why its application up to the present time has been confined to a few special trades and manufactures. We are familiar, for instance, with electrically-driven pumps, electric hoists and cranes, electrically-driven machine tools, and electric power transmission in works—cases in which the generation, transformation, and application occur practically under one roof. Many manufacturers and constructional engineers, wisely and readily incurring additional capital outlay with the object of securing more economical production, have adopted electric motors, which do not entail the use of endless and power-absorbing shafting and countershafting. As yet, however, it cannot be said that the electric motor is in general use, or scarcely other than just past the threshold of its future domain. I shall endeavour to show how large a sphere of influence it is destined to fill. The smaller producer and tradesman, to whom motive power in some form or other is essential, and who feels more acutely than his larger *confrère* the effects of competition, has in the great majority of cases still to put up with very much more cumbersome and very much less efficient means of power production. Almost every town with any pretension to size and importance has its own large staple industries, as well as many minor industries and businesses, requiring the use of other power than hand power. There are also some handicrafts which are at present unavoidably confined to hand power, because steam, gas, oil, and hydraulic power are each and all inapplicable. There can be little doubt that the electric motor would be welcomed and readily adopted in these cases if

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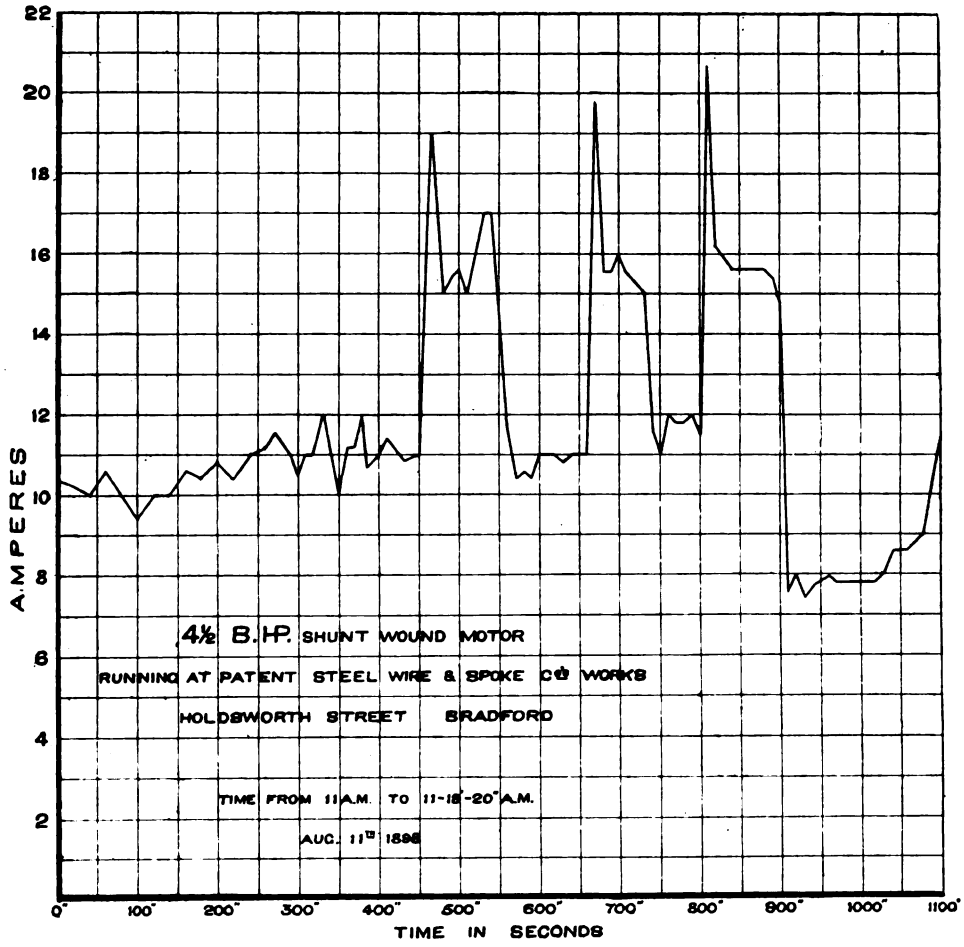
only its simplicity and adaptability were known and understood. I will give a somewhat full, though by no means exhaustive, list of these trades: acid manufacturers, aerated water manufacturers, agricultural implement makers, automatic electric signs, back and vat makers, bag makers, aerated bread makers, basket makers, bicycle makers and repairers, boiler makers, book binders, boot makers, boot polishing, bottle cleaners, bottle makers, box makers, brass finishers, brush makers, cabinet makers, carpenters, carpet beaters, coach builders, coffee grinders, coopers, cutlers, cranes, dairymen, dentists, engineering workshops, engravers, fans for ventilating and other purposes, forage cutters, forced draught, founders, grain elevators, hoists, hair-brushing machinery, laundries, lifts, lithographers, millwrights, musical instrument makers, oil refiners, opticians, organ builders, organ blowing, packing-case makers, paper makers, pianoforte makers, picture-frame makers, presses, printing machinery, pumping, racket makers, rope makers, sack makers, saddlers, sausage makers, saw makers, saw mills, scientific instrument makers, seed crushers, sewing machines, shop fitters, smallware manufacturers, smelters, smiths, snuff manufacturers, soap makers, stick makers, stuff manufacturers, sugar refiners, surgical instrument makers, theatrical machinery, timber merchants, tinplate workers, tobacco cutters, tool makers, toy makers, turners, umbrella makers, undertakers, watch makers, wire drawers and workers, zinc workers, etc. Other special and local industries will occur to you without enumeration which can be placed in the same category.

The advantages of driving electrically in some of these cases are of a very distinctive character, and it will be well to consider briefly one or two prominent examples.

Boiler Makers.—The practice of drilling all rivet-holes in boilers with the overlapping plates *in situ* is an operation which is much more rapidly, readily, and economically performed if the drilling machines can be brought to the work instead of taking the shells to a fixed machine tool and there adjusting them for every fresh set of holes to be drilled.

Book Binders, Boot Makers, Cutlers, Presses, Saddlers, Saw Mills, Smiths, etc.—These trades are instances in which several machines are frequently employed, but of which intermittent use only is required. By any method of driving, other than by electricity, it is incumbent to employ lines of shafting and countershafting, and to keep these in continual motion in order to use any one machine when required. In such cases, by direct coupling to the machine to be driven, and by its unequalled facility for starting and stopping, the electric motor has unique and all-important advantages.

Letterpress and Lithographic Printing.—This class of machinery has been successfully operated for upwards of two years by electric motors applied direct to the main driving shaft of the machine or by toothed gearing. Since the first attempts were made many improvements have been introduced, until, at the present time, nearly all the leading houses in the trade have either adopted the system of single-machine driving in its entirety, or some such modification of it as best seems to suit their particular methods of working. It is doubtful if printers realise the immense loss that occurs by the old method of driving. Wherever the system of shafting and belts is used to transmit the energy generated by the driving engine there is a great loss of power; not only so, but a mass of machinery and gearing has to be kept wastefully running whilst possibly only one or two machines may be utilised. In one case where tests were made it was found that the shafting and belts absorbed 56 per cent. of the actual power generated by the engine. In this industry the extremely steady and even motion imparted by the rotary action of the electric motor is also an important feature.



Cranes and Hoists.—In almost every town there are warehouse and other cranes, and passenger and goods hoists, in general use. The advantages of the electric motor for these purposes are (1) the possibility of placing the motor close up to its work, (2) direct coupling or reduction gearing of high efficiency, and (3) the economy resulting from the power used being practically proportionate to the work done.

There is no need for me to give you further examples in detail. The application of ordinary mechanical tests for efficiency, and the experience already obtained by the substitution of electric motors for other methods of power production, have proved beyond doubt its exceeding adaptability and superiority. Notwithstanding all this, however, many obstacles yet remain to hinder its general adoption by what may be termed the commonalty of the manufacturing world, and among the principal may be mentioned the following.

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1. The extreme aversion to innovations which characterises the industrial world in this country especially.
2. The existence of other motors in good working condition.
3. The unsuitability of alternating currents of electricity for motors where the power required exceeds 2 h.p. or 3 h.p.
4. The want of capital to lay out in new machinery; and
5. The want of confidence in the electric motor by the non-technical manufacturer.

The first and second points do not require any further commentary or elucidation, and I shall therefore dismiss them without more observation. With regard to the third point, it is much to be regretted that the alternating-current motor is not yet capable of doing the same work as a continuous-current motor. The energy required to operate either type must, of course, be derived from some source—usually a steam dynamo—from which distribution mains carry the current in any direction; and as this is the most efficient method known of transmitting energy and the motor the most efficient medium for transforming it into useful work, the principle has been applied in the workshop as well as for public supply. There is no need to dwell upon the advantages of the centralisation of steam power, nor upon the universally admitted fact that electricity for power purposes can be supplied from public lighting mains at a very low cost. But in addition to these there is one equally important advantage of deriving power from public mains from the user's point of view—I refer to the actual resultant taken on the average of the varying loads, which is characteristic of the electric motor, and the facility for instantaneously switching "on" and "off" as required. This feature is illustrated in the accompanying curve which has been taken from the most modern machines. It will be seen that the maximum horse-power was 6·4, and the duration of time 18 minutes, which, if the maximum power had been a constant load, would represent approximately 2 horse-power hours. But after the resultant has been carefully obtained with a planimeter, the actual horse-power hours are found to be 1·06. This difference between the maximum horse-power required and the mean horse-power used is rarely taken into account or even understood by many small power users—it is a most difficult thing to get them to appreciate it. Thus, when selecting, say, a 6-h.p. motor, they think it will always be rising current equavalent to 6 h.p., and that the generating will be heavy in consequence.

The chief obstacle to the more rapid adoption of electric motive power, especially in the case of small tradesmen, throughout the country is undoubtedly the want of capital to purchase the necessary motor; but where the power to purchase exists, the buyer will probably have little or no experience or knowledge of electrical matters to guide him in his purchase; if his means are at all limited he will be tempted to venture on a cheap line, and become the dupe of those who simply make to sell. The solution of these difficulties—which to my mind appears the most satisfactory, because it is the one fraught with the greatest advantages to all concerned—is that the owners of electricity supply undertakings, whether a public company, municipality, or other local authority, should themselves purchase good, reliable motors, and let them out on hire. Antecedently this scheme may appear a sort of parental *régime*, but it is suited to present circumstances at any rate, and experience proves it to work well. Unfortunately, all local authorities have not got powers to borrow money for this purpose, although it appears from the Electric Lighting and Public Health Acts that borrowing powers may be granted by the Local Government Board for works of a permanent nature. Electric motors do not yet come within that category, although gas-stoves do, a legal decision having been given in their case. All future municipal parliamentary Bills should therefore contain clauses which would confer such powers and secure freedom of action in this respect. I do not propose here to run into elaborate details with regard to terms or general scheme of hire, but I may say that in Bradford we have found a rental charge of 10 per cent. upon the initial cost of each motor to be amply sufficient. This is made up of 3 per cent. for interest, 3 per cent. for sinking fund, and 4 per cent. for depreciation and contingent expenses. The Bradford Corporation inaugurated their scheme of hiring (in which also arc lamps are included on similar terms) in November, 1896, and the following table will show the extent to which these facilities have been appreciated:

Year.	Number of motors connected to the Corporation mains during the year.		Board of Trade units sold per annum.
	Owned by consumer. Not on hire.	Owned by Corporation. On hire.	
1895	35	nil.	35,919
1896	23	7	54,972
1897	14	39	117,176
1898 (Six months only.)	6	42	63,820

From this table it will be seen that the increase in electricity supplied for motive power in 1896, in which year the hire system had been in operation for two months only, was 19,053 units; in 1897 the increased sale over 1896 was 52,204 units; and in the present year the increase is likely to be 62,834—or a sale of 180,000 units, or 53 per cent., over 1897.

Hitherto the supply has been confined to small power uses—such as cranes, hoists, fans, pumping, aerated water making, electric advertisement signs, and similar purposes During the last month, however, so popular has the electric motor become that applications have been received from a large spinning and weaving firm requiring 200 h.p, two foundries for blower purposes, an engineering shop requiring 50 h p., and a saw mill requiring about 20 h.p. I referred a moment or two ago to the want of confidence of the small power user in the electric motor; that confidence, however, is soon gained. It is gratifying to be able to state that several consumers in Bradford who originally applied on the hire system, and at the time with much trepidation and many enquiries, have since decided to purchase the motors outright. The accompanying table has been compiled from replies to an enquiry which I made recently of each municipal electrical engineer where the continuous-current system has been adopted, and from it may be gathered the extent to which electric motors driven from electric lighting mains have been employed. The figures given are up to the end of 1897:

Town.	Population.	Number of motors supplied.	Total h.p. of motors.
Aberdeen	140,000	14	65
Bradford	231,260	119	470
Brighton	122,310	100	Not given
Belfast	320,000	Not given	165
Birkenhead	110,000	4	15
Bury	63,000	5	12
Blackpool	40,000	7	7
Burnley	90,000	8	32
Chester	37,100	20	70
Dewsbury	29,847	4	16½
Dundee	169,000	15	20
Edinburgh	295,000	167	343
Glasgow	750,000	37	131
Hull	213,000	14	46
Lancaster	38,224	28	80
Liverpool	641,063	57	152
Manchester	505,368	257	696
Norwich	101,000	61	120
Nottingham	213,877	18	50
Oldham	148,000	11	60
Southampton	90,000	18	23
Shoreditch	124,000	31	434
Sunderland	147,000	23	240
Wolverhampton	92,000	2	3
Whitehaven	20,000	—	—
Walsall	72,000	7	13½

I have endeavoured in this paper, and in the necessarily limited time and space at my disposal, to place before you the outlines only of a method of extending the adoption of electric motive power by the general manufacturing community. Those who have the management of public electricity supply undertakings know full well the value of the electric motor as a factor in the reduction of the working costs, which is also the principal argument for the combined working under one roof of electric lighting and electric tramway systems. But there are other and probably greater effects which the electric motor will produce with its more complete adoption in the near future—I refer to the beneficial effects upon the trade and productions of the country, and the hygienic and social effect on the community generally.

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In the first of these aspects it is possible to foresee the revival once more of a number of small and independent industries—such as existed, but under very different conditions, in former years. The possibilities are already being grasped by the artisan in France, Germany, Switzerland, and the United States. By the aid of the electric motor he begins to find that he can at least hold his own in competing with immense manufacturing concerns and combinations; he has a practically unlimited available power at his own door—which is a great boon to the artisan, and one which offers him an inducement to become his own master. In a very small and limited degree the gas-engine has already accomplished something in this direction, but its many imperfections, its cost, and the fact that it has never been available on the hire system, have kept it more or less in the background. The effect of hiring-out is thus mutually advantageous, and its natural tendency is to create fresh demands; in fact, the muncipality which includes this scheme in its electric light undertaking offers a great inducement to the influx and establishment of new industries within its area. With a more complete return to a multiplicity of industrial operations, there may also revive some neglected trades—such as those which have passed from us to other countries, and which now form our imports. From an hygienic point of view the electric motor is far and away the best; it is cleanly in its working, gives off no deleterious gases, and displaces the boiler and smoky chimney. One of the ultimate results must also be the raising of the status of the working part of the community. By becoming his own master the artisan gains self-respect, becomes more resourceful, and therefore a more important member of society; and the more intelligent interest which he will display in his business must appreciably affect the general welfare of the country.

ELECTRIC POWER AND ITS APPLICATION ON THE THREE-PHASE SYSTEM TO THE BRISTOL WAGON AND CARRIAGE WORKS.*

BY W. GEIPEL, M.I.E.E.

While there have been several papers read in this country before engineering societies on the application of electric power in works, yet this subject does not appear to have been brought prominently before the members of the British Association. It is presumably one of the purposes of this association that man generally shall procure the greatest possible service from the sources of energy placed by nature at his disposal, and that the subjects of this realm shall be in the van of progress in attaining this object; while it is well known that the waste of energy by the uneconomical use of coal is enormous, more especially in this country.

Lord Armstrong, in his address to this association at Newcastle in 1863, said that "the greatness of England much depends upon the superiority of her coal, in cheapness and in quality, over that of other nations; but we have already drawn, from our choicest mines, a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce." He then proceeded to explain that the total amount of workable coal in this country was calculated to be about 80,000 million tons, which, allowing for the then rate of increase of 2¾ million tons per annum, would only last 212 years. He further states, that "long before complete exhaustion takes place, England will have ceased to be a coal-producing country on an extensive scale. The ultimate results will be to render labour so abundant in the United States, that our iron manufacturers will be underbid by the unrivalled iron and coal resources of Pennsylvania. The question is not, how long our coal will endure before complete exhaustion is effected, but how long will those particular coal seams last, which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing?" Are we not already about to realise by experience what Lord Armstrong prophesied a third of a century ago? It is the case that many large collieries have already been closed because the expense of working prevented their competing; it is also the fact that foreign firms can already deliver in this country manufactured iron at lower prices than we can supply it, notwithstanding their disadvantage in shipping rates. Within the past few weeks, for example, the Corporation of Glasgow itself obtained tenders for a large quantity of cast-iron pipes, when it was found that tenders from the United States were lower than any of the local firms.

In the year 1895 the stationary engines in Great Britain alone amounted to an aggregate of 2,200,000 h.p. Assuming that each horse-power requires as little as 5lb. of coal per hour, and that the average run is 10 hours per diem for 300 days per annum, the total coal used by stationary engines alone would amount to 15,000,000 tons per annum; it is probably far greater than this judging from the general inefficiency and wastefulness of the existing engines. The author's main object is to localise the cause of this waste in the case of our important workshops and factories, and to discuss how this may best be obviated by the use of electricity. Other objects which he has in view, however, are the attainment of the maximum output of machine tools, which can only be obtained by driving the tools at a steady maximum speed, and the greatest economy in labour, and otherwise in producing the driving power.

In the past there has been a tendency on the part of the trades unions to look upon one at least of the above objects as being opposed to the interests of the workman. American visitors quickly observe the slow speeds in our union-ridden shops. The late strike in the engineering trade has corrected this misconception as to the true interests of the workman, while it has put an end to the harrassing policy hitherto adopted by the trades unions which has so long delayed works improvements. The employer is henceforth free to control his own shops, and it is now left to him to make use of every available means of increasing and improving the output. If Great Britain is to continue in her present front position in manufacturing for the world, it behoves her leading employers to take prompt advantage of such improvements as tend in the above direction.

The methods of driving large works more generally in use may be divided into two classes: One that in which the power is transmitted by long steam-pipes to engines scattered in different parts of the works. This results in loss by radiation and condensation from the pipes, and in loss attending the use of small engines. The other in which the transmission is from a large engine by means of wasteful gearing and long lines of shafting and belting. On the former system are arranged such works as shipyards, rolling mills, engineers' works, etc., where the net consumption of steam may be even 10 times that of an economical engine. On the latter system are works such as cotton mills, where the engine may be highly economical, and yet but 1 per cent. of the power may be applied to the cotton itself. The advantages and economy obtained by substituting electric power in works using scattered engines are probably more distinct than in the case of works using a single large engine. One of these works alone will use as much energy as is demanded by an average provincial town for its electric lighting. The Bristol Wagon and Carriage Works, for example, use 710,000 horse-power hours per annum—that is, the equivalent of over 400,000 Board of Trade units of electric energy—and is considerably more than last year's electricity supply in such towns as Aberdeen, Belfast, Cardiff, or Dover.

The directions in which improvement may be looked for are chiefly the following: saving of coal, saving of water and stores, saving of labour and attention, reduction of loss in shafting and gearing, increased output owing to steady speed of machinery, facility of extending by adding extra motors.

Saving of Coal.—Small scattered engines use as much steam per horse-power hour as requires 6lb. to 10lb. of coal with an average boiler. An economical engine, on the other hand, should not use more 1½lb. to 2lb. of coal. Tests published by Sir T. Richardson in a paper read before the North-East Coast Institution of Engineers and Shipbuilders confirm this. At his own works there were 31

* Paper read before the British Association at Bristol,

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engines developing from 94 h.p. downwards, and using an average of 51lb. of steam per indicated horse-power hour, exclusive of losses in steam-pipes. There were required to generate steam no less than eight main boilers and 23 auxiliary boilers. Electric power has since been adopted throughout these works, with the result that the whole of the main boilers and the majority of the auxiliaries have been replaced by a pair of marine boilers, while there is an actual saving of 100 tons of coal per week. At Messrs. Dorman and Long's, Middlesbrough, six engines were replaced by electric motors, and as a result two Lancashire boilers were dispensed with, while there is a saving of 32 tons of coal per week. At the Bristol Wagon Works five Lancashire boilers are required for the present engines; with electric power plant one Lancashire boiler will suffice, and the saving in coal is estimated at 37 tons per week. The loss of steam by condensation in pipes is most serious. Even with the best lagging the loss is considerable, while in most works where long pipes are used, the lagging is generally inferior, and frequently there is little or no lagging at all. Roughly speaking, every square foot of uncovered pipe-service, if continually under steam and exposed to the atmosphere, condenses as much steam per annum as takes one-half ton of coal to generate, and with covering it may be from that to one-sixth of a ton. At Messrs. Richardson's the pipes varied in length up to 1,200ft. At the Bristol Wagon Works there are 730ft. of pipe in use.

Saving of Water and Stores.—With small scattered engines it is generally impracticable to have satisfactory condensing arrangements, therefore the whole of the feed water is probably lost. With a common engine proper condensing arrangements may be made, and in any case there is a saving in water commensurate with the saving of coal above indicated. With a surface condenser and a cooling pond the water required may be as little as one-fortieth of that used by small separate engines. The stores, oil, etc., used by one common engine are of course less than those used by a number of engines.

Saving of Labour.—It is obvious that more men are required to attend to a number of engines than to one. It is equally apparent that a reduction in the coal consumption and in the number of boilers in use results in a saving of labour in firing.

Reduction of Loss in Shafting and Gearing.—The loss under this head varies greatly according to the conditions of each case. Prof. Kennedy stated in his address to the Institution of Mechanical Engineers in 1894 that for 100 h.p. of useful work it required 145 i.h.p. at the engine, that is to say, there was a loss of 45 h.p., of which, say, 13 h.p. would be lost in the engine, leaving 32 h.p., or 22 per cent., as the loss in the shafting. Mr. Crompton gives the loss in shafting as 32 per cent. Sir T. Richardson found the loss to vary from 25 to 70 per cent.; the average was 43 per cent. At Messrs. Furness, Westgarth, and Co.'s engine works, Middlesbrough, the loss in one shop, in which two long lines of shafting and a comparatively small number of tools were used, was 75·6 per cent. In two other shops it was 59 and 42 per cent., or about a general average of 50 per cent. for the whole works. In several different factories in Cleveland, Ohio, Mr. C. H. Benjamin found the loss to vary from 50 to 80 per cent. At the Bristol Wagon Works the loss varies from 22 to 57 per cent.; it is more often nearer to the latter figure. With efficient electric power plant the losses apart from engine friction need not exceed for the dynamo 7 per cent., for the conductors 2 per cent., and for the motors 12 per cent., say 20 per cent. in all, or, making an allowance for lower efficiency of the plant when loaded below the normal, say 24 per cent. in all. The loss in the conductors is proportional to the load, and is only a maximum when the load is a maximum, and similarly there is no loss in those motors which are out of use. On the other hand, the loss in the shafting is continuous whilst it is running, therefore the efficiency in those cases where machines are intermittently in use—that is, the general condition—is considerably below the above figures. For example, if, say, 50 h.p. is lost in the shafting continually and there is 50 h.p. in use for one-half of the whole time, then in a day of 10 hours there would be 500 horse-power hours lost in the shafting and 250 horse-power hours used by the tools, so that out of 750 horse-power hours, 66 per cent. are wasted in shafting. Frequently the hours of use are even less than half, so that the loss in such cases is still greater.

Increased Output.—It is most frequently to be found in the use of small scattered engines that the governing is defective, and the engines are so loaded that throwing on machines may seriously reduce the speed of the rest of the tools. With good self-regulating motors the speed is maintained constant for considerable excesses even of normal full load. As to the main engine, there is no difficulty in securing governing to practically constant speed; moreover, when large numbers of machines are operated by one main engine, there is less tendency, apart from the governing, to cause a fall in speed than is the case with a smaller engine running a less number of machines. At the Bristol Carriage and Wagon Works one of the existing engines pulls up to one-half its normal speed when the rack saw is thrown on. This, of course, seriously reduces the output of the whole of the tools driven off this engine, added to which there is the increased wear and tear of machinery and gearing, due to inconstancy of speed. Moreover, it is found with a constant speed that a higher speed may be adopted for the tools, which results in a still further output of work.

At Messrs. Richardson's works, for example, where electric driving was adopted, the speed of the tools was increased by an average of 20 per cent., with a corresponding increase of output. In a rail-rolling mill in the United States, where electric motors have been adopted, it is stated that the work hitherto done by 6,000 hands with separate engines, is now accomplished by 4,000 with electric power.

Facility of Extending.—As further machinery is added, the makeshift policy of altering the slide valve of the engine to cut off later is frequently adopted, regardless of the ensuing loss of steam. Electric power is vastly more flexible, it being the simplest matter to add an extra motor when further machinery is put down, so that little or no provision is necessary in the motors.

Method of Applying Motors.—At present the first cost precludes the use of a separate motor to each machine, unless it be a large one. It is generally better to group a number of machines on to one motor, more especially if the load on the machines is variable. Very large powers should not be sent along one long line of shafting; it is better to use two or more motors in such a case. Variable machines should be more or less separated from machines where the load is steady, as it is desirable that in the case of a steady load the motor should be running continually at its most efficient load; whereas, if surplus power be required for a variable machine, then the motor would not run continually at its efficient load. For example, a large fan, which has a constant load, should not be grouped with a lift used intermittently on to one motor. In dealing with heavy work, portable tools driven by motors should be used to obviate the present expense and loss incurred in moving heavy castings from one tool to another. Several of these tools can work at one casting at the same time, thus considerably expediting the passage of heavy work through the shops. Heavy tools, such as lathes and large planers, may remain fixed, but drilling, slotting, shaping, milling, and cylinder-boring tools should be made portable where work on heavy castings is concerned.

The Bristol Wagon and Carriage Works.

Description of the Old Steam-Power Plant.—There are five horizontal steam-engines in all, varying from 100 i.h.p. to 10 i.h.p. Three of the engines are antiquated, having ordinary slide valves, and being controlled by a throttle valve operated by a slow-speed governor, while they are so overloaded that the valves are set to give steam practically the full length of the stroke. Two of the engines are modern, having variable expansion gear, while the slide valves are set to cut off and give a fair rate of expansion. Steam is generated in five Lancashire boilers placed in three different parts of the works, near the larger engines. The steam-pipes, therefore, are not unduly long, with two exceptions, where the lengths are 158ft. and 112ft. respectively.

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TABLE A.—Table of Horse Power Used or Lost at the Bristol Wagon Works.

Number of engine.	Engine friction 85 per cent. of maximum.	Loss in shafting.	Total lost.	Percentage of power lost.	Used by tools and their countershafts.	Percentage of power used.	Light load.	Normal load.	Maximum load.	Power saved by dispensing with certain shafts and engine friction.
	H.P.	H.P.	H.P.	Per cent.	H.P.	Per cent.	H.P.	H.P.	H.P.	H.P.
1	15	21·7	36·7	37·3	61·7	52·7	76	98·4	103·7	25
2	7·5	27·2	34·7	73	12·8	27	40	47·5	100	21
3	2	4	6	75	2	25	6·4	8	11	2
4	6·2	11	17·2	54	14·5	46	25	31·7	42	6
5	14·7	24	38·7	57	29·2	43	60	67·9	97	22
Total ...	45·4	87·9	133·3	—	120·2	—	207·4	253·5	353·7	76

Water and Coal Consumption of the Old Plant.—The steam consumption is calculated from diagrams taken at various states of the load. An allowance was made for cylinder and port clearance, but no allowance for loss by leakage past the cylinder, nor for initial condensation in the cylinder, as the measurement of the steam was made near the exhaust end of the diagram. The re-evaporation which takes place during expansion, would cancel the initial condensation to some extent, though not materially so in all cases. It is impossible without actually weighing the steam used to say what deduction should be made for this loss. The following table summarises the results of the different tests:

Engine.	Pounds of steam per I.H.P.-hour. Full load.	Normal load.	Light load.
1	41	46	58·7
2	40	44	47
3	70	96	96
4	34	33	48 5
5	35	32	32
Average	44	50	56·5

No. 3 engine, which is the most wasteful, is the smallest, the cylinder being 10in. by 16in. It was found by removing the cylinder cover that there was an excessive leakage past the piston. If 25 per cent. be added for this, and the condensation calculated in 158ft. of steam-pipe, which connects it with the boiler, the steam per indicated horse-power hour would reach nearly 150lb. The next most wasteful engine is the No. 1, whose cylinders are 18in. by 30in., where the cut-off took place as late as about 80 per cent. of the stroke, while the loss of pressure in the steam-pipe, owing to valves and bends, was 20 to 30 per cent. of boiler pressure. No. 2 engine has also a very late cut-off, it being 83 per cent. of the stroke, and the loss of steam pressure between boiler and cylinder is 40 per cent. This engine is greatly overloaded—in fact, with heavy load the speed is reduced to one-half the normal, with a consequent loss of output. Engines Nos. 4 and 5 are not exceptional in lack of efficiency seeing that they use low-pressure steam and are non-condensing. In the case of engine No. 4, however, there is a steam-pipe 112ft. long, of large diameter, and uncovered for two-thirds of its length.

Losses in Steam-Pipes.—There was no means of measuring the condensation, which was, therefore, determined by calculation, using a formula based on actual experiment. It has been found that the rate of transmission of heat through iron steam-pipes is 3·5 British thermal units per hour per square foot of surface for each degree Fahrenheit of difference in temperature between the steam and the surrounding atmosphere, and for indifferently lagged pipes with bare valves and flanges the coefficient may be 2·5. Taking the difference in temperature to be 300 – 50 = 250deg. F., and the time during which the pipes are in use as 3,000 hours per annum, each square foot of bare pipe would condense about 3,140lb. of steam, and of covered pipes about 2,250lb. of steam. The yearly loss by condensation in pipes would then be approximately :

	Lbs. steam.
For 457 square feet of bare pipe × 3,140 =	1,440,000
For 277 square feet lagged pipe × 2,250 =	620,000
Total	2 060,000
Adding 25 per cent. for extra surface exposed in flanges, tees, valves, and fittings, and conduction through supports and otherwise	515 000
	2 575,000

Fuel Consumption.—The total fuel consumed per annum is approximately 2,500 tons, of which between 400 and 500 tons is waste wood, the value of which is about the same as that of coal.

The average load on the five engines is about 254 i.h.p., and the time of working about 2,800 hours per annum. The energy used per annum is, therefore, about 710,000 indicated horse-power hours, and as the normal steam consumption was found to be 50lb. per indicated horse-power hour, the total yearly steam consumption is 35,500,000lb.

To this add, say, 10 per cent. for leakage past piston and condensation in engines..	3,550,000lb.
Loss in steam-pipes, as above.....	2,575,000lb.
	41,625,000lb.

This consumption of steam, divided by the weight of fuel, 2,500 tons, gives an average evaporation of rather less than 7 5lb. of water per pound of fuel. Two of the boilers are working under very unfavourable conditions, owing to the length of and restricted and tortuous nature of the flues, otherwise a better evaporative result would have been obtained. The average consumption of fuel is 7·91b. per indicated horse-power hour.

Power Developed by Existing Engines.—A number of diagrams were taken off each engine under various conditions and from maximum to minimum load. The results of these are summarised in Table A. From this table are deducted the following averages :

	I.H.P.	Per cent.
Total normal load	254	—
Loss in shafting	87·9	34·5
Loss in engine friction ...	45·4	17·8
Total loss ..	133·3	52·3
Power utilised by machines and their countershafting or gear	120·2	47·7

It will be seen on reference to the table that in the case of engines No. 2 and 3, the power lost in shafting and engine friction was no less than 73 to 75 per cent. In the case of No. 1 nearly half the power of the engine was utilised for driving three powerful fans placed close to the engine, which accounts for the somewhat smaller percentage of loss in the shafting. In the transmission of the remaining 60 per cent. of the power of this engine to the various fitting-shop tools, fully 50 per cent. is lost. These results confirm those obtained by Sir T. Richardson, Mr. Westgarth, and Mr. Benjamin. They are, however, widely different from those published by Prof. Kennedy and Mr. Crompton. It may be noted that while the former are the results of actual test, the latter are presumably estimates.

Power Required by Various Tools.—There is comparatively little data published as to the power required for driving various tools; the author believes, therefore, that the following deductions made from the tests may prove useful :

	H.P.
Large blowing fan for smithy	15
Smaller ,, ,, ,, ,,	10
Large circular rack saw, cutting 2ft. log of English oak	20
Vertical frame saw, when cutting 22in. by 20in. pine, with 14 blades	14
Planing tool for wood	5
Foundry lift	2
Horizontal saw for wood	13
Circular ,, ,, ,,	8
Small fan for foundry	5

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Seventy-five miscellaneous tools in engineers' shop, comprising lathes, drills, slotting, shaping, and shearing machines, grindstones, and emery wheels, etc., of which about 41 were in use whilst indicating the engine	24

Power Required for Electric Driving.—The power required by the various tools will be greatly increased, owing to their greater output, but the power wasted in shafting and engine friction will be considerably reduced. Instead of transmitting power from five engines, the shafting will be driven by 10 or more motors. These motors, owing to the small space which they occupy, are placed close to the point at which work is taken off the shafting. For both of these reasons considerable shafting is discarded. For example, in the case of engine No. 2 the normal load is 47 i.h.p., of which about 20 h.p. is lost in heavy underground gear and shafting, most of which is being dispensed with. The total power of the motors to do the present work is 76 h.p. less than that now indicated by the engines neglecting loss in transmission—that is, 254 - 76 = 178 h.p.

Coal, Water, and Labour on the Electric System.—The new boiler will evaporate at least 9lb. of water per 1lb. of coal, while the engine will at working load, which is five-eighths of full load, use 16lb. of steam per indicated horse-power hour—that is, 1·8lb. of coal per indicated horse-power hour, or, say, 2lb. in all. Somewhat better results than this might have been obtained by the use of a more complicated plant, but it was decided that the extra first cost would barely compensate for the small additional saving. It has been stated above that the motors will develop about 178 h.p. to do the present work. To this must be added the losses in the new transmitting system. The efficiencies may be taken as follows:

	Per cent.
Engine friction and rope, say	90
Generator efficiency	92
Conductors	98
Motors, average	85
Total efficiency	69

Each horse-power at the motor pulley, therefore, requires 1·45 i.h.p. at the engine cylinder. The normal indicated horse-power of the new engine will be about 178 × 1·45 = 258 i.h.p., which is within 2 per cent. of the power developed by the old engines. Taking 2,800 hours of work per annum, there are, then, 725,000 indicated horse-power hours, which at 2lb. of coal per hour consume 650 tons of coal per annum. There is thus a saving of 2,500 - 650, say 1,850 tons of fuel. The water required on the new system will be about 10 per cent. of 16lb., say 2lb. per indicated horse-power hour, for making up the feed, and about 4lb. for making up that lost in the cooling apparatus, say 6lb. of water per hour, so that the yearly consumption of water will be 435,000 gallons, or a saving of 4,162,500 - 435,000 = 3,727,500 gallons, a large part of which has been hitherto purchased from the town water-works. In addition to this there will be a saving of oil and stores as well as of labour, inasmuch as there will be only one fireman in place of those at present required. The total saving is approximately £1,000 per annum, quite apart from the other various advantages.

Reasons for Adopting the Three-Phase System.—Full consideration was given to the merits and demerits of the direct-current and three-phase systems, and the directors of the Bristol Wagon Works took the opportunity of seeing both systems in practical work under conditions analogous to those in their own works. The first cost of the two systems was approximately the same, while the following are the advantages of the three-phase system which appealed to the Bristol Wagon Works Company: (1) The absence of commutators on both generator and motors, and the fact that the current passes direct through clamped terminals from the generator to the motors. (It was noticed that the commutators of the direct-current motors and dynamos were worn, and caused trouble, more especially in comparatively dirty workshops.) (2) The more mechanical design and construction of the generator and motors, the windings of the latter being entirely enclosed by the iron frame of the machine, protecting them from accidental damage. (3) The fact that the three-phase motors can be left running for long periods without any attention, even when considerably over-loaded, which is not advisable in the case of the direct-current motors. (4) The freedom from possibility of breakdown as compared with the direct-current system.

Brief Description of the Electric Plant.—Steam will be generated by one Lancashire boiler 28ft. by 7ft. 6in., fitted with a Bennis automatic stoker. The stoker is regulated by a piston in communication with the boiler, which throws the feed in or out of gear according to the steam pressure. The piston also operates a damper in the main flue, so that the pressure of the boiler is automatically maintained constant within 2lb. It is therefore only necessary for the fireman to fill the hopper with fuel and regulate the feed. A Green's fuel economiser will be inserted in the main flue, while there is provision made at the back of the boiler for the insertion of a superheater. The engine, in order to provide for extension, is good for 400 i.h.p., and is of the horizontal compound type, having cylinders 13½in. and 25in. in diameter by 32in. stroke placed on either side of the flywheel. The admission valves are on the Proell system, with Corliss exhaust valves. The air-pump, which is of the Edward's type, will be worked by a bell crank off the end of the low-pressure piston rod. A centrifugal pump driven off the shafting will circulate the cooling water. A surface condenser with 650 square feet of cooling surface will be placed at a sufficient distance from the engine to admit of a filter for removing the oil before the exhaust passes to the condenser. As there is neither a natural supply of condensing water nor a cooling pond available, a cooling tower will be used for cooling the circulating water. The generator, which is of the Brown-Boveri type, will be driven off the flywheel by ropes, while the adjacent fitting-shop shafting will be also driven off by the flywheel. The generator will absorb 275 b.h.p., and is provided with sliding foundations. The main switchboard will consist of three panels, one being for the generator, with a regulator for the exciter; another for the motors, each circuit having a triple switch and fuse, and ammeter; the third for the lighting circuit, with double switch and fuse on each circuit. The boards will consist of enamelled slate mounted on iron supports, so as to be entirely incombustible, no wood whatever being used. There will be seven motor circuits—that is, one to each shop—each circuit being composed of three conductors. The number of motors at first will be 10, varying from 65 h.p. down to 2 h.p. The larger motors—viz., those of 65 h.p. and 50 h.p.—will drive by ropes, the smaller motors by belts. There will be about eight lighting circuits, one running to each department. They will consist of two wires only, one being the phase wire, the other being connected to a fourth or neutral wire, which is connected to the centre of the star winding. The voltage of the motors will be 190 and of the lighting circuits 110. The lower voltage was adopted for the lighting circuits to enable the use of more efficient incandescent lamps, and to be at the same time more suitable for the arc lamps. There will be 750 incandescent and 32 arc lamps, which will give a better illumination at considerably less cost than the present gas lighting. The whole of the conductors will be insulated with rubber, and run in hardwood casing throughout. The generators and motors are being supplied by Messrs. T. Richardson and Sons, of Hartlepool, while the whole of the work is being carried out by the firm with which the author is associated

Discussion.

The discussion of the three preceding papers were taken together, as they referred to different branches of distribution of power.

Prof. Silvanus P. Thompson opened the discussion by asking Mr. Siemens what actual saving had been effected at the Charlton Works by the introduction of electrical distribution of power. Was he correct in saying it saved about 3,000 tons of coal per annum, and the wages of six stokers and engineers? When Mr. Siemens said that continuous currents were preferred for the distribution of power, the speaker thought the statement should be qualified by the words "preferred in England," and he disputed the author's statements as to defects of alternate-current motors as regards starting and lack of power. Turning to Mr. Gibbings's paper, Prof. Thompson accused the author of suppressing all information as regards the use of motors

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on alternate-current mains. This could not be said to be due to defects in the alternate-current motor, as in the city of Frankfort more motors were at work than in Edinburgh and Bradford together. Yet the Frankfort electricity works supplied single-phase alternate currents. Again, there was no limit to the size of alternate-current motors. He had recently visited Switzerland and was surprised to see how much ahead of us the Swiss were in such matters. There the polyphase system was used almost everywhere. He heard of one case in which a factory had been equipped with direct current only a few years ago, and in which all these motors had been displaced by three-phase motors. He also criticised Mr. Siemens's remarks about intermittent working, and stated that in America electric travelling cranes were everywhere adopted.

Mr. T. PARKER said the last speaker was ignorant of what was being done in our country in transmission work. He knew what could be done by three-phase systems, but considered the direct-current high-tension system better and more economical. Mr. Geipel's figures were only calculations, and in the absence of confirmation in practice could not be accepted for comparisons. In fact, in several places Mr. Geipel's conclusions seemed to him to be erroneous. The absence of commutators only applied to small three-phase motors, and the enclosing of the motors could not be claimed as a comparative advantage over direct-current motors.

Mr. H. FARADAY PROCTOR pointed out that Mr. Siemens's conclusion, that it was not economical to introduce transmission of power by electricity where the power is only wanted at intervals and for a short time, did not hold universally, as, where the power was obtained from a central supply station, it was just such a case in which electric power was most valuable. As regards Mr. Gibbings's paper, he considered the charge of 10 per cent. on the initial cost of the motors too low. A 3 per cent. depreciation allowed for a life of 33 years, which was too high. In the same way the 10 per cent. on arc lamps was much too low a charge. He also pointed out that the table did not give the total motors connected to the mains on any one date, but the number added each year.

Mr. F. G. BAILEY said that it must be remembered that for the supply of light and power from the same main the three-phase system was not satisfactory, and that our consulting engineers had not, therefore, been far wrong in not adopting it for town lighting and power schemes. It was interesting to note the figures given by Mr. Siemens of 1·3d. per unit generated and to compare it with the figure 1·5d. obtained at the Edinburgh station. The question of whether it paid to transmit power by electricity or coal was still to be settled in many cases. Thus, allowing that electric power cost ½d. per unit for coal, and allowing a 5 per cent. line loss, the cost of transmission came out at ·0125d. per unit. On the other hand, allowing 6lb. of coal per unit and 1d. per ton-mile as the cost of transport, the cost came out at only ·003d. for transmission by rail of the same power over a distance of one mile. This shows that the coal transmission is cheaper, but the speaker explained that local conditions varied the figures enormously.

Colonel CUNNINGHAM referred to the fact that economy was not the only consideration in power transmission. The question with small users was more often that of convenience. Hence motors which might not be the most economical might often be adopted for the convenience with which they would be applied.

Mr. W. H. PREECE explained how largely the Post Office used electric distribution of power in their various offices and factories. Thus, the works at Clerkenwell, where some 500 men were employed, were equipped throughout with electric motors. In the Post Office, small motors were also used for many purposes—such as stamping letters, folding circulars, etc. The human labour saved was a great item. Mr. Preece then referred to the distribution of power for traction purposes on the Metropolitan and District Railways. He assured those present that all systems would have a fair trial, and that the best system would ultimately be adopted. In his opinion sufficient attention had not been paid by the speakers to the great value of a motor load to an electric supply station. Thus, at Bristol it had been shown that if the tramways were to be supplied from the Corporation electricity works at cost price, the charge for electric light could even then be reduced 1d. per unit. Unfortunately, the tramway company had been too strong for the proposed arrangements to be made.

Mr. A. SIEMENS said that Prof. S. P. Thompson had, in criticising his conclusions, overlooked the fact that he was intimately connected with the German firm of Siemens and Halske. Thus he had placed at his disposal all the plans and drawings of their three-phase installations, and was able to follow closely the developments. Hence he knew all about the capabilities of the three-phase system, and did not prefer the continuous-current system through ignorance, as had been suggested. As regards Mr. Geipel's paper, he would point out that a three-phase motor, except at one particular load, was very inefficient. Continuous-current motors, on the other hand, can be obtained with good efficiency down to quarter full load. Again, travelling cranes were not worked intermittently, as Prof. Thompson had suggested, but most regularly, and electric cranes were to be found in very many shops in England. What he meant by the intermittent working, he would illustrate by the example of the guttapercha shops. Here, large power was sometimes required, and yet the shops never worked regularly, and it was found better to leave in the steam plant. The whole question of the economies in the three-phase work depended on great distances of transmission. Mr. Geipel's figures were calculations only, and he did not believe he would find the coal consumption as low as 2lb. of coal per indicated horse-power hour. The advantage of having no commutator on the three-phase plant was a craze. Commutators on a well-built direct-current motor gave no trouble and needed no attention. Two men at their works were responsible for 180 motors, many of which were placed where they were not easily accessible. Also they had no difficulty with motors in dirty places, as inferred by Mr. Geipel.

Mr. A. H. GIBBINGS said that he had not applied to the alternate-current stations on account of the few motors used on the English single-phase systems.

Mr. W. GEIPEL explained that the high frequencies in use in England had much to do with the bad performance of alternate-current motors. On the Continent lower frequencies were universal. He also referred to the fact that three-phase motors are now employed for railway purposes in Switzerland. As regards lighting and power being supplied from the same mains, he did not think the balancing trouble with the three-phase system any more serious than those found in the three-wire direct-current system. He knew of motors which would work efficiently at anything from 30 per cent. to 130 per cent. of full load. The starting of three-phase motors gave no difficulty. He believed his figures would be confirmed in practice after the work was completed.

ANALOGIES BETWEEN THE YEARLY RANGES OF SOM METEOROLOGICAL AND MAGNETIC PHENOMENA.*

BY DR. VAN RIJCKEVORSEL.

This is the second part of a paper read at the Toronto meeting, in which it was shown how exactly similar the yearly temperature curves are for a large part of Europe, and how the anomalies which these curves show may contribute in a large degree to the discovery of their origin. In the diagram accompanying the present paper are plotted down six annual curves for temperature, air pressure, rainfall, magnetic declination, and for the vertical and horizontal components of the earth's magnetic force. A portion of these curves are for Greenwich, others for two different stations in the Netherlands. It is now shown that all these curves, however dissimilar in their general directions, are exactly alike in their anomalies. Except in a very small number of instances, where the data at hand were not yet sufficient to make the phenomenon appear, every maximum or minimum in one curve seems to have its exact counterpart in every other curve, be it meteorological or magnetic. This is even the case for very small accidents of a curve, so that it is probable that it will ultimately prove to be true for every single feature of these curves, however insignificant. These facts, in the first place, show once more how all the phenomena on the earth must be, to a large extent, governed by one and the same potent cause. But they also seem to give a valuable method for discovering, if not always the cause of meteorological phenomena, yet of the centre on the globe from which such a cause emanates.

* Abstract of paper read before the British Association.

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POWER DISTRIBUTION.

The Bristol meeting of the British Association is now practically over for all but those who have time to take the conducted holiday tours arranged to enable visitors to see the surrounding country. The past meeting has been productive of several interesting discussions, and the arrangements by which several papers on kindred subjects have been discussed together have been greatly appreciated. Thus, on Tuesday last the practical consideration of the mutual interference of magnetic observatories and electric tramways were brought before a joint meeting of Sections A and G and the International Conference on Terrestrial Magnetism and Atmospheric Electricity. At this joint meeting no less than five different papers were read which could be conveniently considered together. Leaving this until our next issue, we propose to refer to the three papers on distribution of power by electricity which came before Section G on Monday last. These papers were read respectively by Mr. Alexander Siemens, Mr. A. H. Gibbings, and Mr. W. Geipel. All dealt chiefly with the distribution of power, although Mr. Siemens's paper was headed "Transmission of Power by Electricity." These papers are given *in extenso* elsewhere in this issue, so that we need not summarise their contents here. The facts given by the first two authors were derived from work actually carried out, while Mr. Geipel's paper suffers in comparison by being only an estimate of probable results. These estimates were considered by several speakers to be rather too favourable. This arises from the author taking trial trip figures rather than figures obtained over a period of practical work. Thus Mr. Geipel estimates that with the new plant to be installed at the Bristol Wagon and Carriage Works he will obtain all the power required throughout the year for 2lb. of coal per horse-power hour indicated on the engines. This figure, in the face of those given by Mr. Siemens, and also by Mr. Robert Hammond in his recent paper on "Works Cost" before the Institution of Electrical Engineers, is much too low. We also note that Mr. Geipel does not add to this coal anything for steam-pipe losses, or for the coal used in the boilers when banked. These three papers led to a battle of systems, which Prof. S. P. Thompson, fresh from an undigested trip to Switzerland, started. The three-phase alternate-current system was to be seen at its best in Switzerland, and hence the professor taunted the English profession with being ten years behind the times in the scientific application of the forces at their command. Unfortunately, neither he nor those who spoke afterwards gave anything beyond their personal opinion unbacked by comparative figures. The most valuable contribution to the debate was made by Mr. F. G. Bailey, who did not take the side of either party. He pointed out, as we have done before, that it does not follow that long transmission of power schemes will pay where coal and transport are cheap. This is the key-note of the whole difference between the English and Swiss practice, and it lies not in the

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distribution of power in factories or compact areas, but in its transmission to long distances. In Switzerland water power is abundant and cheap, while coal is dear. There power can be obtained at cheaper rates from long transmission lines than from isolated engines driving works by steam power. For such transmission three-phase currents are most convenient, as in such a system higher voltages can be used conveniently than are possible with continuous currents. For power distribution the two systems are about on a par, and in England the relation between first cost and efficiency will determine which shall be used, but where the power is to be transmitted, as in Switzerland, the three-phase system of distribution saves in conversion, and hence gains the day. The further question of light from three-phase systems which are supplying power was referred to, but Mr. Geipel has yet to learn the facts in this respect. Thus he thinks that the zero wire in a three-phase system is used so that a more convenient voltage could be obtained, and not because it tends to remove the balancing trouble. In conclusion, we must add that the Swiss engineers have undoubtedly perfected the three-phase system, and that they may well be proud of their achievement. Still, they are not in a position to condemn British practice, as neither the Swiss nor German firms make direct-current dynamos which will compare in efficiency with those turned out by English manufacturers.

REVIEWS.

Munro and Jamieson's Pocket Book of Electrical Rules and Tables. Thirteenth edition. Published by Charles Griffin and Co., 12, Exeter-street, Strand, London. Price 8s 6d.

Every mechanical engineer swears by his Molesworth. The above little pocket book has evidently been intended to fill a similar place in the everyday life of the electrical engineer. Electrical science has, however, neither the definite limits nor the fixed requirements of mechanical science. In spite of this, a praiseworthy attempt has been made to furnish useful information on most points connected with electrical engineering. It would hardly appear necessary, however, to give tables for converting watts into horse-power (p. 529); anyone knowing the conversion factor could perform the necessary arithmetical operation in the time occupied in consulting the table. When describing the Clark cell as a standard of E.M.F. it is rather surprising that no mention is made of the Reichsanstalt standard cadmium cell, which presents the advantage of possessing no temperature coefficient. A short article on Röntgen rays may assist those who wish to take X-ray photographs, but the diagram on Marconi's wireless telegraphy would hardly appear likely to supply any general want. An improvement might have been effected if some of the descriptions of apparatus had been brought more up-to-date. Thus, one of the earliest forms of the Ayrton-Mather galvanometer is alone described. Similarly, we might have expected that such an important improvement in the method of measuring the insulation resistance of a cable as that introduced by Mr. Price might have found a place on pp. 193 or 194. It will be remembered that the improvement alluded to enables us to entirely eliminate errors due to surface leakage on the cable or bad insulation in the galvanometer. It thus, for the first time, permits of accurate results being obtained from experiments on a short length of cable. Some warning would further seem necessary when giving a formula for calculating the E.M.F. of a cell from chemical data. As is well known, the Daniell cell is almost the only one for which such calculations give even approximately correct results. Many electrical engineers will also feel some disappointment on finding that the section nominally devoted to electro-metallurgy is really entirely occupied with details of electro-plating. Much really accurate and useful information is, however, gathered together in this little book, and it can hardly fail to prove of service to the class for which it was written.

The Indicator Handbook: a Practical Manual for Engineers. By CHARLES N. PICKWORTH Wh.Sc. Part I: The Indicator: its Construction and Application. Published by Emmott and Co, Limited, 175, Strand, London. Price 3s. net.

This is a well-written little book, suitably illustrated by over 80 views and diagrams. A noticeable feature in it is that the indicator is treated as an instrument liable to serious errors, which must be carefully guarded against. In fact, a reliable indicator diagram represents the correct solution of a somewhat difficult physical problem; on the other hand, a diagram by itself means little or nothing unless the conditions under which it was obtained were such as to preclude the vitiation of the result by experimental errors. As in any other experiment, we must ask our question in a definite and unambiguous manner in order to obtain a reliable answer. A mere repetition of the table of contents will show how systemmatically the subject has been considered: "Preliminary Observations," "The Construction of the Indicator," "Errors of the Indicator," "The Attachment of the Indicator," "Errors of Indicator Connections," "Indicator Reducing Gear," "Errors of Indicator Reducing Gear," and "The Use and Care of the Indicator." The last chapter, especially, should prove of great value. It evidently represents the result of many years' experience with the use of various indicators.

The second and concluding part of the work, which is in active preparation, will be devoted to the "Indicator Diagram and its Analysis."

NOTES ON THE ELECTRIC LIGHTING SYSTEM AT BRISTOL, WITH SPECIAL REFERENCE TO AUXILIARY PLANT.*

BY H. FARADAY PROCTOR, A.M.I.C.E., M.I.E.E., CITY ELECTRICAL ENGINEER, BRISTOL.

In the following paper it is proposed to give a mere outline of the electric lighting undertaking at Bristol, and the results of the working of some of the auxiliary plant. The electric lighting works at Bristol are the property of the Bristol Corporation, and alternating current is supplied to private customers, and continuous current is used for the public street-lighting.

Generating Station.—At the present time the whole area equipped is supplied from one generating station, which has a water frontage to the floating harbour, and is situated at Temple Back, well within the area of supply. The engine-room and boiler-house both extend the length of the building, and adjoin one another. The coal bunkers occupy a wedge-shaped piece of land between the boiler-house and the floating harbour.

Boilers.—There are 12 Lancashire boilers; three of these are 24ft. by 8ft. diameter, and the other nine are 28ft. by 8ft. diameter, all working at a pressure of 125lb. The boilers are all fitted with coking stokers, mechanical elevators and conveyors, driven partly by steam-engines and partly by electric motors. An economiser has been laid down recently. Two chimneys are placed between the third and fourth boiler and adjoining the twelfth boiler respectively. Welsh pea-sized coal is used, and is delivered from the barges which come alongside over a weighbridge direct into the coal bunkers. From each boiler a single 5in. steam-pipe leads through the engine-room wall to the steam-ring mains.

Engines, Dynamos, etc.—The main engines are all of the Willans central-valve type, and vary in size from 100 i.h.p. to 700 i.h.p., the aggregate horse-power being 3,700. Alternators with revolving disc armatures are direct-coupled to the engines, and run in parallel with one another. Four dynamos, each giving 80 amperes at 600

* Paper read before the British Association at Bristol.

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volts, are used for arc lighting and for driving the station motors. Two dynamos, each giving 500 amperes at from 100 to 130 volts, and a small battery of accumulators supply the exciting current for all the machines, and also energy for a portion of station lighting.

Switchboards.—The main switchboards are of double-pole type, and will probably be soon replaced by single-pole boards, when the outer conductors of the cables will be earthed. A new arc lighting switchboard has just been introduced, the arrangements providing for the coupling of any of the 18 new arc circuits on to any of the four dynamos; this switchboard is particularly compact, each circuit requiring only 3½in. of the length of the board.

Cables, etc.—Eighteen high-tension feeder cables run direct to transforming stations; the distribution of energy to customers is on the three-wire system by triple-concentric cables, the low-pressure system being divided into three distinct networks. There are about 130 miles of cables, all of which are lead sheathed and steel armoured; these are laid direct in the ground, being loosely covered with common bricks as a guard against accidental injury by picks or other road tools. The street arc lamps are arranged with 12 lamps in series on each circuit, all the circuits being run in parallel on one or more dynamos. There are 38 sub-stations, which, with the exception of a few of those originally laid down, are all constructed under the footways, their dimensions being 12ft. by 6ft. by 6ft. 6in. deep. They are built of brick with cement, the walls being 1ft. 6in. to 2ft. thick. The ventilation is by means of two 6in. pipes—inlet and outlet—connected to a small divided box with vertical gratings set against or let into the nearest external wall of adjoining premises. No trouble from gas or sweating has ever been experienced since the adoption of these arrangements. (Note.—Five of the 38 sub-stations are not yet working.)

General.—A considerable amount of machinery has been added during the past few months. The following are the results of trials made with sundry of the auxiliary plant. In all cases the steam consumption has been ascertained by condensing the exhaust steam, and weighing the water collected, and the results of the pump tests have been reduced to show the steam consumption per horse-power hour of work done, such being calculated from the volume of water and the pressure at which it was delivered. For the purpose of facilitating comparison, the result of electrically-driven plant are given in pounds of steam consumed, 32·01lb. of steam per kilowatt-hour, or 23·87lb. per electrical horse-power hour being allowed, that being the steam consumption of the smallest generating plant used in the station. The feed pumps consist of a steam-pump with a capacity of 4,000 gallons per hour, and an electrically-driven pump of the same capacity. The steam-pump is compound, duplex, direct-thrust, non-condensing; it has been in use about five years, and is in good repair. The motor pump is a three-throw feed pump, driven by a 600-volt continuous-current motor, running at 650 revolutions per minute, with speed reduction by cotton ropes, and a pair of spur wheels, the ratio of reduction being 12·9 to 1. The results obtained during trials were: At full load, steam-pump 98lb. steam per brake horse-power, electric pump 43·2lb.; at about one-sixth full load, steam-pump 252·1lb. steam per brake horse-power, electric pump 245·4lb. In this trial at one-sixth load the steam-pump was run slowly to reduce the output, but the output of the electric pump was reduced by the opening of "by-pass" or "relief" cocks, the pump being run at full speed. On reducing the speed of the electric motor 25 per cent. by lowering the armature voltage, the efficiency at partial load is very much improved. At about three-quarter full load, with all three plungers of the pump doing full work, the steam consumption is 35·3lb. per brake horse-power; at about half load, with two plungers doing work, the steam consumption is 43·7lb. per brake horse-power; at about quarter load, with only one plunger doing work, the steam consumption is 74lb. per brake horse-power, and when running light the total steam consumption is 66·25lb. During these four trials the three-quarter speed was maintained, the delivery being again regulated by the by-pass cocks. On lowering the speed of the motor still further by reducing the armature voltage to 100, the efficiency at a low output is again improved. At one-seventh of full load the pounds of steam per brake-horse power = 68·4, being only 27 per cent. of that consumed by the steam-pump at correspondingly light load. The conclusions arrived at are: (1) the motor feed pump will work with from 27 per cent. of the steam consumption of the steam-pump; (2) the output of a motor pump should be controlled by regulating the speed of the pump, the employment of by-pass cocks resulting in the loss of much energy; (3) with a motor-driven feed pump, where the motor runs at 580 revolutions per minute and the pump at 45, an efficiency of 67 per cent. can be obtained.

The donkey pumps are steam and motor driven pumps. The steam-pump is duplex, direct-thrust, non-condensing; its capacity is 2,500 gallons per hour, pumping against a head of 41ft.; the pump has been in use about five years, and is not in good repair. The electric pump is a 5in. centrifugal pump, driven direct by a 600-volt motor at 400 revolutions per minute; its capacity is 25,000 gallons per hour, pumping against a head of 26ft. 6in. The steam-pump consumes 544lb. steam per brake horse-power hour, the electric pump 95·5lb. It will be noticed that these pumps are not directly comparable, their capacities being very different, but the steam consumption is so very much less with the electric pump as to indicate somewhat the comparative efficiency of the two kinds of plant. The efficiency of the 5in. centrifugal motor pump, with a head of 26ft. 6in., is found to be 25 per cent.

The centrifugal circulating pumps consist of a steam-pump having a capacity of 2,300 gallons per minute, and a motor pump of the same capacity, both working against a head of 15ft. The steam-pump is a 12in. centrifugal pump, coupled direct to a vertical compound-condensing engine, working at 210 revolutions per minute. The motor pump is a 12in. centrifugal pump, direct coupled to a 600-volt motor, running at 400 revolutions per minute. The result of the trials show that the steam-pump takes 90·65lb. steam per brake horse-power, and its efficiency is 25·2 per cent.; while the motor pump takes 48·26lb., and its efficiency is 46·3 per cent.

The mechanical stoker is driven by steam and by electricity. An elevator, conveyor, and the stokers of seven boilers are driven by a vertical non-condensing engine through a belt and one pair of spur wheels, the speed reduction being in the ratio of 12½ to 1 of the stoker shaft. An elevator, conveyor, and the stokers of five boilers, all of the same make as those above mentioned, are driven by a 600-volt motor, through a belt and with worm gearing, the speed reduction being in the ratio of 38½ to 1. The whole of this latter apparatus being quite new, it is probable that during the trial it worked rather more stiffly than the older steam-driven gear. To work the elevator, conveyor, and the stokers of five boilers, the engine indicated 4·1 h.p., and the motor absorbed 4·6 e.h.p., with a total steam consumption of 109lb.

With regard to the feed-water filters, a considerable amount of difficulty has been experienced in efficiently extracting the small quantity of oil found in the condensed water. A low-pressure filter in which coke and wood shavings were employed was first used. A high-pressure filter packed with sawdust is now employed, and also a centrifugal cream separator. The centrifugal separator is found to extract the oil most perfectly, and when driven by an electric motor the value of the power absorbed is very small, being about 1¾d. per 1,000 gallons separated. The separator is of one of the usual types employed for dairy purposes, and has a Laval steam-turbine attached. Its capacity is 400 gallons per hour. When separating 400 gallons per hour the steam consumption is 220lb. per hour when driven by the steam-turbine, and 37·6lb. per hour when driven by the motor. As the separator when worked by the motor was driven by means of a leather strap and the steam-turbine was not disconnected, it is probable that with direct driving the cost of separation can be reduced to below 1d. per 1,000 gallons. The separation is so perfect and the power required so small that filtration by centrifugal action is thought worthy of careful attention and further development.

Tables giving details of the foregoing trials have been prepared by the author, and are given herewith.

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STEAM FEED PUMP.

Type: Duplex, direct thrust, double acting, non-condensing. Pumping capacity: 4,000 gallons per hour. Steam-cylinders: Compound tandem; two high-pressure, 5in. diameter; two low-pressure, 8in. diameter. Pump plungers: Four, 4¾in. diameter. Stroke: 8in. Normal speed: Fifty complete cycles per minute.

Per cent. of full load.	Speed per minute.	Gallons per hour pumped.	Pounds pressure at delivery.	I.H.P.	B.H.P.	Steam consumption per hour in pounds. Total.	Steam consumption per hour in pounds. Per B.H.P.
130	62	5,230	125	—	7·627	800	105
130	62	5,230	125	—	7 627	760	99·65
128	59	5,124	125	—	7·471	666	89·13
18	13·9	730	130	1·612	1·11	279	252·4
16	13·18	636	130	—	·96	243	251·9

MOTOR FEED PUMP.

Type: Three-throw, driven by 600-volt continuous-current motor with double-reduction gear. Capacity: 4,000 gallons per hour. Plungers: 3in. by 5½in. diameter, 5in. stroke. Speed: Motor, 800 revolutions per minute; pump, 62 strokes per minute. Gear: Three 2½in. cotton ropes; driving pulley 14in. diameter, driven 3ft. 10in. diameter; two spur wheels—driving 25 teeth, driven 112 teeth, 1¼in. pitch. Motor: Bar armature simple horseshoe magnet type separately excited at 100 volts. The pump has by-pass cocks connecting the deliveries with the common suction by which the amount of water to be pumped can be regulated, the pump speed being constant.

Per cent. load.	Speed.	Armature volts.	Gallons per hour.	Watts, exciting.	Watts, armature	Total watts.	E.H.P.	B.H.P.	Pounds steam per hour. Total.	Pounds steam per hour. Per B.H.P. hour.	Efficiency per cent.	Pounds pressure at delivery.
111	—	635	4,440	520	11,340	11,860	15·9	88	380	43·1	55·4	170
19	800	600	768	540	8,372	8,912	12	1·17	285	245	10	130
9	800	600	360	533	8,052	8,585	11·5	·55	275	503	5	130
0	800	600	—	520	3,105	3,625	4·9	—	116	—	—	—
Pressure supplied to armature reduced 25 per cent.												
80	576	445	3,200	535	5,437	5,972	8	5·41	191	35·3	68	145
57	579	445	2 271	535	4,495	5,030	7	3·71	162	43·7	55	140
27	584	445	1,088	535	3,271	3,806	5·1	1·65	122	73·7	32	130
0	588	447	—	535	1,605	2,140	2·9	—	66	—	—	—
Pressure supplied to armature reduced 83 per cent.												
14	111	100	556	535	1,200	1,735	2·32	·81	55·5	68·4	35	135

STEAM DONKEY PUMP.

Type: Duplex, direct thrust, non-condensing, double acting. Pumping capacity: 2,500 gallons per hour. Cylinders: Two high-pressure, 3in. diameter. Plungers: Four, 4in. diameter. Stroke: 6in. Suction: 8ft. Delivery: 33ft.; total head, 41ft. NOTE.—A higher load than 74 per cent. cannot be obtained.

Per cent. of full load.	Speed per minute.	Gallons per hour pumped.	I.H.P.	B.H.P.	Steam consumption per hour. Total.	Steam consumption per hour. Per B.H.P.	Steam consumption per hour. Per I.H.P.	Efficiency, B.H.P./I.H.P.	Actual head (feet)	Total head (feet), allowing for pipe friction.
74	65	1,850	1·8	·39	240	613	134	21·8 %	41	41·79
67	55	1,668	1·5	·35	182	516	119	23·2 %	41	41·79
55	48	1,379	1·3	·29	147	505	111	20·0 %	41	41·79

FIVE-INCH CENTRIFUGAL MOTOR PUMP.

Type: 5in. centrifugal pump, driven direct by a 500-volt continuous-current motor, separately excited at 100 volts; speed, 650 revolutions per minute. Suction, 7ft. 6in.; delivery, 19ft. Total lift, 26ft. 6in. Suction, 5½in. diameter; delivery, 5in. diameter. Pipe friction at 21,000 gallons per hour 1·86ft. head, and is allowed for (28·36ft. head).

Gallons per hour delivered.	Watts, exciting.	Watts, armature.	Watts, total.	E.H.P. absorbed.	B.H.P. output.	Pounds of steam per hour. Total.	Pounds of steam per hour. Per B.H.P.	Efficiency per cent. B.H.P./E.H.P.
25,222	658	9,375	10,033	13·45	3·33	321	96·4	24·8
20,930	658	8,100	8,758	11·74	3·0	280	93·3	25·5
20,450	658	8,100	8,758	11·74	2·93	280	95·6	25·0
20,400	658	8,200	8 858	11·87	2·92	283	96·9	24·6
0	658	1,872	2,520	3·38	—	108	—	—

TWELVE-INCH STEAM CENTRIFUGAL PUMP.

Type: 12in. centrifugal pump—pumping capacity, 2,300 gallons per minute, driven direct by a vertical compound-condensing engine. Engine: cylinders—one high-pressure 6in. diameter, and one low-pressure 12in. diameter; stroke, 7in.; speed, 210 revolutions per minute. Pump: suction, 8ft.; delivery, 7ft.; total head, 15ft.; speed, 209.

Gallons per hour delivered.	I.H.P.	B.H.P.	Pounds steam per hour. Total.	Pounds steam per hour. per B.H.P.	Efficiency, B.H.P./I.H.P.
2,008	36·25	9·13	—	—	—
,,	,,	,,	846	92 6	25·2%
,,	,,	,,	821	90	,,
,,	,,	,,	821	90	,,
,,	,,	,,	813	89	,,
,,	,,	,,	813	89	,,
,,	,,	,,	846	92 6	,,
,,	,,	,,	831	91	,,
,,	,,	,,	831	91	,,

TWELVE-INCH CENTRIFUGAL MOTOR PUMP.

Type: 12in. centrifugal pump, driven direct by a 600-volt continuous-current motor, separately excited at 100 volts; speed, 400 per minute. Suction, 8ft.; delivery, 7ft.; total head, 15ft. Capacity: 2,300 gallons per minute. Gallons per minute delivered: 2 274 25. Watts, exciting: 1,000. Watts, armature: 15,660. E.H.P. absorbed: 22·33. B.H.P.: 10·34. Pounds steam per hour: total, 499; per B.H.P., 48·26. Efficiency, B.H.P./E.H.P.: 46·3 per cent.

MECHANICAL STOKER DRIVING.

A chain and bucket elevator, a worm conveyor, and the mechanical stokers of seven Lancashire boilers, are driven by a non-condensing vertical engine through a leather belt and one pair of spur wheels, the speed reduction being in the ratio of 12·5 to 1 of the stoker shaft. Speed per minute, 200; engine running light, 0·60 i.h.p.; engine and shafting only, 2·72 i.h.p.; engine and shafting and conveyor, 3·28 i.h.p.; engine, shafting, conveyor, and seven pairs of stokers, 4·67 i.h p.

It therefore appears that the power absorbed by the sundry parts of the plant is as follows: Speed per minute, 200; engine running light, 0·6 i.h.p. Speed per minute, 16; shafting running light, 2·12 i.h.p.; elevator and worm loaded, 0·56 i.h.p.; seven stokers (14 fires, all plungers, and firebars working), 1·40 i.h.p.

NOTE.—Steam consumption trials could not be made owing to the new electrically-driven stoker plant not being out of the contractors' hands.

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DISCUSSION.

Mr. W. GEIPEL agreed with the author as to the great waste occurring in steam-driven feed pumps. He gave an instance of a plant in which for every 7cwt. of coal used 1cwt. was required for the auxiliary plant. He asked if Mr. Proctor had considered the efficiency of injectors for feeding purposes in comparison with the electrically-driven pumps.

Prof. S. P. THOMPSON said that in the use of motors for driving auxiliary plants we were much behind Canada and the United States.

Mr. A. H. GIBBINGS asked how the bricks were arranged to protect the cables. As regards the separation of the oil out of the condensed water, this became serious if a temperature of over 180deg. F. is used, as the iron of the boiler is attacked by the decomposed oil.

Mr. F. G. BAILEY explained that at 200deg. F. almost all oil were decomposed, and then formed a compound which was a good insulator of heat. Great losses were thus caused apart from the corrosion of the iron.

Mr. W. H. PREECE said that great credit was due to Mr. Proctor for the success of the Bristol electricity works, as during the past five years there had not been one case of complete breakdown.

Mr. PROCTOR, in reply, said he did not consider injectors suitable for electric lighting stations, as a constant boiler feed was required, and the feed from an injector could not be regulated to the load on the boiler. The bricks were laid on the top of the cable so as to warn workmen, when they were excavating near the cable, that they were approaching the mains.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE III.

(Continued from page 341.)

The two temperatures given in the table—viz., that at which the respective material softens and that at which it becomes pliable, have merely a relative value, and only hold good for the particular method of testing here employed. The softening temperature is determined as follows: A thin plate of the guttapercha to be tested is placed in a large shallow water bath, which is slowly heated over a gas-burner. A rather long lever is supported at one end by a pivot, and carries a 1lb. weight at the other. Half-way along the under side of the lever is fixed a vertical stud of 3mm. diameter, and under this stud the guttapercha plate is placed from time to time to see whether any permanent impression is produced. As soon as this is the case, the temperature of the surrounding water is read off and recorded as that at which the material "commences to soften." The temperature at which the material "becomes pliable" is obtained in a somewhat similar way to that which I showed you a little while ago. A strip of the material to be tested, about 70mm. long, 25mm. wide, and 2mm. thick, is held vertically in a tall water bath, the upper end is provided with a clip, and to this a thin cord is fixed, which passes over a pulley and carries a ½oz. weight at the other end. A definite pull being thus exerted on the strip, the temperature is observed at which this pull is just sufficient to tear it asunder. The "time of hardening" is that taken by the material to become sufficiently rigid to resist the pressure of the stud in the apparatus used for the softening temperature; but filled with water kept exactly at 75deg. F., the material, which is in the form of a 2mm. plate, having previously been heated to the temperature at which it becomes pliable. The time of hardening is, as the table shows, greatly affected by the amount of resin in the material, and I have found that its variation with the percentage of resin can, with certain restrictions, be represented by a continuous curve.

APPLICATION OF GUTTAPERCHA TO VARIOUS PURPOSES.

At the beginning of this lecture I mentioned that Charles Hancock was the pioneer of the practical application of guttapercha, and I will now add that his first patent (No. 10,185, O.L.) was dated May 15, 1844, and entitled "Certain improvements in cork and other stoppers and a new composition or substance which may be used as a substitute for, and in preference to, cork, and a method or methods of manufacturing the said new composition or substance into bungs, stoppers, and other useful articles." Hancock proposes to mix guttapercha in the plastic state, or a combination of guttapercha and caoutchouc, with powdered cork, or with wood sawdust, in a masticator, and to press the composition into moulds for further use. He also proposes to use a solution of guttapercha or caoutchouc, or a mixture of glue and treacle, for the same purpose.

The editor of the *Mechanics' Magazine*, Mr. J. C. Robertson, evidently took a great interest in the matter, and regularly published abstracts of the various "Guttapercha Patents" in his journal, giving them consecutive numbers; but curiously enough he called Brooman's specification (No. 10,550* O.L.) of March 11, 1845, "No. 1," and described it as a master patent, Hancock's prior patent being entirely ignored. The explanation of this appears to be that Charles Hancock himself was the inventor of the subject matter of Brooman's specification, and his first patent was evidently considered a weak one. It was, therefore, to Hancock's own interest that nothing further should be said about it, after he had obtained the second and stronger patent through Mr. Brooman. In this connection it is perhaps of interest to mention that the last-named gentleman and Mr. Robertson had the same business address, and were, I believe, related to each other. We may therefore conclude that the omission of Hancock's original patent was made with his consent, and not against his wish, as one might be inclined to think. On June 6, 1851, Mr. Hancock filed a disclaimer to his first patent, in which all parts referring to the use of caoutchouc alone, of glue and treacle, and of guttapercha in its native fluid state in combination with powdered cork or with wood sawdust, were disclaimed.

Brooman's patent (No. 10,550*), the first of the guttapercha patents enumerated in the *Mechanics' Magazine*, is really a most comprehensive one, in spite of its modest title, according to which it purports to deal only with the application of guttapercha to the manufacture of artificial fuel, mastics, and cements. We became acquainted with the machines for washing and kneading guttapercha described in this patent in our last lecture, and I should now like to refer to some of the other proposals made therein. Brooman suggests the use of guttapercha for artificial fuel, mixed with small coal and coal-tar pitch. I need hardly tell you that such an application is entirely out of the question at the present time, but the resin extracted from the inferior kinds of this substance by the hardening process is, I believe, used for some such purpose. I myself made a number of experiments in that direction with this resin years ago, but failed to obtain really satisfactory results, on account of its low melting point and the smoke it produced during combustion.

Brooman further proposes to mix guttapercha with various other ingredients for different purposes—for instance, with caoutchouc, as was already suggested in Hancock's first patent. I have such mixtures here which I prepared fully 20 years ago, and you see they are still in a very fair state of preservation. Mixtures of this kind may be useful for special purposes, where a somewhat greater degree of elasticity is required than that possessed by guttapercha alone. Other circumstances recommended by Brooman for admixture with guttapercha are sulphur, pigments, French chalk, emery, and sand; French chalk rendering it smooth and emery making it abrasive, as these specimens show which I have brought with me. Brooman proposes to use some of the mixtures for making picture frames, cornices, mouldings, and other architectural ornaments, for panels, mosaics, buttons, studs, and a variety of other things. He also proposes the use of guttapercha for parts of machinery, such as valves, belting, etc., and describes an arrangement for applying it in the plastic state to cotton wool and other textile materials to render them waterproof, and suitable for table-covers, floorcloths, tarpaulins, and so on.

Many of these articles are exhibited here to-night, and I should like to call your attention particularly to the beautiful exhibits from the Guttapercha Company in the centre of the table, where you will see some exceedingly fine work in guttapercha. Most of these exhibits are very old, some of them having been manufactured as early as 1846, and being, therefore, over 50 years old; these were shown at the Great Exhibition of 1851. There are also some interesting documents here, which refer to the early importation of guttapercha. Other objects made for the 1851 exhibition by the Guttapercha Company are lent by the Kew authorities, and you will no doubt remember the collection of articles made by natives, which was shown in the first lecture (*vide* Fig. 13, *ante*).

Messrs. R. and J. Dick, of Glasgow, exhibit specimens of their present manufactures, such as boot soles, horse pads, pump buckets, hydraulic rings, driving belts, acid bottles, etc.

Another patent (No. 10,582*) was taken out by Brooman about a fortnight later—viz., on March 27, 1845—which is probably also to be ascribed to Charles Hancock, although I cannot with certainty say so. Its title is: "A thread made from a substance not hitherto applied to that purpose, and also the application of it to the manufacture of piece goods, ribbons, paper, and other articles." In this specification a machine is described for cutting sheets into threads by rotating circular knives, and for pressing guttapercha through a die-box, allowing the threads to harden in cold water. I have here some thin guttapercha cord, prepared about seven years ago, but in

* Cantor Lectures delivered before the Society of Arts.

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a different way—viz., by stretching—and you observe its excellent state of preservation.

On May 20, 1845, Christopher Nickels, of London, took out a patent (No. 10,673*) for "Improvements in the binding of books, etc." He proposed to use a solution of guttapercha in place of paste or glue, and also as a "vehicle for colours" in colouring the edges of books. He further proposed the use of sheets of guttapercha either alone or mixed with various substances, as a suitable binding, in place of leather and cardboard.

Charles Keene, also of London, followed with a patent (No. 10,692*) taken out May 29, 1845, and entitled "Improvements in boots, shoes, gaiters, overalls, and other like articles of apparel." His idea was to render the articles referred to waterproof, either by coating them with a solution of guttapercha, or by guttapercha applied in the plastic state, or by the introduction of thin layers of the material, as, for instance, between the outer and inner soles of boots. He also proposed to manufacture the above articles of guttapercha mixed with various other substances—*e.g.*, leather, hair, cotton wool, caoutchouc. The various parts of articles so made could be united by passing a hot iron over the joint, thus obviating the necessity of sewing.

The next patent (No. 10,825*) was taken out by Henry Bewley on Sept. 4, 1845, for "Certain improvements in flexible syringes, tubes, bottles, hose, and other like vehicles and vessels." His proposal was to press guttapercha in the plastic state into moulds or to apply a solution of guttapercha in successive thin coats to a mould until the required thickness was obtained. He also proposed to make tubes by forcing plastic guttapercha over a mandril and through a circular die.

Specimens of tubing and a collection of models of various guttapercha articles are exhibited by Messrs. H. Rost and Co., of Hamburg and Harburg.

The patents just mentioned were the first six referring to guttapercha, and were all taken out before the end of 1845. In the course of the next three years Charles Hancock obtained six more patents in connection with guttapercha—viz., Nos. 11,032 and 11,208 in 1846, Nos. 11,575 and 11,874 in 1847, and Nos. 12,153 and 12,223 in 1848. Of these I mentioned three in my last lecture. Patents were also granted to Thomas Hancock and another in 1846 (No. 11,455) and in 1848 (No. 12,007); also to Thomas Forster in 1847 (No. 11,917); and to William Henry Barlow and Thomas Forster in 1848 (No. 12,136); to Anthony Lorimer in 1848 (No. 12,206); and to John Lewis Ricardo in 1848 (No. 12,262). These make a total of 18 patents taken out prior to 1849.

Perhaps the earliest practical use to which guttapercha was put was that for surgical appliances, Drs. Montgomerie and Oxley warmly recommending it for bandages, splints, receptacles for vaccine virus, etc. On his first furlough from India, Dr. Montgomerie brought the new substance to the notice of the principal makers of surgical instruments in London, but they all declined to have anything to do with it. He also suggested the use of guttapercha for stopping decayed teeth, and for this purpose it is still largely employed.

Guttapercha is sometimes used for ear-trumpets and also for the handles of surgical instruments, such as saws, knives, etc., as it affords a firm grip, and is preferable to wood for antiseptic reasons; but I am informed that it has to be hardened by vulcanisation for such purposes. It is employed by the medical profession in the form of very thin tissue, under the name of guttapercha lamellata; in the form of sticks after special purification, as guttapercha depurata, and lastly in the form of a 10 per cent. solution in chloroform, under the name of traumaticin, as a substitute for collodion. For chemical purposes, it is used in the form of tubes, pumps, syringes, funnels, bottles, etc., and I have some specimens of the latter, containing hydrofluoric acid, on the table. For mechanical purposes, it is used as rings and cups for pumps, and hydraulic presses, driving bands, etc. For the latter purpose balata is also largely used, interposed between canvas; such belts can be joined by means of a solution of balata or guttapercha in carbon disulphide as I have it here in this bottle.

Another application of guttapercha is one which was shown in this very room in 1845 by the secretary, Mr. Whishaw—viz., that for taking impressions from medals. I have prepared such impressions, which are in this small case, from three medals—namely, the gold medal awarded to Dr. Montgomerie by the Society of Arts in 1845; the Queen's jubilee medal of this year; and the Siemens and Halske jubilee medal also of this year. In the same case you observe the galvano-plastic copper reproductions of the medals. This is a small self-contained apparatus here on the table, in which the depositing process is going on at the present moment. Before starting the current it is necessary to rub the surface of the mould well with plumbago to make it conduct electrically.

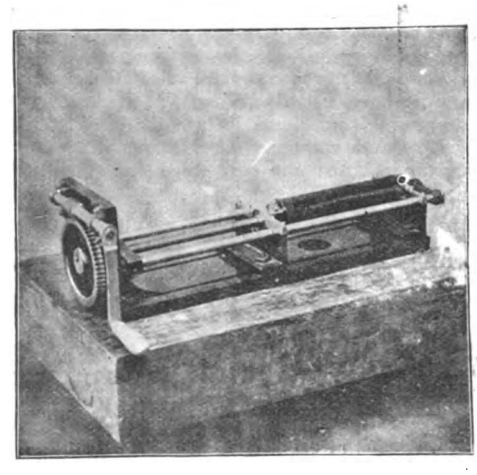

FIG. 50.—Siemens Screw Press (1847).

There are also some beautiful guttapercha medals here, exhibited by the Gutta Percha Company, and some very old ones from the Kew Museum. More ambitious impressions than those from medals are such as are taken from the interior of guns for inspection, and I have to thank the Director-General of Ordnance Factories and Commander Chevallier, R.N., of the Royal Arsenal, Woolwich, for the interesting specimens which are exhibited to-night. Here you see some fine impressions in guttapercha, which show the action of cordite and powder respectively on the steel liners of guns.

For small guns and breechloaders, the impression is taken by covering a long wooden stick with the soft plastic guttapercha, which is passed through the barrel. Wedge-shaped sticks are then driven in at both ends so as to press the guttapercha against the inner wall of the gun tube. Here is a specimen of the stick that is used, and here an impression, which has been made in that way, showing the powder chamber and the rifling. The practice of taking impressions of gun tubes in guttapercha was introduced at the Royal Arsenal in 1856 by a Mr. McKinley; previously wax was used for that purpose.

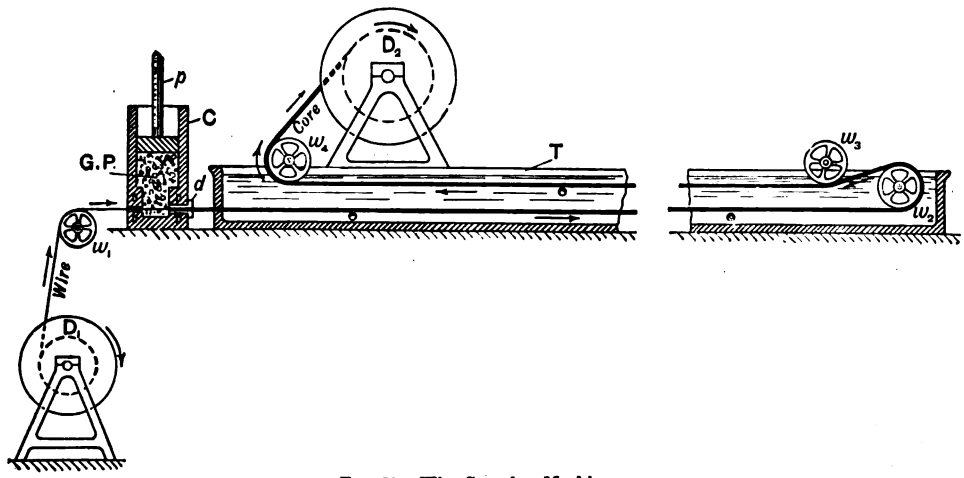

FIG. 51.—Wire-Covering Machine.

The application of guttapercha to the insulation of submarine and subterranean cables, to which I shall now draw your attention, is undoubtedly by far the most important one hitherto made of this substance. I have shown you by an experiment the excellent insulating property of guttapercha, and I have also given you the actual figures for comparing it with that of some other insulators.

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I mentioned that Dr. Werner von Siemens first proposed the use of guttapercha for insulating purposes in 1846, and that in the following year he designed a screw-press for the seamless covering of wires with that material. This little machine is illustrated in Fig. 50; it is now in the Imperial Museum of Posts and Telegraphs at Berlin, where I saw it a year or two ago. Early in 1848 it was used for the manufacture of some wire for a subterranean telegraph line 2½ miles long, from Berlin to Gross Beeren, belonging to the Prussian Government.

Fig. 51 illustrates the principle of the machinery used for covering wires with guttapercha. The wire, usually of copper, is wound on a reel or drum, D_1, and from it passes through the lower part of a cylinder, C, provided with a piston, *p*, which is actuated by means of a screw and nut. There are two cylinders used alternately, so as to provide a continuous supply of guttapercha to the wire. The guttapercha contained in the space between the piston and the bottom of the cylinder is forced through a die, *d*, where it surrounds the wire, which then enters a long trough with cold water, in which it passes to and fro several times, until the guttapercha has become sufficiently hard to admit of the covered wire being wound upon a drum, D_2.

The guttapercha-covered wire is kept immersed in water and tested with a high battery power for electrical insulation at a standard temperature, usually 75deg. F. Its inductive capacity is also tested, and sometimes it is submitted to alternating currents of very high voltage. At Messrs. Siemens Bros. and Co.'s works, for instance, the core used for Atlantic cables is thus tested with over 5,000 volts.

(*To be continued.*)

COST OF POWER STATIONS.

Mr. William O. Webber, in the *Engineering Magazine* for September, 1898, gives some interesting estimates as to the comparative cost of steam and water power stations. He estimates that in 1870 the annual cost, including buildings, machinery, coal, attendance, etc., per horse-power amounted to £5. 1s. 6d. At the present day, using an improved steam-engine, the annual cost is about £3. 2s 3d. The saving in first cost is 18·6 per cent., whilst the cost of attendance, etc., is reduced by 53 per cent. He further works out the cost per horse-power per annum, using a small water-power plant, as about £1. 0s. 3d. In the same magazine Mr. F. E. Cooper gives some interesting photographs, illustrating the construction of the Metropolitan and District Underground Railways, London. A section of Queen Victoria-street is given, showing the existing and proposed tunnels.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

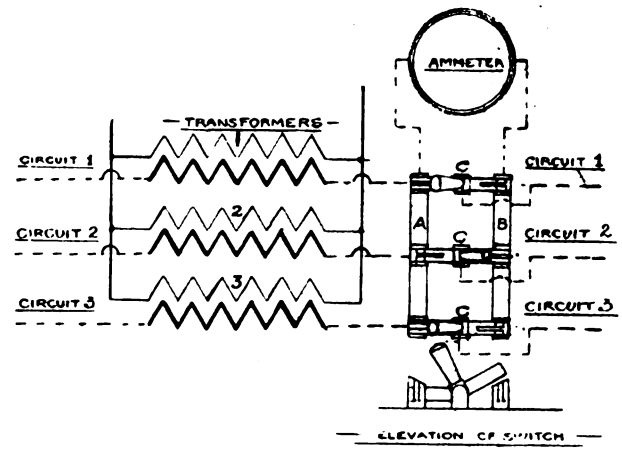
98. Describe, with sketches, the best method of testing the capacity of a cable when laid.—A. BROUGHTON.

99. For separating oil from the feed water when condensers are used, many forms of oil-filters are in the market. Describe, with sketches, that which you consider the most suitable for central-station work.—W. B.

ANSWERS.

Question No. 92.—Three transformers are working in parallel in a sub-station. Describe, with sketches, the connection you would use so that with one ammeter the distribution of load between the three can be ascertained without in any way interrupting the circuits.

Best Answer to No. 92 (*awarded* 10*s.*).—This can be done by using a two-way throw-over switch, which is constructed so that the circuit is completed on one side before the other side is broken. For three circuits three of these switches will be required, which make contact on one side with an omnibus bar, A, to which is joined the three transformers and one pole of the ammeter; on the other side with another omnibus bar, B, to which is joined the other pole of the ammeter. The three circuits are joined to the centre contacts of switches at C respectively. In the sketch the



current in circuit 2 is being taken; the switches for circuits 1 and 3 are on A, and the current passes direct from A to C, C and B being broken; the switch for circuit 2 is on B, so that A to C is broken; the current passing from omnibus bar A, through ammeter to omnibus bar B, and thence through switch to circuit. By this simple arrangement the current in any circuit can be taken independently of the others, or the current in two circuits, or the total current.—W. A. JACKSON.

Answer to No. 92 (*awarded* 5*s.*).—The question is one which has to be overcome in all properly-designed sub-stations, and there is no difficulty in answering it owing to the great variety of switchboards in use doing the same work—namely, to measure whether any transformer is taking up its proper proportion of load without disturbing the circuits. The switchboard shown (Fig. 1), although

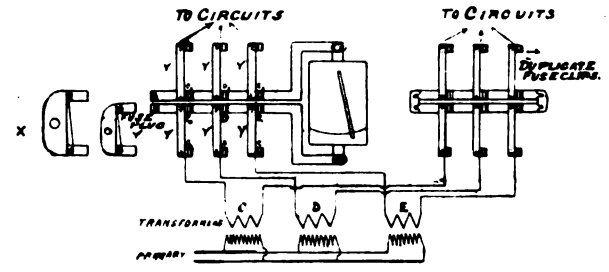


FIG. 1.

showing three circuits, can be added to *ad lib.* This board—one of many—answers the case exactly, and is in use in over a dozen sub-stations to the writer's knowledge. The fuse-plug clips, both on 'bus bars and on terminals, are made in duplicate so as to enable two plugs to be in position at once; the reason for this will be seen shortly. The fuse-plugs are made in two sizes, X and Y. To measure total current going out of sub-station, the board is arranged with only plugs of Y size in position, so that all current from transformers has to pass along 'bus bar B, through ammeter, and along 'bus bar A to circuits. Supposing you want to measure current going out from transformer C, then you insert two plugs of size X alongside plugs, Y, in clips, D_1 and E_1 (the need for duplicate fuse clips is here demonstrated), these two long plugs bridge across from D_1 to D_3 and from E_1 to E_3, now pull out plugs, Y, at D_1 and E_1.

The arrangement now will be similar to the sketch (Fig. 2). It will be seen that current from transformers D and E does not now go through ammeter, although current from transformer C does. You can take your reading and proceed on similar lines for the other transformers. It will be readily seen that for all this switching no circuit is broken, nor is the paralleling arrangement interfered with. The other half of switchboard has two

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boosters, which are joined together at the ends; this is to allow room for the two sets of plugs at the top and bottom, and in switching, as before explained, these plugs are not interfered with. Various other arrangements of connection

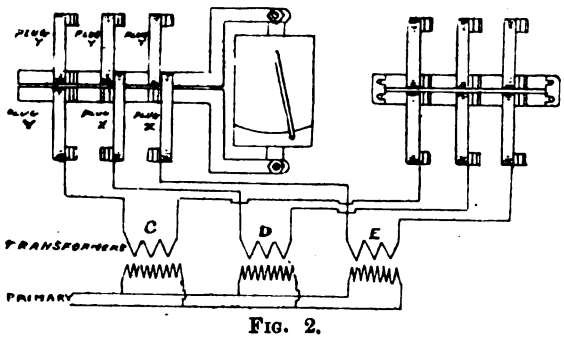
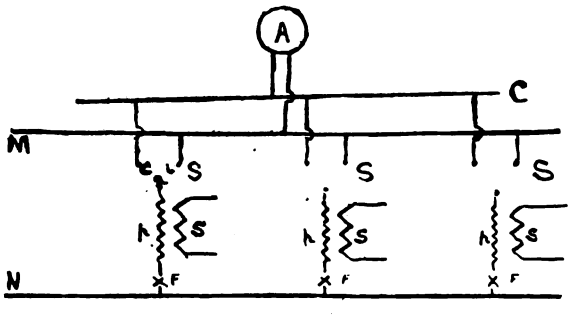


FIG. 2.

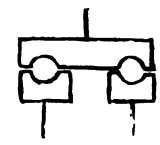
to do the same work will from this become apparent to the reader.—J. E. DONOGHUE.

Answer to No. 92 (*awarded* 5*s.*).—If the sake of cheapness a transformer sub-station is to be fitted up with one circuit ammeter only, a connection must be made for changing the ammeter over to the various circuits. Such apparatus must have the following qualities: (1) safety from shock to operator; (2) reliability and therefore strength and simplicity; (3) cheapness; (4) impossibility of error through carelessness; (5) continuity of supply of current while apparatus is being used; (6) impossibility of damage to mains, instruments, etc., through its use.

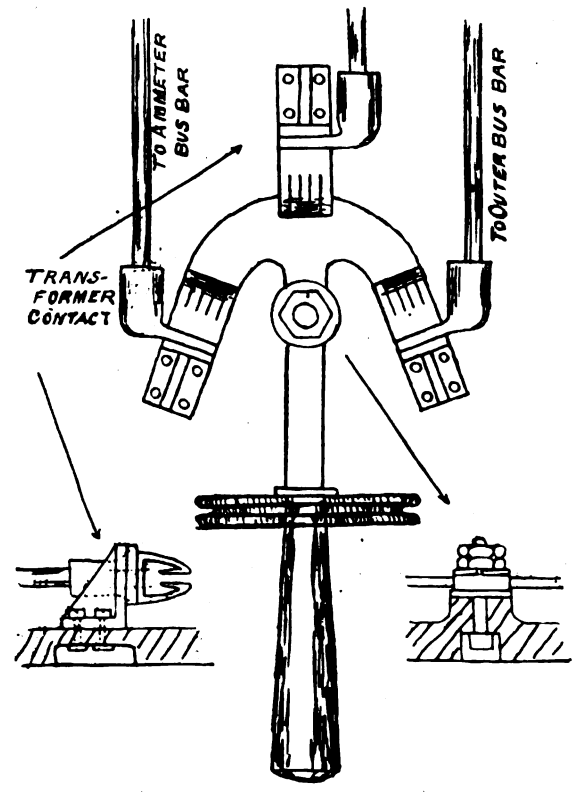
It should be remembered in designing such an apparatus that it may be left for some time without inspection, possibly in a damp atmosphere, and therefore it should not be liable to get clogged or the connections to work loose. Also that gas from leaky mains may accumulate in the sub-station if underground, and a small spark from the apparatus would probably interrupt the supply of current for a short time. A diagram of an arrangement which



is suitable for three transformers working in parallel off the primary leads, M N, and which may be extended to any convenient number of transformers, is given herewith. C is an auxiliary 'bus bar of the same capacity as M N, to which one terminal of the circuit ammeter, A, is connected. The other terminal is connected to the 'bus bar M. Although screw connections are bad for work with alternate currents, owing to their working loose, it is not essential to have sweated connections at A, as the ammeter will not be in use for extended periods. *s s s* are change-over switches for cutting the ammeter in and out. They will be described later. *p s* are the primaries and secondaries of the transformers. Some transformers are fused as supplied by the makers. If not, a fuse should be put at F F F. This is on the assumption that the 'bus bar M—*i.e.*, the outer—is earthed. If this is so, then the change-over apparatus and the ammeter, being on the outer, will not be at a high voltage from earth. Of the three terminals (sweated) on each switch, the primary of the transformer is connected to *a*, the ammeter 'bus bar, C, to *c*, and the main outer bars, M, to *b*, as shown. Suppose *a* and *b* to be connected. The current passes from inner (N) through primary winding (P) directly to outer (M), leaving the ammeter cut out. On changing over to *c*, the current then passes from *p* to C and through A to M. Hence to measure the current in any circuit (primary), it is only necessary to cut the switch over from *b* (its normal position) to *a*. If they are all cut over to this position, we get the total primary current in sub-station in A. By this apparatus the ammeter may be removed for calibration or repairs without interrupting the supply. The switch must be massive, to carry a large current if necessary without heating, and strong to stand sudden and violent handling. It should always cut in the ammeter before cutting out the direct connection. For this reason, a couple of plugs arranged as shown would be dangerous, though simple, as



it leaves too much for a man in a hurry to think about, and he might pull out one plug before plugging in the other circuit. A form of switch suggested is shown in the sketch. The thimble-plate is sweated on to the contact, which is screwed into an angle-piece, the screws being secured by a small lock-nut at the back. The



bottom of the angle-plate is anchored on to a pot base by screws having nuts sulphured into position on the other side. The pot base is common to both angle-pieces and the lever, and a boss is raised on it to support the lever. The chopper is so designed that it makes contact with one side before leaving the opposite contact, thus avoiding any sparks. Owing to the long insulating handle, well away from any live parts, there is no risk of shock. A shield may be added if thought requisite. All connections are sweated in, avoiding tendency to work loose. There is no danger of clogging as the contacts spring easily. Owing to the rubbing contact the surfaces are kept clean. In using the change-over switch it is well to move it over slowly, and make sure that the ammeter needle swings before cutting over entirely to the ammeter circuit, as a connection may possibly be loose.—J. A. SEAGER.

SUNDERLAND.

The following is the report of the borough electrical engineer on electrical tramways to the Tramways Committee of the Sunderland Corporation:

Mr. Chairman and Gentlemen,—At your request I presented a preliminary report on the various systems of electric traction in August, 1897, and I now lay before you a more detailed report, which I think will cover all the salient points, together with a recommendation as to the system I advise you to adopt,

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with reasons for that conclusion. There are the following electrical systems extant—viz.: (1) overhead trolley wire system; (2) conduit system; (3) accumulator system; (4) combined overhead and accumulator system; (5) surface contact system; and I propose to deal with these seriatim.

I. Overhead System.

The points in favour of this system are: (1) it is the cheapest of all mechanical tramway systems to construct; (2) it is the cheapest of all mechanical tramway systems to maintain; (3) it is the cheapest of all mechanical tramway systems in working expenses; (4) its great simplicity; (5) the comparatively small interference with streets; (6) less liability of leakage of electric current than in a conduit system and less chance of "faults"; (7) it is the most efficient mechanical system of propulsion known, and by far the most efficient of electrical systems, the units per car mile being on an average 0·68 to 0·85, as against 1·0 per car mile in a conduit system, and 1·95 per car mile for an accumulator system, and 1·37 to 1·5 in a combined overhead and accumulator system.

It is the cheapest to construct, the cost per mile of single track, including permanent way and line equipment, being £6,505. The difference between this system and the conduit being in the cost of the poles or span wires and overhead lines, as against the culvert in which the conductors are laid in the latter system, necessitating expensive construction, drainage, and alteration to existing pipes and sewers. It is the cheapest in maintenance, that of the line and overhead equipment (excluding cars) being about ½d. per car mile. In the conduit system there is the constant cleaning due to road silt, etc., being deposited in the culvert, in addition to replacement of insulators and repairs to conductor, representing 4-5d. per car mile, and in the accumulator system the replacement of the battery plates (which require constant renewal) representing some 1 3-5d. per car mile. It is the cheapest in working expenses. This is almost a corollary of the preceding paragraph, there being a less charge for repairs and renewals of line equipment, the energy required is less, implying less costs of generation and less generating plant installed, which again implies that there are less capital charges to be met. It is exceedingly simple in construction, the trolley wires being supported from insulators fixed to side or centre bracket poles, or to span wires fixed to side poles on the kerbs, or to "rosettes" fixed on the house fronts. The poles can be made exceedingly ornamental, and can be further utilised for street-lighting. The permanent way is quite of ordinary construction, with the exception that the rails, being used in part as "returns" for the electric current, require to be bonded at each joint. This is effected by means of copper rods rigidly fastened to the two ends of the rails and connecting them.

The objections which have been raised to this system are: (1) unsightliness of the overhead wires; (2) dangers to person from falling wires; (3) dangers to telephone systems for contact between trolley wires and broken telephone wires; (4) corrosion of neighbouring gas and water pipes caused by stray electric currents.

1. It has been generally expressed that the public at first object to this form of construction, but that opposition is entirely removed after the cars begin to run, all then being agreed as to its utility and its freedom from unsightliness. In Hamburg, where there are nearly 70 miles of streets equipped on the overhead system, the wires are barely noticeable, with the exception of a few important crossings. There would be but few of these in Sunderland. I feel sure that each member of the deputation was convinced that the overhead wires and equipment need not be made unsightly, and if we can obtain wayleaves to fix rosettes to the buildings, so as to adopt span wires wherever possible, it will both cheapen the construction and remove any possible objection from an æsthetic point of view. The Hull Tramways Committee, in their report, say "that they gather that in all cases more or less objection is raised to overhead wires when they are first introduced. The objection, however, appears to be largely due to prejudice, and is to a great extent removed by a recognition of the superior facilities afforded by electric traction as compared with horse or steam traction. The sub-committee are assured that the vast majority of the public in the districts served by the electric overhead tramways (which they inspected) recognise the superiority of such tramways over the horse or steam tramways which have been superseded, and that, whatever may have been the feeling respecting the overhead system in the first instance, the general feeling now is in favour of the extension of that system." The Sheffield Tramways Committee state that "the chief objection urged against the overhead system is its appearance; but the deputation, from their own personal observation, have come to the conclusion that very little objection can be taken from an æsthetic point of view. In several places where at first the people had strong objections to the overhead system on account of the alleged unsightliness of the wires, poles, etc., they soon became reconciled to the appearance of the streets, and now have no objection to the apparatus. In some of the places visited the poles were ornamental rather than otherwise. This is not merely the opinion of the deputation, but careful enquiries made from the officials of the various municipalities (who may be said to represent public opinion), as well as from the managers and engineers of the tramways companies, prove this to be the general view." The Glasgow Tramways Committee says in their report: "Would it be proper for the Glasgow Corporation to adopt the overhead system right through the centre of the city or to exclude it from a certain prescribed area, as some other cities—particularly the capitals of Europe—have done? Our observations leads us unhesitatingly to say that the overhead system can be extended over all existing tramway routes in Glasgow without any disadvantage. The one great and practically the only serious objection urged against the overhead wires is the objection to their appearance. We started our investigations more or less in sympathy with this objection; but we are bound to say that what we have now seen has quite removed from our minds any objection to the overhead wires. Where the system is carried out in the most approved manner we found that the wires gave only the very slightest offence to the eye, and that a few hours' familiarity removed the objections entirely." Recently the Blackpool Corporation had occasion to apply to the Board of Trade to change from their existing conduit system to the overhead. Considerable opposition was raised by some of the townspeople on the ground of unsightliness, and on the strength of that opposition the Board of Trade would not then grant the application, and suggested that accumulators should be adopted instead. After a deputation had visited many towns on the Continent, and obtained much information on both systems, they found that they could not under any consideration recommend the accumulator system, and they state in their report that "from the evidence brought before them, and from the result of their investigation, the deputation have unanimously come to the conclusion that the overhead trolley wire system is the only system of traction which can be made both successful and remunerative in Blackpool, and that the overhead wires, if properly suspended, would not appreciably detract from the appearance of the promenade and streets of Blackpool." On the strength of this report the Board of Trade withdrew their opposition, and have since sanctioned the adoption of the overhead trolley wire.

2. The danger of a falling trolley wire is so remote in a well-constructed line that this cannot be urged as any objection to this system. Should the trolley wire break directly contact is made with earth the electric current will be automatically cut off, and in case of the wire coming into contact with any person before it touches the ground the worst result that can happen will be a severe shock and perhaps a slight burn, the pressure or voltage being such that no fatal results could occur. Very few cases of the breaking of a trolley wire have ever been recorded, and Prof. Kennedy, in a report to the Corporation of Douglas, says that with proper construction the danger from this source is nil. Accurate gaugings can be taken periodically to detect any wear or tear on the wire, and with first-class construction this danger is hardly appreciable.

3. More frequent accidents have been caused from the contact of falling telephone wires with the trolley wire, or from the breaking of the guard wires, which are sometimes laid parallel to and above the trolley wire for the purpose of preventing such an accident as the foregoing. Fortunately, in Sunderland the telephone system is about to be laid underground, but in any case it is the general opinion that efficient and reliable means can be adopted to prevent the first-named accident arising; and the second class of accident can be entirely obviated by the use of small wooden strips securely fixed to the upper surface of the trolley wire, thus doing away entirely with these guard wires. This objection can therefore be dealt with satisfactorily.

4. The Board of Trade effectually protects the interests of the gas and water companies by a stringent clause in its regulations, whereby the fall in electrical pressure is limited to a certain figure, which is so low as to prevent any possibility at any time of corrosion being set up in neighbouring pipes, which might be caused by current leakage. The Board makes it imperative that a continuous record of this pressure shall be made at the generating station. The cost of equipping the whole of the sections recommended by the Tramways Committee—that is, of the permanent way, the line equipment and feeder cables, cars and car sheds (but exclusive of extensions of plant which would be required at the electric lighting station, and of the cost of purchase of the present company's undertaking)—will be £218,225. The towns in the United Kingdom which have this system working or under construction, or have decided to adopt the same, are as under: Bristol, Glasgow, Hartlepool, Leeds, Plymouth, Norwich, Dover, Kidderminster, Cardiff, Dublin, Oldham, Southampton, Sheffield, Middlesbrough, Hastings, Wednesbury, Bury, Carlisle, Cork, Llandudno, Stockton, Blackburn, Kingston-on-Hull, Coventry, Burnley, Nottingham, Bradford, Wigan, Blackpool, Walsall, Halifax, Douglas, Southend-on-Sea, Liverpool, Belfast, Dundee, Manchester, St. Helens, and many others. This list will be sufficiently indicative of the rapid strides that the overhead trolley wire system is making in

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the United Kingdom, and of the universal favour which it finds with the several corporations.

II. Conduit System.

There are many systems of electrical conduit tramways all similar in principle, but different in detail; the principal and most apparent difference being in the position of the slot through which communication is made between the car and underground conductors. The principle of construction is an underground conduit of concrete having numerous inspection boxes in communication with it, and in which are one or two conductors; one, if the rails are used as the return of the electrical current, as in the overhead system, and two, if both positive and negative conductors are contained in the conduit, the rails not then being bonded, or in any way made use of for conduction. The advantages of this system are: (1) no wires are within sight, and no poles or span wires are required; (2) no trouble is thereby possible from falling guard wires or trolley wires. The disadvantages are: (1) the excessive cost of construction; (2) greater difficulty in preventing leakage of current; (3) excessive maintenance due to cost of cleaning conduit; (4) length of time during which streets must be closed during construction; (5) excessive stoppage of service arising from any fault to the conductors; (6) troubles arising from the width of the slot at crossings.

The advantages of this system are apparent, and the preface will have indicated the method of construction, and will demonstrate for it the two advantages enumerated.

1. Dealing with the disadvantages of this system, the cost, taken on the same basis as the previous estimate of the overhead system, may be taken at £10,400 per mile, or 1 3-5 times the cost of an overhead system, with the same quality of rails, foundations, and paving; and, compared on the basis of a double track throughout, the disparity would be very much more striking, since a double conduit is necessary in this system, but the same poles, etc., will suffice for the other systems, with the addition of a second trolley wire.

2. Owing to the insulators being placed underground, and, from the construction of any of the conduit systems, it is more difficult to obtain the same high degree of insulation as in the overhead system. This, of course, implies that more energy is required to be generated at the power station with this system than with the other for the same amount of rolling-stock.

3. The cost of cleaning the continuous accumulation of road silt and dirt from the conduit is very high. At Brussels, where, in my opinion, one of the best of the underground systems is installed, this figure is put at £100 per annum per mile of single track. This would represent in the system proposed by the committee a charge of £2,200 per annum, a very serious addition to the working expenses of the line. In addition, there is the trouble of efficiently draining the conduit during heavy rainstorms; and in a town having the contour of Sunderland excessive trouble would be experienced from storm water flooding the dips in the line.

4. The construction of this system necessarily occupies a long time, some of the principal boulevards in Brussels having been disturbed for a period of eight months, principally roads in which it would have been thought that the utmost expedition would have been used. I must, however, say in fairness that this appears to be an unnecessarily long time, though no satisfactory explanation was given of the delay. Two months would seem to be a sufficiently long time, even allowing for removal and replacement of gas and water pipes, etc.

5. In the system examined at Brussels the conductors could not be renewed without breaking open the street. There is a conduit system, however, of recent design, known as the "Simplex," and only applied as yet to a trial length in which the conductor is flexible, and it is claimed can be renewed from the inspection boxes without redisturbance of the streets.

6. Troubles have been recorded at Budapest and at Blackpool from bicycle wheels being caught in the slot, and in the case of a centre slot horses frequently slip on the two rails of which it is formed, and it is complained of all the conduit systems that the ploughs which connect the cars to the conductors are constantly being broken, occasioning frequent stoppages of the car and perhaps of the service.

I think I have shown sufficiently that the financial and working disadvantages of the conduit system by far outweigh its advantages, or the disadvantages of the overhead system, and I can see no reason whatever which can induce the Corporation to adopt it in this borough.

III. Accumulator System.

The accumulator system represents a third method of electric traction. There is no doubt that if only the disadvantages attendant upon this system could be overcome, it would be in every way the best, because no different construction from that of an ordinary horse tramway (excepting heavier rails and road bed) are necessary, and the energy required to propel the cars is contained in them. Unfortunately, there are two things which must always make this system more expensive than the other two, however perfected accumulators may be in the future, and these are: (*a*) the extra weight of the cells carried requiring more energy per car for propulsion, and (*b*) the loss of energy which must always obtain in the chemical change which takes place in the accumulators, and which at the present moment cannot be put at less than 35 per cent. In any case accumulator traction cannot be wisely adopted at the present day. The overhead would be the cheapest to adapt to an accumulator system in the future, if such improvement should be made which might render this type of traction commercially possible.

The advantages of this system are: (1) no overhead construction nor underground conduit is required; (2) energy for the propulsion of the car is contained in it. The disadvantages are: (1) the greater weight of the cars; (2) excessive cost of maintenance of the accumulator plates; (3) greater amount of energy required to drive the heavier car; (4) loss of efficiency in charging the cells; (5) occasional troubles from the fumes and spilling of acid; (6) occasional fires caused by short-circuiting of the cells.

I have already dealt with the advantages which this system would offer if perfected; unfortunately, this is as yet very far from realisation, and have also dealt with some of the disadvantages, which do not therefore require further comment. In Berlin the extra weight which the cells add to the car is from three to four tons. A motorcar, therefore, ordinarily weighing 7½ tons would weigh 10½ to 11½ tons. The cost of upkeep in Berlin is given at 1·15d. per car mile, and the life of the plates in the cells was found to be only two years. No doubt there are some types of accumulators which would have a longer life than this, but in any case the cells will not stand the wear and tear which the starting of the motors and tramway working generally demand. I have myself had some practical experience with accumulator traction on street tramways, and that experience showed that the depreciation of the cells and the excessive cost of maintenance (which at the time I was connected with it alone amounted to 5½d. per car mile), added to the extra energy required in charging the cells, render it (certainly at present) out of the question, and more especially on gradients like that of Silksworth-row. I have also had experience of nearly all the types of accumulators extant, and while admitting that great improvements have been and are being made, and that stationary accumulators subjected to steady loads are excellent adjuncts to an electrical station, I am still of opinion that Sunderland will have to wait a very long time indeed for accumulator traction to become commercially successful. The increased working expenses must of necessity react on the fares, and therefore it would be impossible to give the same advantages to the public as can be obtained from the trolley system. As already quoted, the Blackpool Corporation has deliberately decided against this form of traction. It has been tried in Brussels and given up, and in Berlin, on a fairly large scale, where it is being superseded by the overhead system. There is no doubt the present tendency is to centralise the generating plant, and not to carry the source of power on the cars. This system involves an extra of some £370 per car for the cells, and a very large increase in the rolling-stock reserve to insure that some cars may be standing whilst the cells are being charged, and, moreover, frequent charging is absolutely necessary, involving certain delays in the service of the cars. It must also be pointed out that owing to the inefficiency of the cells (about 65 per cent. energy efficiency) there would be required either a greater amount of plant installed at the station to generate the extra units required, or an increase in the number of accumulators to enable a steady load to be put on the station plant, in which case a smaller amount of power installed might only be necessary.

IV. Combined Overhead and Accumulators.

This system has been adopted in Hanover. The cells, which weigh about 2½ tons, are carried under the seats of the car, and instead of stopping at certain points to be recharged, the cells are charged from the trolley wire on other parts of the line during the run, and discharge when running through the centre of the city, where the authorities have not yet permitted the erection of the trolley system. It is stated that the only reason for the adoption of this combined system was that, as soon as the authorities had become used to the trolley wires, and satisfied as to their unobjectionableness, they would permit their extension throughout the city. The cost of working, while not so high as in the accumulator system alone, is yet very much increased over the trolley wire, and there seems to be no reason at all which would warrant the Corporation in adopting this combined system, which is a makeshift at the best.

V. Surface Contact System.

There remains yet another class of electrical traction, but which may be dismissed in a few words. Steel knobs are provided between the rails, standing some ⅜in. above the roadway and some five yards apart. These knobs are conducted to main conductors, not directly, but indirectly, through the medium of electromagnetic switches, actuated by a passing car, and thus temporarily charging the knobs with current from the main cables, the current not remaining permanently connected to the knobs. There are some serious objections to this system—

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viz. (1) liability of magnetic switches to become deranged and a dangerous pressure therefore left on the knobs, also causing excessive leakage of current; (2) objectionable nature of the knobs themselves, standing up in the street and endangering traffic; (3) excessive maintenance of innumerable and delicate switches; (4) heavy capital outlay. This system offers no advantages over the conduit system, in my opinion, and there are many practically insuperable difficulties.

RECOMMENDATION.

I therefore strongly recommend the adoption of the overhead trolley wire system, on the ground that it is the cheapest in construction and working expenses, and affords the best facilities to the public and ratepayer both as regards minimum fares and quick and reliable service. A certain amount of opposition is entirely removed as soon as the increased advantages of this system are brought home to the public. The Corporation have their own electric lighting station, and it must be borne in mind that the same station, with certain additions of plant, will serve both for lighting and traction, reducing the costs of management and wages, and materially helping in the reduction of the general engineering costs of both concerns, and the combination of the two systems will materially increase the prosperity of not only the tramways scheme, but also the electric lighting undertaking.

JOHN F. C. SNELL, Borough Electrical Engineer.

CHELTENHAM ELECTRICITY WORKS.

The accounts of the Cheltenham electricity works made up to March 31, 1898, have just been issued. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.	£	s.	d.	£	s.	d.
Generation of Electricity.						
Coal and other fuel	£704	7	3			
Oil, waste, stores, etc.	172	10	10			
Salaries and wages	828	18	5			
Repairs and maintenance—buildings	2	5	6			
Ditto, machinery	96	15	8			
Carbons and miscellaneous	12	15	2			
				1,817	12	10
Distribution of Electricity.						
Salaries and wages	71	2	7			
Repairs and maintenance—mains and services	9	11	8			
Ditto, house connections	70	9	8			
Ditto, sub-stations	11	0	3			
				162	4	2
Public Lamps.						
Salaries and wages	236	7	0			
Carbons, renewals, etc.	89	7	1			
				325	14	1
Rent, Rates, and Taxes.						
Rents	22	10	0			
Rates and taxes	70	0	0			
				92	10	0
Management Expenses.						
Salaries and wages—engineer	114	19	6			
Ditto, clerks	83	1	6			
Ditto, collector	10	0	0			
Stationery and printing	67	13	4			
General charges	50	4	7			
				325	18	11
Special charges—insurances				24	1	4
				2,748	1	4
Less goods sold				30	11	5
				2,717	9	11
Amount carried to net revenue account				1,262	1	5
				£3,979	11	4

Cr.	£	s.	d.
Electric energy at 6d. per unit, £2,830. 6s. 10d.; less cash discounts, £132. 18s.	2,697	8	10
Electric energy at 5d. per unit, £186. 1s. 11d.; less cash discounts, £9. 6s. 2d.	176	15	9
Electric energy at 4d. per unit, £75. 15s. 8d.; less cash discounts, £3. 15s. 10d.	71	19	10
Electric energy at 3d. per unit	53	4	9
Electric energy sold by contract, £71. 19s. 2d.; less cash discounts, £1. 0s. 5d.	70	18	9
	3,070	7	11
Less rebates	203	1	7
	2,867	6	4
Public lighting	1,110	15	0
Meter rents	1	10	0
	£3,979	11	4

GENERAL BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	47,485	0	0
Sundry creditors—capital account, £6,396. 19s. 3d.; revenue account, £462. 5s. 11d.	6,859	5	2
Interest on debentures	299	16	7
Sinking fund provision account	852	11	7
Cash due to treasurer—capital account £2,002. 11s. 2d.; revenue account, £3,859. 8s. 2d.	5,861	19	4
Amount of sinking fund	2,012	0	3
	£63,370	12	11

Assets.	£	s.	d.
Capital account—amount expended for works	55,690	11	6
Stores in hand March 31, 1898—coal, £15. 1s. 10d.; oil, waste, etc., £42. 10s. 10d.; carbons and general, £45. 19s. 9d.	103	12	5
Sundry debtors for electric energy to March 31, 1898	935	4	2
Other debtors—capital account: goods sold, etc., £193. 18s. 11d.; revenue account: goods sold, etc., £5. 7s. 6d.	199	6	5
Net revenue account—balance at debit thereof	4,367	15	7
Electrical engineer's advance account	62	2	7
Sinking fund investments, £1,990; borough treasurer cash at bank), £22. 0s 3d.	2,012	0	3
	£63,370	12	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.	344,010
Quantity used in public arc lamps	107,898
Quantity sold to private consumers	140,618
Quantity used at works	16,843
Quantity used at central offices, stores, etc.	16,540
Quantity unaccounted for	62,111
Number of public arc lamps	68
Number of private consumers	246
Number of 8-c.p. lamps connected	14,900
Maximum rate of supply during year (kilowatts)	267

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The ninth annual general meeting of this Company was held on Monday last at the Cannon-street Hotel, E.C.

Mr. J. B. Braithwaite, who presided, said he proposed first to deal with the most interesting feature in the balance-sheet—the profit and loss account. The gross trading profit was £9,768 more than last year, whilst the net trading profit showed an increase of £7,976 on last year. But as £1,847 more had been spent on maintenance of plant and buildings than last year, the position was that they had been able to maintain the whole of the gross profits as net. This showed that the expenses incurred on extra buildings and works at Loughborough had been fully justified, as they had been able to earn £10,000 additional gross profit with no additional increase of administrative expenditure. The directors proposed, in view of this prosperity, only to waive one-quarter of their fees, and not one-half as hitherto. The total general charges came to £11,276, as against £11,970 last year, a reduction of £700. There had been no exceptional outlay on plant or machinery, but the directors had followed the policy of keeping everything in the highest state of efficiency, and many machines and worked-out tools had been replaced. Although they had spent £21,500 on the enlargement of the works at Loughborough, the actual amount charged was £17,569. 4s. 5d., and this was accounted for by the sum realised by the sale of the Boroughwood works being placed to credit of the maintenance account. Stock showed a slight reduction of £1,380 from last year. They had sold the whole of the output of the year and £1,500 more, which showed they were not making stock which did not find a ready market. Compared with last year, their position was that they had £25,191 in cash, and, after paying the dividends of last year, they had spent £17,569 in additions to the works. So that, in spite of having paid away nearly £50,000 in hard cash, they were still £25,000 better than at this time last year. The capital had been reduced by the redemption of the second debenture stock to the extent of £26,770, leaving the amount outstanding £50,000. The profit-share to be paid to employés amounted to £11 more than last year, and with the approval of the shareholders £1,000 would be placed to account of the workmen's compensation claims. He desired it to be understood that the whole of the sum available for dividend was not earned in the business, a proportion of it being from dividends on investments, which had been considerably reduced through sales to provide for the cost of the works additions at Loughborough. As the best answer to the query as to the wisdom of this expenditure, he pointed out that so soon as an addition had been completed it was filled with machinery and fully occupied with orders as fast as they could be turned out. The car shop was not only full of work, but the directors were seriously considering the necessity of doubling the size again to meet the demand. Owing to the increased demand for electric traction the directors had already begun building workshops and taking orders for electric motors. These were now required in

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very large numbers, and the directors had been compelled to put up a shop which would turn them out at the rate of 1,000 a year. They had already spent on additions to the works £25,000, and were now about to erect an additional car shop, which would occasion further expenditure on the capital account, but they had plenty of resources in hand to meet it. With regard to the great lock-out in the engineering trade, although approached by the Employers' Federation, they had refused to join that body, and their men had remained at work. The men had done exceedingly well during the past year, and he believed that even better results would follow in the ensuing year. With regard to orders which had been executed during the past year, there was nothing very special. As usual, they had been drawn from a great variety of sources. One of the reasons of the Company's success was the fact that they were not dependent on any one particular class of manufacture. Sometimes one particular class of orders headed the list, and in another year another class. The run last year had specially been on rolling-stock. In addition to orders for as many tramcars and more than they could undertake to build, they had orders for a considerable amount of rolling-stock for the Central London Railway, which they had still in hand at the works, and they had equipped during the past year their first complete electric tramway. Electric traction had made comparatively slow progress in England, people being naturally cautious, and although they would give them orders for the cars, they often specified that American-made motors must be supplied, because they saw these were a success in America. But this year they had gone further, and had entrusted them with an order to equip a tramway completely with British-made plant, and they had supplied their first electric tramway with English-made engines, generators, cars, and English-made motors under the cars. The line was the Kidderminster-Stourport Tramway, and it had proved a great success. He believed British workmen could make electric motors as well as, if not better than, others. Just to illustrate the variety of their manufactures during the past year the orders which had been executed in the factory expressed in percentages were made up as follows: Rolling-stock headed the list, and represented 33 per cent. of the orders during the year. Dynamos came next with 18 per cent., transformers ran them close with 17 per cent., while engines were 13 per cent., locomotives 8 per cent., and the balance of 11 per cent. was made up of miscellaneous items for smaller articles which were not worth mentioning by themselves. Perhaps the shareholders would look a little askance at a profit-sharing scheme which gave the employés nearly 1 per cent. on the ordinary share capital, but he believed that the unanimous vote given by the shareholders when the scheme was started would, if necessary, be repeated. The profit-sharing scheme now embraced about 200 workmen, but they hoped the time would come when every workman who had been in their employ a year or two should share in it.

The report was adopted, and a dividend of 6 per cent. on the preference shares and 3 per cent. on the ordinary was agreed to.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Plymouth.—Tenders are invited for the supply of an enclosed (iron-clad) continuous-current motor, particulars of which appear in our advertisement columns. Tenders by Oct. 6.

Salford.—The Electric Light Committee are prepared to receive tenders for lead-covered high-tension cable. Specifications, etc., may be obtained from the Electrical Engineer, Walness-road, Broughton, Salford. Tenders by 23rd inst.

Thrybergh (Rotherham).—Tenders are required for lighting Thrybergh Colliery by electricity. For particulars and permission to inspect apply to Mr. W. Hargreaves, agent, Rothwell Haigh, Leeds. Tenders to be addressed to Messrs. J. and J. Charlesworth, Limited, colliery proprietors, Milnes House, Wakefield. by Sept. 26.

Hull.—The Corporation invite tenders for the erection of a power station in Osborne-street. Forms of tender and other particulars may be obtained at the office of Mr. A. E. White, city engineer, Town Hall, Hull. Tenders, endorsed "Tender for Power Station," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office before noon on Sept. 21.

Aberdeen.—The Corporation invite tenders for the supply for one year of electricity supply meters, house fuse boxes and service cables. Booklet of specifications and conditions of contract may be obtained on application to Mr. J. Alex. Bell, city electrical engineer, accompanied by a deposit of 10s., which amount will be refunded on receipt of a bona fide tender for any one of the above classes of goods. Tenders are due by Sept. 17.

Torquay.—The Electricity Committee invite tenders for the supply and delivery of (1) meters, (2) arc lamp carbons, for a period of 12 months from Oct. 1, 1898. Further particulars and form of tender may be obtained from Mr. P. Storey, the borough electrical engineer. Sealed tenders, endorsed "Meters" or "Arc Lamp Carbons," as the case may be, to be sent in to the Town Clerk, Fredk. S. Hex, Esq., Torquay, not later than 2 p.m. on Sept. 19.

Leeds.—The City Council invite tenders for the supply of (a) poles, (b) trolley wire and attachments, in connection with the extension of their electric tramway systems. Tenders must be sent in by noon on Sept. 20. Plans may be seen and forms of tender obtained on payment of a deposit of £5, which will be returned on receipt of a bona fide tender, from the City Engineer, Municipal Buildings, Leeds, or from 5, Victoria-street, Westminster, S.W.

Ashton-under-Lyne.—The Market Committee of the Corporation are prepared to receive tenders for the installation of the necessary wires, fittings, etc., for the electric lighting of the public market. The current will be supplied from the town mains. Specification, etc., can be obtained on application to Mr. John Neal, borough comptroller, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender and specification. Tenders by Oct. 3.

Gloucester.—The Corporation require tenders for new buildings for electricity works. Plans and specification may be seen at the office of Mr. Harry A. Dancey, 26, Clarence-street, Gloucester, between 10 a.m. and 5 p.m. The quantities are being prepared by Mr. Dancey, and may be obtained from him on payment of a charge of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Electricity Works," to be delivered at the Town Clerk's Office, Guildhall, Gloucester, before 11 a.m. on Sept. 19.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Hull.—The Electric Lighting Committee invite tenders for the supply of the following cars, etc.—viz, 45 electric motorcars, 20 trail cars, 2 sprinkler cars, 2 traversing platforms. Specifications and forms of tender may be obtained of Mr. A. E White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Rolling Stock," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 30.

Bexhill.—The Bexhill Urban District Council invite tenders for the following work in connection with their electric lighting station: (Section A) water-tube boilers; (B) steam dynamos and balancer; (C) switchboards; (D) storage battery; (E) underground cables and pipes, arc lamps and posts. Copies of the specifications, with form of tender and general conditions, can be obtained at the office of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster, S.W. Applications for any or all of above must be accompanied by a cheque for £5. 5s., which will be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting, Tender for Section —," must be delivered at the offices of Mr. Fred. A. Langham, clerk, Council Office, Bexhill, by 10 a.m. on Sept. 28.

Hull.—The Corporation are prepared to receive tenders for the steel roofs, etc., for the extension of the electric light station, Sculcoates-lane. The work includes seven plain trusses about 50ft. span, and seven about 40ft. span, and the total weight of steel and iron work is about 26 tons. Specifications and forms of tender may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. A limited number of blue prints of the contract plan will be furnished on payment of 5s., not returnable, but the Corporation do not undertake to supply all applicants. Remittances to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Roof Extension," are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 29.

Hull.—The Corporation invite tenders from firms who are able to give early delivery for steel roofs and sundry iron and steel work for the tramway power station. The work includes nine plain trusses, 44ft. span, and nine 63ft. span, and the former will have to be delivered on the works within nine weeks, and erected within twelve weeks from the day of notice to commence. Specifications and forms of tender may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. A limited number of blue prints of contract plan will be furnished on payment of 5s., not returnable, but the Corporation do not undertake to supply all applicants. Remittances to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Roofs, etc.," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 21.

Rathmines.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pumps, ejector, economiser, electric motor; (B) engine-house plant—high-speed steam dynamos and accessories; (C) condensing plant and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) underground work—trenching, cables, etc.; (H) posts for incandescent street-lighting; (I) lanterns and incandescent lamps for same; (J) meters. Tenderers are at liberty to tender for any section, but not part of a section, and applicants must state for which section they wish to tender, in order that the

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requisite drawings may be forwarded. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, 64, Victoria-street, London, S.W., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders, sealed and marked "Tender for Electricity Works," must be addressed to Mr. F. P. Fawcett, secretary to the Township Commissioners, at the Town Hall, Rathmines, co. Dublin, and be delivered on or before Oct. 5.

RESULTS OF TENDERS.

Halifax.—The Corporation have accepted the tender of the Leeds Steelworks, at £6. 10s. per ton, for the supply of 1,000 tons of steel rails and 47 tons of fishplates.

Halifax.—The tender of Messrs. Macartney, McElvoy, and Co., London, at £4,718. 8s., for the supply of poles and brackets in connection with the electrical tramways, has been recommended for acceptance.

Hampstead.—Messrs. H. G. Ellis and Co., Limited, electrical engineers, have secured the contract for the electric installation and fitting of the Hampstead Workhouse, which has lately undergone considerable extension in the shape of a new wing, laundry, etc.

Blackpool.—The Corporation have accepted the tender of Messrs. S. and J. Whitehead, Elizabeth-street, for the construction of foundations for condensers at their electricity works; also of Messrs. Lowdon Bros., for the combined electric lighting and tramway traction poste; and the tender of the British Insulated Wire Company, Limited, of Nov. 20, 1897, for tramway cables in connection with the overhead trolley system.

Cardiff.—The following tenders for engines have been received:

Parsons and Co., Newcastle (turbine)	£2,425
W. H. Allen and Son, Bedford (own make)	2,760
Brush Electrical Engineering Company, Loughborough (Universal)	3,126
Siemens Bros. and Co., London (Belliss) (accepted)	3,130
Easton, Anderson, and Goolden, Erith (Willans)	3,179
Ferranti, Limited, Hollinwood (own make)	3,250
General Electric Company, London (Willans)	3,310
Mather and Platt, Manchester (Belliss)	3,332
Siemens Bros., London (Willans)	3,350
Electric Construction Company, Wolverhampton (Belliss)	3,450
Mather and Platt, Manchester (Willans)	3,559
J. Fowler and Co. (Willans)	3,624
Electric Construction Company (Willans)	3,685
Ferranti, Limited, Hollinwood (Willans)	3,800
Ferranti, Limited, Hollinwood (Belliss)	3,800

BUSINESS NOTES.

Blackpool.—After discussion the tram manager's salary has been raised by £26 per annum.

Barnsley.—A committee of the Guardians is shortly to meet to consider the electric light question.

Sunderland.—Various minor extensions of the electric lighting system have been decided upon by the Corporation.

Bradford.—The Gas and Electricity Supply Committee of the Corporation propose to borrow £10,000 for the extension of electricity cables within the city.

Liversedge.—The District Council have had a meeting with a representative of the British Electric Traction Company with reference to the proposed trams.

Dundee.—Motor tramcars are now running. At present there are only three of them, but another is now on order, and ere long it is believed that six will be running.

Removal.—The offices of the Cowper-Coles Galvanising Syndicate, Limited, will be removed on the 29th inst. from 39, Victoria-street, to Grosvenor-mansions, Victoria-street.

Mirfield.—On Wednesday last a statutory meeting of owners and ratepayers at Mirfield approved of opposition to the application of a private company for electrical powers.

Hove Electric Lighting Company, Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum upon the share capital, payable on Oct. 15.

Bude.—This town will probably soon have the electric light. Several inhabitants have decided to form a company with a capital of £1,500, and to raise an equal amount on debentures.

Haslingden.—The Town Council have resolved to apply to the Board of Trade for a provisional order to supply electric energy for public or private purposes in the borough of Haslingden.

Llanelly.—The Borough Council have passed a resolution condemning the Bill promoted by a company who propose to supply electrical energy in wholesale competition with local authorities.

Castleford.—The Council are treating with the Triticine Company as to the terms and conditions upon which they would supply the electric light to the market hall and several public streets.

Brighton.—Mr. W. A. Ducat held an enquiry on the 14th inst. on behalf of the Local Government Board into the proposal of the Brighton Town Council to borrow £56,300 for purposes of electric lighting.

Edinburgh.—The Corporation have agreed to fix the minimum charge for private consumption of electric energy at the rate of £1 per annum.

Valves.—We are informed that the Ludlow Valve Company, of Troy, New York, which has an office in London, has just completed a valve weighing 34,500lb., and 18ft. by 8ft., the diameter being 72in.

Mauritius.—The contract for electric lighting Port Louis, Mauritius, has been placed with the Birmingham Installation Company. The estimate is £75,000. Mr. F. J. Warden-Stevens is the consulting engineer.

Aberdeen.—An application by the Aberdeen Steam Navigation Company for the introduction of the electric light to the Waterloo goods sheds is being considered by the Docks and Pilotage Committee of the Town Council.

Harrogate.—The enquiry with respect to the Harrogate and Knaresborough light railway will take place on Sept. 23. The Town Council have appointed a committee to take steps to oppose the scheme, and prepare evidence for the enquiry.

Bangor.—The plans of the electric light works have been submitted to the Lighting Committee in their amended form, and they, together with the plans and specifications, will be printed, so that copies may be supplied to intending contractors.

Carlisle.—Workmen are at present busily engaged in laying cables in the streets of Carlisle, and in a few weeks it is hoped that the city will be lighted with electricity. The Corporation have decided that the charge at the outset shall be 5d. per unit.

Sculcoates.—The District Council have appointed a committee to discuss with Messrs. A. M. Jackson and Co. the proposal made by them on behalf of a client who has in contemplation a plan for building an electric tramway from Hessle to connect with the new system in Hull.

Ayr.—The lighting of the electric lamps on the Racecourse-road has commenced. The rest of the arc lamps will be ready shortly. To extend the present cable from opposite the showground to Whitletts-road will cost £220, including transformer and trenching, etc.

Metropolitan Electric Supply Company.—The directors of this Company have declared an interim dividend of 5s. per share on the original shares for the half-year ended June 30 last, payable on 23rd inst. The transfer registers will be closed from to-day to 22nd inst., both days inclusive.

Bedford.—The Town Council have decided to combine with other corporations and companies using the alternating system of distribution, in resisting the claims of Mr. Rucker to enforce payment of royalties under the Zipernowski-Deri patent, and have agreed to contribute to the defence fund.

Taunton.—The Electric Lighting Committee's report states that the total lamps connected during the month of August were equivalent to 524 8-c.p. lamps. Having regard to the recent strike in South Wales, the committee have resolved to stack 100 tons of coal at the works for emergencies.

Wallingford.—In view of the high price of gas—viz., 4s. 9d. per 1,000ft.—and the refusal of the company to sell the works to the town, it is proposed to introduce a system of electric lighting. A memorial is in course of signature asking the Council to take steps to introduce a better and cheaper illuminant.

Stowmarket.—The proprietors of the electric light in this town have converted their undertaking into a company, registered as the Suffolk Electricity Supply Company, Limited, and it is intended to carry on business in Stowmarket and other towns. It is stated that applications for shares exceeded the amount offered.

Paisley.—At a private meeting of the Town Council on the 12th inst., the respective schemes of the Glasgow Corporation and the British Electric Traction Company for the introduction of a system of electric cars into Paisley, referred to elsewhere, were considered and voted on, and the Glasgow scheme was adopted by 16 votes to 4.

Stafford.—The increase of electricity sold during the quarter ending June 30 amounted to no less than 38 per cent., and the consumption for the last four weeks showed an increase of nearly 21 per cent. The salary of Mr. J. H. Clothier, the chief assistant at the electricity department, has been advanced by £25 per annum.

Jamaica.—The *Times* correspondent wires from Kingston that the Government are considering a scheme for the conversion of the railway into an electrical line at a cost of £197,000. An expert reports that the Black and Roaring Rivers are able to supply the necessary power. The report went by the last mail to the Secretary of State.

Leeds.—At a meeting of the Tramways Committee of the Leeds Corporation held on the 12th inst., it was decided to call a special meeting of the City Council to obtain permission to apply for a provisional order in Parliament to authorise the Council to proceed with the extension of the tramways to the city boundary at Stanningley.

Electrical Company, Limited.—We have received an advance copy of a new list of direct current dynamos and motors manufactured by this Company. It embraces new types, a wider range of machines than hitherto, and improvements in all of them. We notice that the instructions for fixing and running the dynamos and motors are very complete.

J. H. Heathman and Co.—We have received an extensive catalogue showing the numerous kinds of ladders, pumps, and fire appliances manufactured by this firm. We note especially the Bray ladders, and a variety of telescopic ladder towers used

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largely for attending arc lamps and overhead wires. Trucks and carts of all descriptions, hose, and fire-engines complete the list.

Geneva.—A Reuter telegram from Geneva says that the switching apparatus of the great electricity works of the city of Geneva, situated on the Rhone, near Chevres, caught fire on Wednesday week, and in a short time the entire works were destroyed. In consequence the transmission of the electric current for motive power and the illumination has ceased throughout the canton of Geneva.

African Telegraphs.—A reduction of the postal rates in Rhodesia is expected as soon as the Imperial Government abolish the Bechuanaland in-transit rate, and a reduction in the telegraph rates to 2s. 6d. per 10 words as soon as the Cape Government will make Rhodesia similar concessions to those made to the Transvaal, the Orange Free State, and Natal. In this case a telephone exchange would be constructed at once in Bulawayo.

Thornaby.—At Monday's meeting of the Town Council it was reported that, as a consequence of the installation of the new electric tramway system from Stockton to Middlesbrough, there had been a great falling off in the number of licenses issued to brakes for the Stockton race days, these being almost entirely confined to the local areas, instead of extending as far as Leeds and Bradford. The number was 32, as against 91 last year.

Derby.—The committee have reduced the applications (62 in number) for the post of electrical engineer and manager to three, and have submitted the following names to the Council: James T. Baron, of 47, Stanhope-street, Euston-road, N W.; E. W. Lancaster, of Albert Works, Birmingham; and T. P. Wilmshurst, of the electricity works, Foundry-street, Halifax. Mr. Wilmshurst was appointed to the position at a special meeting on the 13th inst.

Bournemouth.—The Town Council has resolved to apply to the Board of Trade for a provisional order for the supply of electricity for public and private purposes within the borough. It is stated on good authority that the British Electric Traction Company intend very shortly to make an application to the Light Railway Commissioners for power to construct a tramway from Christchurch to Bournemouth, which will run through the Pokesdown district.

Accident.—On Saturday Corporation workmen were engaged repairing damage which had been done to the electric light wires under the pavement in Princes-street, Edinburgh, through the fusing of one of the main wires the previous evening, when something of the nature of an explosion occurred. The fire brigade was called out, and after examining the cellars of several of the shops they came on some woodwork which was burning as a result of the explosion.

Bolton.—A discussion took place at the last meeting of the Town Council in reference to the purchase of land by the Electricity Committee for the extension of the works in Spa-road. The extension has been rendered necessary in view of the proposal to run the trams by electricity, and for the purpose of laying down the necessary plant to supply the areas recently added to the borough, borrowing powers for this purpose having being acquired to the extent of £250,000.

New Companies.—The following companies were registered at Somerset House during August: Aron Electricity Meter, Limited, £1, £250,000; Berry's Electrical Company, Limited, £1, £3 000; Electrical Thawing Syndicate, Limited, £1, £25,000; Frendenberg's Multiple Telephone Syndicate, Limited, £1, £10,000; Frendenberg's Automatic Telephone Syndicate, Limited, £1, £10,000; Mackey's Electric Lamp Company, Limited, £1, £2,000; Suffolk Electricity Supply Company, Limited, £10 and £1, £10,000; Thomas Parker and Sons, Limited, £10, £50,000.

Swansea.—In connection with the dispute between the Swansea Corporation and the British Electric Traction Company over the relaying of the system for electrical purposes, it is estimated that the street improvements at alleged dangerous spots which the Corporation consider should be effected will involve the company in an expenditure of over £20,000. It appears that the traction company are prepared to fight the question of passing places at the Board of Trade inspection, but the Mayor states that he hopes the Corporation will be able to refute the company's affidavits in the matter.

Liverpool.—The Tramways Special Construction Committee of the Corporation, with Sir Arthur Forwood, Bart., M P., as its chairman, and accompanied by Mr. Brodie, city engineer, etc., made an inspection of the Dingle line of electric tramways on the 12th inst. An early opening of the line is expected, but no definite date has been fixed, as a considerable amount of work remains to to be done. The committee will recommend the Town Council to utilise the services of Mr. Talbot, the principal representative of the late Dr. J. Hopkinson, who was the consulting engineer to this experimental scheme.

Appointments Vacant.—The Electric Lighting Committee of Barrow-in-Furness are prepared to receive applications for an engineer-in-charge. Applications are to be addressed to the Chairman of the Electric Lighting Committee, and endorsed "Engineer-in-Charge," and sent to Mr. C. F Preston, town clerk, not later than 12 o'clock noon on Sept. 19.—Mr. W. Halliwell, having obtained another appointment, has resigned his position as improver at the electric lighting station at Dewsbury. The Town Clerk will advertise the vacancy, applicants to state the salary required.—Particulars of a few minor vacancies appear elsewhere.

Stockton.—The Town Council have received the sanction of the Local Government Board to the borrowing of £28,482 for a period of 25 years, and also the approval of the Board to the use of certain land for the purposes of electric lighting. The original request was for £30,000. The difference in the loan is accounted for in the fact that the Local Government Board declined to include in the loan the sum that was required for the procuring of the order, and the amount that was to be paid to the gas account. The committee are not losing any time in the matter, and they expect to be able to supply the town with electric lighting within 12 months.

Vienna.—The protracted negotiations between the Vienna Town Council and tramway company, based upon the proposals submitted by Messrs. Siemens and Halske of Berlin, have, according to the *Financial Times*, now been brought to a successful issue. Under the agreement entered into, the local authorities will acquire the tramways and lease them to a new company until the year 1925, the whole of the lines to be converted to the electric system. The new company to be constituted will pay 40 per cent. of the net receipts to the local authority by way of rental, and at the expiration of the concession the whole of the plant and equipment will pass into the possession of the town without payment.

Jedburgh.—The Police Commissioners, on the 12 h inst., had under consideration a letter from an Edinburgh civil engineer stating that he had along with a London traction company, projected a scheme for a light railway between Jedburgh and Hawick, *vid* Denholm, but before taking any active steps in the matter they were anxious to ascertain the mind of the Jedburgh Town Council and district on such a scheme. It appears that the cost of the proposed railway is estimated at £50,000. The company is prepared to furnish from a third to a half of the required working capital, provided the remainder be subscribed or guaranteed. The Commissioners have empowered a committee to meet with the engineer and report.

Southport.—The shareholders of the Birkdale and Southport Tramways Company last Friday confirmed the agreement with the British Electric Traction Company for the purchase of the former company's shares at £7. 10s. each. The agreement is conditional on arrangements being made with the Southport Corporation and the Birkdale District Council as to the future leasing of the lines. The Corporation have leased the Southport lines for 17 years, and may purchase the Birkdale lines three years hence. The Traction Company have purchased more than three-fourths of the shares of the Southport Company, and propose to work both the existing lines by electricity, and also the new lines which the Corporation are planning to develop the complete system.

Rhyl.—At Tuesday's meeting of the Urban District Council it was reported that the Council had under consideration draft schemes for supplying certain parts of the town with electric light, and also for laying down a tramway from near the entrance to the Grand Pavilion to Prestatyn. Plans had been submitted by the engineers, Messrs. Alfred Dickinson and Co., and, without pledging the Council to them, the committee who inspected them expressed approval of them and requested Messrs. Dickinson to submit a detailed scheme for consideration. It was resolved that the members should in a body visit some of the Lancashire seaside towns, including Southport, Blackpool, Morecambe, and Fleetwood, to inspect similar works carried out there.

Yarmouth.—At the last monthly meeting of the Town Council, the recommendation of the Electric Lighting Committee, that the Corporation retain their monopoly to supply electrical energy to Gorleston and Southtown, was adopted without discussion. A letter was received from Messrs. Worship and Rising, solicitors, asking whether the Corporation would undertake electric tramways themselves or sell current to a company, taking all the risk. The Council referred this communication, and the whole question of tramways for Yarmouth, to a committee. In the course of conversation it was stated that the Council's electric light undertaking was so far prospering that no deficiency had to be provided for this year, but that, on the contrary, there was a clear surplus of £200. Much larger profits were anticipated for the next year.

Dewsbury.—The directors of the Dewsbury, Batley, Birstall, and Gomersal Tramways Company have had an interview with Mr. Garcke, managing director of the British Electric Traction Company, and with one of their engineers. It is understood that the Electric Traction Company desire to negotiate with the tramway directors for the purchase of their undertaking, with a view to the Dewsbury to Gomersal line being connected with the electric tramways which they are proposing, if permitted, to make through Dewsbury, Thornhill, Ravensthorpe, Heckmondwike, Staincliffe, and Dewsbury Moor. A great deal depends upon the attitude of the local authorities through whose districts it is proposed to lay lines. If they support the company the permission of the Board of Trade to go on with the scheme will be asked; if they all, like the Dewsbury Town Council, threaten opposition, the whole thing may be dropped.

Johnstone.—The *Glasgow Herald* says the decision of the Paisley Town Council to join with the Corporation of Glasgow effectually shuts out all possibility of Johnstone being granted electric tramway facilities with either Paisley or Glasgow. The Johnstone Town Council were looking to the British Electric Traction Company to construct a line from Johnstone giving through communication *vid* Paisley to Glasgow, and the scheme, which had been thoroughly considered, had been cordially approved. Johnstone has had no negotiations whatever with Glasgow, and if powers be granted to confirm the Glasgow and Paisley municipal compact, Johnstone will be the sufferer. The British Electric Traction Company not only intended to give travelling facilities to Johnstone and Elderslie, which have a population of fully 12,000, but they intended to give facilities to Bridge of Weir and Kilbarchan. The 20th inst. is fixed for the hearing of the application of the above company for power to complete the undertaking.

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Kirkcaldy.—The Town Council have been discussing a proposal that they should take up the electric lighting and tramways. A local company has offered to take up the scheme and allow the Council to take the same over at the end of 35 years at a price fixed by arbitration. The Edmundson Electric Lighting Company has also offered to introduce electric lighting to the burgh, allowing the town to purchase the scheme at the end of 10 years at 15 per cent. on the cost. The Town Council have ultimately agreed to apply for a provisional order to introduce the electric light themselves, while a motion has been made to apply further for an Act of Parliament or provisional order to empower the Council to introduce electric tramways. The idea is that the town, having got parliamentary sanction for these schemes, could then hand them over to any company offering the best terms. A committee has been appointed to arrange for procuring these orders.

Newington.—At a special meeting of the Vestry on the 14th inst., a report from the Electric Lighting Committee was received recommending that the following resolution of Feb. 16, 1898, be rescinded—viz : "That application be made to the London County Council for a loan of £40,000 to enable the Vestry to comply with the provisions of the Newington Electric Lighting Order, 1897, such loan to be receivable in four instalments of £10,000 as the work proceeds, and repaid within a period of 50 years, with interest, the first of such annual instalments to be deferred for a period of five years from the date of the loan"; and that the following resolution be substituted in lieu thereof—viz. : "That application be made to the London County Council for a loan of £50,000 to enable the Vestry to carry out the provisions of the Newington Electric Lighting Confirmation Act of 1897, such loan to be taken up in instalments of £10,000 as the work proceeds and repaid within a period of 42 years, and that the Council be asked to defer the repayment of the principal for a period of five years under Clause 11 of Section 13 of their Money Act of 1898."

Wolverhampton.—The following report is on the agenda for this week's meeting of the Town Council : "As foreshadowed in a previous report, the Lighting Committee have under consideration a scheme for the extension of the undertaking involving a large capital expenditure, which it is proposed to submit to the Council in October next. The scheme provides for the extension of the generating plant and distribution plant at an estimated capital cost of £29,000, and should meet all demands likely to be received in the winter of 1899-1900. Having regard, however, to the extreme difficulty in obtaining electrical machinery, except upon long notice, owing to the congested state of the electrical industry, the committee desire the authority of the Council to forthwith obtain and accept tenders for one 300-i.h.p. steam dynamo set and one combined battery-charging and balancing set, the estimated cost of which is £3,200. This plant and the cost thereof will form part of the £29,000 scheme previously referred to, but it is very essential for the reasons before stated that no time should be lost in inviting and accepting tenders in respect thereof. Whatever scheme may be hereafter adopted, the above plant will be an absolute necessity."

Middlesbrough.—The *North-Western Courier* states that the Corporation electric lighting order has now received the Royal assent, and the committee, in consultation with Mr. Hammond, electrical engineer to the Corporation, have decided that the station shall be erected on the land belonging to the Gas Committee at the corner of Snowdon road and Washington-street, on condition that the Gas Committee agree thereto and subject to the sanction of the Local Government Board. Mr. Hammond has been instructed to prepare specifications and estimates for lighting the compulsory area. Mr. Clifton Robinson, managing director of the Imperial Tramway Company, has received applications from several public bodies desiring the extension of the system of electric tramways now in operation and connecting the boroughs of Middlesbrough, Stockton, and Thornaby, and in consequence the company propose next month to apply to the Light Railways Commissioners to authorise extensions of their system of tramways so as serve several other centres. The extensions which the company have in view are to the east of their present system through North Ormesby and South Bank to Grove-hill, and in Stockton, westward along Yarm-road to Eaglescliffe Station. It is intended that the extensions shall be constructed, equipped, and operated exactly as the existing electric tramways on Tees-side.

Barrow.—At the last meeting of the County Council, the Highways and Lighting Committee reported that they did not see their way to recommend that any of the streets be lighted by electricity. Since the Highways and Lighting Committee had come to this conclusion, the Electric Light Committee met and decided to offer to supply energy for the 21 arc lamps proposed to be erected at £15 per annum, instead of £17 10s. as previously offered. The matter was therefore referred back to the committee for reconsideration. With regard to the laying of underground telephone wires, it was resolved that the chairman be authorised to settle with Messrs. Claxton and Chambers (of the National Telephone Company, Limited) the terms on which this committee are prepared to sanction the laying of underground telephone wires in the borough. The Council is to grant to the National Telephone Company, Limited, the privilege of laying their telephone wires underground on payment by them of 5s. per annum for each subscriber of the company whose wires are carried through any pipe laid in any street, the minimum number of subscribers to be considered as 100. The agreement to be for five years certain, subject to six months' notice on either side to expire at the end of the five years or subsequently at any time. The arrangement to be also subject to the company agreeing to the Corporation's previous offer of £60 per annum for the private wires for the various police stations, and one exchange wire, on a five years' agreement, these wires to be run in metallic circuit.

Hull.—With regard to the new electric station recently opened in Sculcoates-lane we are indebted to the *Eastern Morning News* for the following particulars : "In the engine-room there are four steam dynamos representing a total of 760 h.p. The current is generated at from 2,000 to 2,500 volts, and transmitted to sub-stations in Albion-street and Argyle-street, and then transformed to safe low pressure of 220 volts. Stretching across the engine-room there has been erected a large travelling crane with a lifting capacity of about 10 tons. In the boiler-room adjoining there has been erected one water-tube boiler of 150 h.p., and two Lancashire boilers of 350 h.p. each, while in addition there is a storage battery, electric pumps, with large tanks, having a capacity of 30,000 gallons, the water for the same being pumped from the Barmston drain. The new station works, together with the installation in Dagger-lane, feeding the same mains in addition to its own network of mains. The new extension consists of about nine miles of mains, supplying chiefly Hessle and Anlaby roads to the Boulevard, and though only just completed, the demand for current has exceeded the most sanguine anticipations. The East Hull mains, now about to be laid, will be supplied from a new sub station near North Bridge, deriving current from Sculcoates-lane. To meet this and other demands new plant of 750 h.p. is about to be ordered. The latter extension brings about the fulfilment of a promise made in the Council-chamber when the Sculcoates-lane extension was under consideration, and 12 months hence the eastern district will be in possession of the new light. Then, with the exception of the suburbs, the chief portions of the city will have electric mains laid in most of the leading thoroughfares, thus enabling the committee to take into early consideration the question of street-lighting by electricity."

Ilkeston.—The first minutes of the Tramways and Electricity Committee, which were adopted by the Town Council on the 10th inst., stated that Alderman Robinson had been appointed chairman and Councillor Chambers vice-chairman. Messrs. Sharpe and Co. were appointed as parliamentary agents to assist in obtaining the provisional orders about to be applied for under the Tramways Act, 1870, and the Electric Lighting Act, 1882 and 1888. Mr. Herbert Talbot was engaged to report on the tramways and electricity schemes, and render services required in the procuration of the provisional orders as aforesaid. The suggested single tramlines for which authority to lay was to be sought in the tramways provisional order were as below : No. 1, from Bridge-street, along Cotmanhay-road, Granby-street, and Bath-street to Station-road; No. 2, from Bath-street along Station-road to the bridge crossing the River Erewash ; No. 3, from the west end of Station-road along Bath-street, the Market-place, South-street, White Lion-square, Nottingham-road, Little Hallam-lane, Corporation-road, and Hallam Fields to the north end of Crompton-street ; No. 4, from the east end of Little Hallam-lane, along Nottingham-road to the county bridge crossing the River Erewash. The gauge of the tramline was fixed at 3ft. 6in., and the extreme width of engine and carriages at 6ft. Negotiations were ordered to be entered into with the School Board for the purchase of a piece of land on Park-road. The list of streets and parts of streets through which the undertakers under the electric lighting order were to lay distributing mains within a period of two years after the commencement of the order was fixed as follows : Cotmanhay-road, Awsworth-road, the Market-place, Market-street, South-street, Derby-road, White Lion-square, Park-road, Nottingham-road, Little Hallam-lane, from Nottingham-road to the north end of Corporation-road, Corporation-road, and Hallam Fields-road.

Bury St. Edmunds.—The Local Government Board have refused the application of the Town Council for an electric lighting loan in view of the large amount of opposition which the proposal in its present form has aroused, and of the uncertainty whether the scheme might not result in a net loss to the borough. They suggest that the scheme might be modified so as to embrace only the compulsory area described in the provisional order, and that the proposals for lighting the streets should for the present be abandoned. The committee, however, are still of opinion their scheme for lighting the town is the best, inasmuch as the inclusion of the public lighting would ensure an immediate income at a comparatively small outlay, and would also release the sum of £2,500 held by the gas company. As, however, the Local Government Board have refused to authorise the entire loan of £20,000, but have suggested a modified scheme should be brought forward, the committee have reported to the Council that there are now two courses open: (1) to adopt a modified form of private lighting, as suggested by the Local Government Board, which is estimated to cost £13,000 for the compulsory area, or £15,000 if the streets in Mr. Medhurst's No. 1 supplemental estimate are included ; (2) to sell the provisional order to a company. The committee feel strongly it would be very undesirable to adopt the latter course. They, however, leave the matter entirely in the hands of the Council. They are prepared, if it be the wish of the Council, to carry out a modified scheme, though they do not anticipate such successful financial results as from their original scheme. If the Council wish to carry out a modified scheme, the committee suggest a deputation wait upon the Local Government Board in reference to the matter, as the provisional order will expire in July next, and therefore it is very necessary, if the Local Government Board are not prepared to accept the modified scheme, to sell the provisional order at once. After discussion, the Town Council have adopted a resolution to the effect that it was not desirable to drop the electric lighting scheme, and requested the committee to submit a modified scheme in October.

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Manchester.—As will be remembered, the City Council, at its meeting in August, passed a resolution declaring it to be "undesirable that the telephone service of the city and neighbourhood should exist as a monopoly in the hands of a private company." In consequence of this a special committee was appointed to consider the matter and report. A report has now been prepared, says the *Manchester Guardian*, and will be presented to the Council in due course. Referring to the report of the Parliamentary Commission on Telephones, it is stated that "having regard to the high authority of this tribunal, the character of the evidence received by it, and the authority of its conclusions, it would appear only necessary to ascertain how these conclusions may be practically applied to the circumstances of our city." The conclusions of the Select Committee are then given, and special reference is made to that passage in the report which indicates "the injury to the public interest which might be suffered by deferring action until the present monopoly approaches the termination of its license." In the opinion of the Manchester committee the Select Committee "has established clearly the moral and legal right to competition," and those passages are quoted from the report which suggest the conditions under which such competition should be conducted. Attention is also drawn to that part of the report which deals with the expediency of municipal bodies conducting the telephone service, and particularly to the financial aspect of the matter. The City Council is reminded that it has already passed a resolution approving of the application for a licence of a local competing company. Communications had been received from the Mutual Telephone Company on the subject of a local competing company, and it is stated that from these it will be seen that such project has received the additional support of the Corporations of Salford and Eccles. The committee recommend that communications should be made with those bodies. The committee are also of opinion "that the Council should authorise them to support the claim of the proposed company for its licence by deputation or otherwise, and if it be found expedient, by combination with the neighbouring authorities which have already expressed their approval of the competitive service. It should be provided that reasonable conditions be fixed beforehand in reference to the exercise of the powers and the determination of the agreement, including a provision that the exchange should be taken over by the Corporation if at any future time the City Council should think well to obtain statutory authority for that purpose, the purchase to be upon terms somewhat analogous to the statutory provisions as to the purchase by local authorities of tramways and electric undertakings."

Glasgow.—The minutes of the First or Upper District Committee of the County of Renfrew, which were issued on Saturday last, deal with the conference held between the sub-committee of the Upper District Committee and the Glasgow Tramways Committee regarding the proposed extension of the Glasgow tramways to Paisley and county districts. The provisional arrangement between the city representatives and the Lower Ward of Lanark Highways Committee as regards that committee's stipulations respecting (1) the tramway (double line); (2) granite causeways; (3) sewers and drains, etc.; (4) motive power; (5) running of "through" cars; (6) fares to be charged; (7) non-use of district roads for experimental purposes; (8) regulation of traffic; (9) liability for accidents; (10) reference in event of differences; (11) agreement not to be founded on for extensions of city boundaries nor for disturbance of road subvention, was explained to the meeting, and, says the *Glasgow Herald*, met with the general approval of the county committee, so far as applicable to the proposed tramways on Paisley-road. As regards the date within which the City Corporation should, in the event of the concession being granted, have the tramway lines completed on the Paisley-road, it was ultimately agreed that the city should become bound to have the tramways completed and ready to be worked within three years from the date of the passing of their special Act, but that should no arrangement be come to with Paisley, the time should, as in the case of the Lower Ward of Lanark, be five years from the passing of the Act, and that the Act should be applied for in the next session of Parliament. As regards the extension of the tramways on Pollokshaws-road, from the city boundary to the "Round Toll," which the city representatives stated they desired to obtain permission to construct, both parties agreed to recommend their constituents to approve of the foregoing stipulations, excepting solely the stipulation as to the three years' limit for completion of works, etc. And, similarly, with respect to the tramway which the Corporation desire to obtain power to construct in Cathcart-road in continuation of their existing system south-westwards to Cathcart Cemetery gate, and as a tramway in that road involves a widened and improved bridge over the River Cart in place of the existing bridge, both committees agreed to recommend their respective constituents that each should bear one half of the cost of a 50ft. wide bridge of a design and construction to be mutually approved of. Further, as regards the application by the British Electric Traction Company, Limited, for an order under the Light Railways Act, authorising the construction of tramways on, *inter alia*, the Paisley-road, the city authorities undertake to bear the expense of the District Committee's opposition in the local inquiry and otherwise. Both parties agreed to recommend their respective constituents in terms of the foregoing provisional arrangements, and it was agreed that the town clerk should prepare a draft agreement embodying same, and send it for the revisal and approval of the District Committee.

Enfield.—At the last meeting of the Urban District Council a letter was read from the Electrical Power Distribution Company with reference to the notice given to the Council in June asking if the Council would assent to the provisional order, and submitting a basis of co operation in pioneering the electricity supply for the district. The company proposed to introduce the supply entirely at their own expense and risk, and they did not object to the insertion of clauses under which at the end of a short term of years the Council may, if it so desired, acquire the undertaking on terms to be agreed at the outset. The attention of the Council was particularly directed to the following points:—"General terms: Our proposal would be to take a lease of your provisional order, either upon the terms that (1) upon the expiring of two years' notice given at any time after the end of 10 years, the Council shall be entitled to purchase the entire undertaking and goodwill at a value to be fixed by independent valuers, or (2) upon the expiring of two years' notice given at any time after the end of 10 years, the Council shall be entitled to purchase the entire undertaking and goodwill at a price equal to the capital expended on the undertaking, plus a premium of 6s. 8d. in the pound. New works: The site to be mutually approved. The company would undertake the works forthwith and would supply electricity in the compulsory area, and such other parts of the town as may be desired by the Council, within 12 months from the completion of formalities. Price of current: Electricity which the Council might require for public lighting or other purposes would be charged on the 'Brighton' scale, at 2d. per unit after the first hour's use at 8d. For all-night street-lighting this would average at the very moderate figure of 2½d. per unit. The company have such confidence in the Brighton form of tariff as a means of popularising the electrical supply that they are prepared to supply customers at 2½d. per unit after the first hour's use at 8d., and put in free of any additional cost the necessary interior wires. System: We have carefully considered the requirements of the district, and think there can be no doubt that the low-pressure system of supply is the best suited to it. Street work in connection with the underground mains to be carried out to the satisfaction of the surveyor, and, if preferred, replacements may be made by the Council at the expense of the company. The company would pay the reasonable costs incurred by the town in connection with the provisional order. The electricity supply is a young business, improvements are being continually made, and it requires a very watchful and highly specialised commercial organisation to control the expenditure and prevent serious mistakes. The interests of the consumers must be specially considered in making terms with the Council, as unreasonable conditions would have to be met by higher rates for the current at starting and longer periods before reductions could be made. The company's policy of free wiring and popular prices is the best way to rapidly and successfully develop the undertaking. We can afford you satisfactory references as to our financial and technical abilities to pioneer the undertaking, and we shall be glad if your Council can make it convenient to appoint an early date when we can wait upon them to reply to any questions which may arise in their minds in connection with this proposal." The subject was referred to committee.

PROVISIONAL PATENTS, 1898.

SEPTEMBER 5.

18894. Improvements connected with electrical signalling or communication on railway trains. Alexander Shiels, 100, Wellington-street, Glasgow.

18900. Improvements in electric arc lamps. Robert Frederick Hall, 24, Temple-row, Birmingham.

18907. New and useful electric switch device for the temporary lighting of staircases, floors, cellars, and the like, also for indicating the heating of shafts and bearings, and for fire-alarms. Wilhelm Blanckenhorn, 33, Augusta-street, Aix-la-Chapelle, Germany. (Complete specification.)

18940. Improvements in alternating-current arc lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Hans Otto Swoboda, United States.) (Complete specification.)

18941. Manufacture of homogeneous mixtures for the incandescence bodies of electrical glow lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

18956. Improvements in or connected with electrolytical condensers and electric current directing devices. Charles Pollak, 47, Lincoln's-inn-fields, London.

18958. Improvements relating to the electrolytic decomposition of alkaline salts. Edwin Edser, 18, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 6.

18964. An electric stop motion and tension device for warping and like purposes. Albert Edward Bancroft, Clifford-street Works, Long Eaton.

18975. An improved electric high and low tension fuse-head for blasting, mining, and the like purposes. William Henry Taylor, 69, Market-street, Manchester. (Complete specification.)

18998. Improvements in phonographs and graphophones. Frederick Walter Baynes, 27, Clement's-lane, London.

19000. Improvements in switching apparatus for controlling electrical motors. Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

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19014. Improvements in apparatus for starting electric motors. James Burke, 46, Lincoln's-inn-fields, London. (Complete specification.)

19015. Improvements in dynames. William Morris Mordey, 46, Lincoln's-inn-fields, London.

SEPTEMBER 7.

19071. An improved system of recording telephonic messages. William Aitken, Oxford-court, Cannon-street, London.

19076. Improvements in wall connections for electric lighting. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London.

19090. Improvements in speed-changing and reversing mechanism for motor vehicles. La Société Anonyme d'Electricité d'Automobiles Mors, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Section 103, July 2, 1898, being date of application in France.)

SEPTEMBER 8.

19108. Improvements in apparatus for measuring the angular distortion in shafts subjected to stress, also applicable as dynamometers. Ernest George Coker, 47, Windsor-street, Wolverton, Bucks.

19116. Improvements in or relating to shields or guards for the carbon pencils used in electric furnaces. Joseph Bastick, 50, Wellington-street, Leeds.

19140. An improved electric arc lamp Henry Vincent James, Westhill, Higher Broughton, Salford.

19162. Means and appliances for indicating at one end of an electric circuit the position of an arm or pointer at the other end of the circuit. Parnell Rabbidge, 166, Fleet-street, London.

SEPTEMBER 9.

19177. Improvements relating to telephone line wires and cables. Harry Cooper, Cobden-buildings, Corporation-street, Birmingham.

19243. An improvement in fusible cut-outs for electric circuits. Frederic William Francis, 262, Brockley-road, Brockley, London.

19246. Improvement in systems of electrical distribution and regulation. Benjamin Garver Lamme 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Section 103, Feb. 10, 1898, being date of application in United States.)

19248. Improvements in alternating-current electric motors. William Phillips Thompson, 6, Lord-street, Liverpool. (Charles S. Bradley, United States.) (Complete specification.)

19255. Improvements in the covers or lids of sewer gas, electric, and telephone supply shafts, holes, gullies, and the like, and in their supporting frameworks. John Price and Joseph Johnson, 11, Burlington-chambers, New-street, Birmingham.

19264. Improvements in electric meters. Cornelius Canté, 1, Queen Victoria-street, London. (Complete specification.)

19265. Improvements in coin-freed mechanism for electric meters. Cornelius Canté, 1, Queen Victoria-street, London. (Complete specification.)

SEPTEMBER 10.

19270. Improvements in or relating to electrical signalling apparatus for use in gaseous or wet mines, and for analogous purposes. Paul Jerrard, 5, St. Ann's-chambers, Broadway, Ludgate-hill, London.

19313. Improvements in shade and lamp holders for incandescent electric lamps. Sidney Herbert Smith and John Howard Smith, 50, Cherry-street, Birmingham.

19339. Improvements in and relating to the manufacture of carbons or carbon pencils for electric lighting. Simon Schreiber, 11, Southampton-buildings, Chancery-lane, London. (Adolf Bein, Austria.)

SPECIFICATIONS PUBLISHED.

1897.

16774. Electric appliances for medical and other purposes. Sanche.

18718a. Electric railways and tramways. Short. (Date claimed under Patents Rule 19, Aug. 12, 1897.)

19431. Electric lamps. Adams.

20914. Coin-freed electricity meters. Raphael.

21496. Electrical water-level indicator or recorder. Cobb.

21534. Electric arc lamps. Mills. (Pomeroy.)

1898.

13478. Apparatus for controlling electric currents of high tension and great quantity. Johnson and Lundell.

15144. Electric railways and tramways on a road contact system. Fletchenmacher.

15646. Electrically-operated cloth-cutters. Garland.

15647. Electrically-ignited fuses for blasting purposes. Bettermann.

15732. Electric telephone transmitters. Massari.

15812. Telegraph printing apparatus. Hachmann.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease	Total receipts for current half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway Company	Sept. 10	4 072	3,578	—	—	—
Blackpool and Fleetwood Tramroad	,, 10	1,112	—	—	8,918	—
Bristol Tramways and Carriage	,, 9	3,443	2,496	+ 947	—	—
City and South London Railway	,, 11	876	879	- 3	10,487	9,906
Dover Tramways	,, 10	244	129	+ 115	5,565	—
Dublin S.D. Electric Tramways	,, 9	1,204	579	+ 625	11,507	8,342
Halifax Corporation Tramways	Aug. 24	297	—	—	—	—
Liverpool Overhead Railway Company	Sept. 11	1,528	1,451	+ 77	—	—
South Staffordshire Tramways	,, 9	739	632	+ 107	22,657*	22,790*
* Receipts since	Jan. 1.					

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	13½-14½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9½-10½
—— 4½ per cent. Cum. Pref.	10	10¾-11¾
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Company, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	108-111
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	10-10¼
——	6	6 6¼
—— Pref. Half-Shares	1	1¼-1¾
—— ,, ,,	5	4¾-5
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6 6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24¼-25¼
—— 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	16¼-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	00	70-72
—— Ordinary	3	2¾-3¼
—— 4 per cent. Debenture Stock	00	136-138
—— 5 per cent. Pref. Shares	10	14¾-15½
—— ,, ,, '96	10	14-15
County of London and Brush Provincial Co., Ordinary	10	13-14
—— ,, ,, ,,	6	8¼-9½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	1¾ 2¼
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2¼-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ordinary Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2¼-2½
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅞-1
Elmore's Wire Company	2	1¾-2
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22½-23½
—— 4 per cent. Debentures	100	102-105
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8¾
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5⅞-6⅛
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Company	10	15½-16½
Oriental, Limited, £1 shares	1	1½-1¾
—— £5 Shares	5	7½-8
—— £4½ shares	4	6½-7
Oriental Telephone and Electric Company	1	⅝-¾
Royal Electrical Company of Montreal	1½	142-145
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2¼ 3¼
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	39-43
—— 5 per cent. Bonds	100	100-105
Waterloo and City Railway, Ordinary	100	120-121
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

Electric Light in Karachi.—The plant for lighting the telegraph offices by electricity has almost all arrived, and will shortly be in working order. This will be the first building lighted by electricity in Karachi.

Presentation.—On Tuesday last the employés of the Hammersmith Vestry Electricity Department presented Mr. F. C. Pay, one of the engineers-in-charge, with a handsome marble timepiece as a mark of esteem on the occasion of his marriage.

Royal Photographic Society.—The forty-third annual exhibition of this society will be opened in the gallery of the Royal Society of Painters in Water Colours from Sept. 26 to Nov. 12 from 10 till 5, and the usual Monday, Wednesday, and Saturday evening entertainment will be given from 7 till 10 p.m. The Press view takes place to-day, a private view from 11 to 4, and the president's soirée in the evening will initiate the season.

Charterhouse Science Classes.—The winter session of the Charterhouse (William Roger's Memorial) Science and Art Schools and Literary Institute will commence on Saturday, Sept. 24. During the late session upwards of 700 students, mostly elementary teachers, availed themselves of the privileges afforded by this institute. Instruction of a decidedly practical character is given in most of the sciences at a nominal fee. Full particulars of the classes may be obtained from Mr. C. Smith. The present president is the Rev. Henry Swann, M.A.

A Living Language.—The motorcar movement has, says the *Financial Times*, enriched the English language with some new and particularly ugly words, but it would appear that we must not complain, for the Flemish Academy at Antwerp has been discussing the correct equivalent of the French "automobile," and, among other suggestions, has had to deal with that of "Snelpaardelooszonderspoorwegpetroolrijtuig." The expression appears to require a good deal of sub-editing before the citizens of Antwerp can hope to save time by hailing a vehicle of this description.

The People's Palace.—The technical college in connection with this social institution is now commencing its winter's work. We note from a circular sent us that the students last year carried off many honours. Thus two Whitworth exhibitions, two National scholarships, and three County Council scholarships were gained by students, but the premier place was awarded to Mr. T. S Moore, who gained a scholarship in natural science of £80 a year, renewable for five years at Merton College, Oxford. The electrical department of this college is in the hands of Mr. E. J. Burrell and Mr. J. J. Morris.

Electric Lighting at Rockhampton.—This town in Queensland is supplied with both gas and electricity by the same company, and from the last half-yearly report we see that the company is a thriving one. The profits on the gasworks are considerably more than those of the electrical department, but the percentage profits do not differ much. As regards the consumption of electricity, it is expected that during the current half-year a still further improvement will be manifested. A large number of remunerative extensions of mains and services have been made, and applications are in hand for further extensions, which, on approval, will be carried out at the earliest possible opportunity.

The Fighting Editor. — This mythical personage, as far as English papers are concerned, became quite common in America during the past war with Spain. One of the most prominent of these gentlemen who have left the pen for the sword and steam-engine is Mr. W. D. Weaver, the editor of the *American Electrician*. At the opening of hostilities with Spain, Mr. Weaver was commissioned chief engineer of the U.S.S. "Glacier," which is now in West Indian waters. Mr. Weaver is a graduate of the Naval Academy of Annapolis, and after having made a most honourable record in the navy, resigned some years ago to enter the field of electrical journalism. He expects to return to his editorial duties shortly.

Electric Advertising.—An enterprising electrician in Brussels has found the means to combine the attractive with the useful in the way of advertising, and is drawing great crowds nightly in the Place de Brouchère, in the heart of the city. He displays advertisements on a screen fixed outside the third-storey window of a house on the square. The advertisements are interspersed with cinematograph pictures, and as the waiting public is not provided with a programme, and can, therefore, not tell whether the next picture will be an advertisement or a free entertainment, the former receive more attention than would be the case if they were exhibited by themselves. Whether the London police would allow the block created by the onlookers is another matter.

Electric Sterilisation of Water.—The water taken from the Bruges Canal at Schoorebrugge is first filtered in the usual manner through beds of different kinds of sand, and is finally pumped through sterilisers, being there subjected to the influence of an electric current at a pressure of 1,000 volts. It is stated that by this means all traces of microbes are entirely destroyed, and the pure water is distributed to the inhabitants of Blankenberge by means of the system previously in use. About 35,000 cubic feet are treated per day in summer, this value falling to about 10,000 cubic feet per day in winter. The electrical installation has an output of 55 h.p. The system, which was invented by Baron Tyndal, has been established in its present practical form by M. Schneller.

The Telephone Question.—The circularising of the London vestries with respect to the telephone question has been quite a feature during the past few months. One vestry or district council passes a resolution and sends copies to all the others. The latest we have seen is from the clerk to the Lee District Board containing resolutions passed by that Board in favour of the whole telephone system of the country being under Government. The resolution states that it is not desirable that the telephone service should be under the control of the London County Council and other local authorities, and that the Post Office should not undertake a distinct telephone service in competition with the National Telephone Company, but should take over the undertaking of the company on terms to be agreed.

"Electrical Engineering."—This little American journal has once more come round to support the independent telephone companies. This it used to do some years back, but was suddenly converted to the Bell interest. Now Mr. C. E. Kammeyer has bought the paper from Mr. Fred De Land, and once more the independent telephones may have hope. Copy can now be easily obtained for the new policy by reprinting the old leaders with careful changes from negative to affirmative and *vice versâ*. The change in other parts of the paper is somewhat ludicrous. Thus the automatic telephone exchange designed by a certain firm, which was condemned in the last issue, gets most favourable mention in the August number. We wish the owner every success, and hope that he will not too blindly follow the side he has chosen.

Teachers' Laboratory Class.—We must again call attention to the excellent course of nine lectures arranged to commence at the Battersea Polytechnic on Oct. 15. The course of lectures arranged is for teachers of physics, and

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will be a continuation of the course undertaken in the previous session, in which elementary measurement was dealt with. The course for this session will deal with the equipment and organisation of laboratories for the teaching of elementary heat, light, sound and electricity, and magnetism. The question of cost of equipment will be fully dealt with. The most suitable apparatus, the degree of delicacy advisable in instruments, and accuracy in measurement will be discussed. The work done in the laboratory will comprise the performance of experiments suitable for elementary courses, with a view to ascertaining the degree of accuracy that should be obtained with the apparatus employed. Instruction and advice will also be given in the manufacture of apparatus.

Faraday House. — The programmes of various technical institutions for the training of electrical engineers still come to hand. This week the Faraday House literature takes the first place as regards weight, and also for artistic arrangement. After some searching, we learn that the new term commenced last Wednesday. Entrance examinations, at which scholarships are awarded, are held twice a year, but the dates of these we do not find in the literature sent to us. As is well known, the students are kept in touch for three years, but the first only of these is spent at Faraday House. In this theoretical instruction is given, and then the student is found a position in one or other of the affiliated firms. The system is good in many ways, but we fancy that the workshop experience at Faraday House might be dispensed with to advantage to allow of more time for theoretical studies. In other words, the time spent at the bench is too short to do much good, and the time available for theory is in the one year too short.

Electro-Harmonic Society.—At the opening smoking concert of the season, to be held at the St. James's Hall Restaurant on Friday evening, Sept. 30, at eight o'clock, the following will be the programme: Part I.—Vocal duet, "The Two Beggars" (H. Lane Wilson), Messrs. Charles Chilley and Bantock Pierpoint; pianoforte solo, "Valse Op. 34, No. 1" (Moskowski), Mr. Alfred E. Izard; recitation, "King John," Act IV., Scene 1., Hubert and Arthur (Shakspere), Mr. Ernest Meads; song, "Maytime and Morn" (Hermann Löhr), Mr. Charles Chilley; bells solo, "The Dear Homeland" (Slaughter), Mr. Harry Tipper; sensational novel, Mr. Frederick Upton; song, "Drake's Drum" (W. W. Hedgcock), Mr. Bantock Pierpoint; ventriloquial sketch, Mr. Sidney Gandy. Part II.—Vocal duet, "The Moon hath Raised" (Balfe), Mr. Charles Chilley and Mr. Bantock Pierpoint; recitation, selection from "Three Men in a Boat" (Jerome) Mr. Ernest Meads; song, "The Eternal Spring" (H. Löhr), Mr. Charles Chilley; bells solo, "I'll Sing thee Songs of Araby" (F. Clay), Mr. Harry Tipper; short stories, Mr. Frederick Upton; song, "Who Carries the Gun" (Needham), Mr. Bantock Pierpoint; humorous sketch, Mr. Sidney Gandy.

The Health-Giving Trolley.—Our New York namesake devotes a column in its current issue to examples of the health-giving properties of electric fans and electric tramways. Fresh air seems to be very scarce in American cities on hot days, and a trip for "air" is getting to be quite necessary. We are still surprised to learn the extent to which this desire to get fresh air is carried in Philadelphia, where people, instead of sleeping in their overheated homes at night or on the blistering brick pavements, are said to be now spending their nights in an atmosphere more beneficial to their health. They now leave their homes at about 10 o'clock at night, board a trolley car, and in about an hour they have reached a spot in the Fox Chase Woods, where there is a difference of temperature of about 10deg. Women and children go as well as men, and it is a novel sight to see hundreds of them camped about in the woods like so many travelling bands of gypsies. Their only baggage, however, is a pillow and a covering of some kind. Fox Chase is free from mosquitoes and other insects which generally make outdoor life uncomfortable in summer. After sleeping or resting in the woods for several hours they return to the city and engage in their day's labour.

The Jungfrau Railway.—The first section of the Jungfrau railway was opened on Monday morning last. The ceremony was attended by a company of 450 persons, specially invited by President Guyer-Zeller, who had a pleasant journey by the new line from the Scheidegg to the Eiger glacier. The railway is worked by electricity. Amongst the guests were representatives of various countries, including the British Minister to Switzerland. Luncheon was served at the foot of the Eiger glacier. When the line is completed, it is intended to build an observatory at the summit of the Jungfrau. At the banquet given to celebrate the opening of the line, Mr. F. R. St. John, the British Minister, proposed a toast to the prosperity of the undertaking. Mr. Edward Morton said that the enterprise would be as much appreciated in Great Britain as in Switzerland. The English toasts were received with the greatest enthusiasm. President Guyer-Zeller stated that the summit of the Jungfrau would be reached in 1904. The next section will, says Reuter's telegram, carry the line as far as the Mönch. It will be remembered that this line is worked by polyphase currents, and that Messrs. Brown and Boveri are both the designers and the contractors for the electrical work.

The Northampton Institute.—The educational and social programme of this institute for the new session—1898-99—has reached us, and shows the great care taken by Dr. R. Mullineux Walmsley in its production. The classes are eminently suited as arranged to benefit youth in the Clerkenwell district. The electrical engineering course is conducted by Dr. Walmsley, assisted by Mr. C. V. Drysdale. The syllabus of these courses give the idea of a well thought-out scheme, as the subject of almost every lecture is arranged beforehand. Special courses are advised for electrical engineer apprentices, for improvers, and for those in actual practice. The same applies to dynamo builders. Electric light wiremen, again, will have a special course, after which a course on central-station wiring and cable jointing can be taken. Then on the other side, classes for telegraphists, telephonists, and electrical instrument makers are provided in various grades, so that a lad can take a progressive course over several years. These arrangements greatly simplify the choice of those entering, and helps to ensure that those joining any class is really receiving the instruction needed for their daily work. In fact, the detailed courses at the Northampton Institute are the best arranged we have yet seen, and we predict that the institute will have a most useful and successful career.

The Overhead Trolley Again.—We learn from an editorial in the *Devon and Exeter Gazette* that the syndicate who own the tramways in Exeter are making an application to the City Council for permission to run the tramcars by electricity. Remembering the past history of the undertaking, the editor confesses that if the horses were replaced by some other motive power that in itself would be a matter for congratulation; but he thinks that the Council need to be very careful, indeed, in dealing with this matter. He asks how the syndicate proposes to utilise electricity. "If the proposal is to have an overhead wire and trolley the application should be refused without a moment's hesitation, inasmuch as this system is both unsightly and dangerous. The electric lighting cables have been put

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underground and the telephone wires are to be placed beneath the surface. To allow new overhead wires to be erected for the use of the tramcars would be a fatal mistake," etc. We think it would pay the tramway contractors of Great Britain to establish a system of tours for editors of papers circulating in towns where electric traction has yet to be introduced. These trips on the Continent and elsewhere would entirely alter the policy of the papers edited on their return, and the cost would be small compared to the benefits derived first by the editors and afterwards by the communities they cater for.

The Analysis of Periodic Curves.—As is well known, Fourier showed that any periodic curve—*i.e.*, any curve, however complicated, which is formed from the addition of similar elements so that any particular ordinate is repeated after a definite interval—could be resolved into a series of sine and cosine curves. Thus the E.M.F. curve of an alternator can be resolved into a series of harmonic curves, with frequencies equal to twice, thrice, etc., the frequency of the primary curve. The calculation of the amplitudes of these components, though tolerably straightforward, is yet very laborious, consequently machines have been invented by Lord Kelvin, Prof. Henrici, Prof. Michelson, and others, to effect the resolution automatically. In the *Revue Général des Sciences* for Sept. 15, 1898, Prof. Weiss gives an account of Ludimar Hermann's method of resolution. By this method the first 20 components may be determined with sufficient accuracy in an expeditious manner. A table is first constructed on a piece of paper containing 440 squares. The number for each square may easily be obtained from the diagram to be analysed, together with tables constructed by Prof. Hermann. Further sheets of paper ruled similarly to that previously used have certain squares cut out, and this sheet being placed over the table already constructed leave only certain numbers visible. These are added together, due account being taken that some of the numbers are positive and some negative, to give the required amplitude. A separate sheet with squares removed in a definite pattern is provided for each harmonic constituent.

Fatal Accident at Bradford.—We much regretted to hear of the fatal accident on the electric tramways at Bradford at the beginning of this week. The mishap occurred on the Great Horton route, which has a continual rise three miles in length from the centre of the city to Horton Bank Top, and attains an altitude of 611ft. from its lowest point. This line has only been opened for three or four weeks. On Monday the traffic was enormously increased by the opening of Messrs. Barnum and Bailey's Show. About 10 o'clock a car, which was practically full of passengers, had got almost two-thirds of the way down the hill when the driver lost control. At this time the car was approaching a point at which the line turns very sharply into a by-road, and in regard to which drivers have been warned to exercise the utmost caution at all times. When the car reached the curve it left the rails, passed over the pavement, and crashed into the solid boundary wall of a chapel at the junction of the road. Those on the top suffered worst, but even of the inside passengers several were seriously hurt. One passenger died within an hour of the accident. The cause of the accident will be fully gone into at the enquiry which Major Cardew is about to hold for the Board of Trade, and till the result of this enquiry is published it is best to reserve comment. Still, we gather from the local reports that the hand brakes had stopped all the wheels before the accident occurred. This, of course, rendered all other brakes useless, and at the same time did not give by any means the maximum braking effort.

The Role of Principles in the Physical Sciences. An interesting paper on this subject is given by Prof. H. Bonasse, of the University of Toulouse, in the *Revue Général des Sciences* for July 30, 1808. In the first place, he inveighs strongly against the historic method of teaching science, which has been recommended to secondary schools. This method, though doubtless one of great interest and importance, should be taught as a branch of comparative psychology to be of any value; further, the vast developments of science render it quite difficult enough to acquire accurate knowledge respecting the state of the science of to-day, without troubling ourselves about its pedigree. In the second place, Prof. Bonasse makes the paradoxical contention that the most valuable general principles do not admit of proof. Thus, he says, the conviction held by anyone as to the validity of Ohm's law, depends in only a small degree on any experimental "proof" he may have performed as a student, or, indeed, on any experimental proof whatever. He accepts the law because he finds it constantly leads to the anticipation of results not otherwise obtainable. It is further contended that the principle of the conservation of energy is accepted with an assurance far exceeding that due tc proofs of its truth. It partakes somewhat of the nature of a logical intuition. Prof. Bonasse rightly takes exception to the proofs, often given in works on theoretical mechanics, respecting the truth of the parallelogram of forces. The proposition is only obscured by the proof given. We are so anxious to be logical, he says, that for fear of putting the cart before the horse we will harness a horse to a motorcar.

Electric Traction on the Brooklyn Bridge.—The trolley cars on this bridge had not been running long before trouble arose, due to the buckling of several of the girders. This has been the subject of numerous scare heads in the American daily papers, and mysterious illusions to the deadly current that is supposed to be continually gnawing at the foundations of the bridge. How far the buckling was due to the excessively hot day on which it occurred, and how far to the extra weight due to the bunching of a number of cars on the bridge, has not been finally determined. Still, from the regulation against the cars being at close space on the bridge, we see that the authorities had fears as to the strength of the bridge even before the buckling occurred. Now we learn from the *American Electrician* that there is, without question, a considerable current flow in the cables of the bridge. This is evidenced in numerous ways. A compass needle placed over the cable will deflect at right angles thereto, and frequently flashing arcs are noticed between the traction cables and the pulleys at the termini. The editor discusses the question of where the currents come from, but undoubtedly the earth return of the tramways are responsible, and also the direction of the current is variable. The question of the effects of these currents on the anchored portion of the chains where the current leaves is one of serious moment, and one which the bridge authorities will do well to investigate. Our contemporary suggests putting heavy copper clamps on the ends of the cables, and by making from these a low-resistance return to prevent electrolytic troubles. A low joint resistance is a most difficult problem in this solution.

City and Guilds Programme.—In looking through the syllabus for instruction in electric lighting and power transmission, and comparing this with the questions set at the last examination, we cannot avoid a feeling of dissatisfaction. The examiners, in the first place, appear to be sadly out of touch with the artisan. For instance, wiremen wishing for a certificate of efficiency from the City and Guilds must answer 10 questions, five of which are pre-

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scribed by the examiners, before they will be permitted to take the practical examination. It must be remembered that the wiremen who take these examinations belong mostly to the labouring classes, and might be said to stand on somewhat the same footing as plumbers, etc. It might, therefore, be expected that at any rate the five compulsory questions would deal with subjects of value to wiremen, and with which they might be expected to have practical acquaintance. What do we find? Question (1) reads: "Describe three different types of primary batteries, and state what kind of work each type is most suitable for." This would be a perfectly fair question for ordinary students of electricity or physics, since these would naturally have opportunities of making themselves practically acquainted with different types of batteries. But for wiremen? What, further, can be meant by the following question, No. 13: "In connecting up a shunt dynamo to run as a motor, would you join the positive pole of the circuit to the positive or negative terminal of the machine? Give full reasons for your answer." Is this merely a catch question, or have the examiners found some reason, heretofore unknown, why a motor would not run equally well whichever way it was connected to the mains.

Electric Locomotives on Elevated Railways.—We must give our contemporary, the *Electrical World* of New York, full credit for its impartiality both in the consideration of foreign practice and also in pointing out faults in American practice. Thus, in the current issue, we find attention drawn to the noise made by the electric locomotives on the Chicago elevated railway. Our contemporary points out that one of the chief advantages to the public often pointed out with respect to the use of electric power on the elevated lines is the reduction of the noise due to the elimination of the cylinder exhaust. A close comparison between the elevated roads now running in New York City by steam power and in Chicago by electric power shows that this advantage of the electric is nullified, or even more than nullified, by another source of noise, namely, the gears. Noise from this source has been pretty well eliminated from surface equipments, but the conditions on an elevated structure are entirely different. The structure itself forms a huge resonator, which responds at once to any vibrations in parts as intimately connected with it as are the trucks running upon its road-bed. The electrically-operated trucks seem also to pound much more seriously over frogs and crossings than do trailer trucks or even steam locomotives. This may be due to the greater amount of deadweight not supported by springs in the electrical equipment. Our contemporary then proceeds to consider the use of gearless motors, such as are used on all our heavy electric lines in England. With these, as proved by the Liverpool Overhead Railway, the objectionable noise is not experienced, but there is some difficulty in obtaining designs of good motors of large power owing to the limited radial space available.

Toothed Armatures.—Within the last year or two there has been considerable discussion as to the relative merits of straight and T-shaped teeth in armature construction, and the subject is further discussed in the current number of the *American Electrician*. Both unquestionably have their advantages. The T-shaped tooth claims, among other features, the great advantage of securing the coils singly and securely without the aid of wire bands by means of wooden fillets in the top of the slot. Further than that, the heating of the pole-piece due to eddy currents is very much less marked with T-shaped than with straight teeth. In a toothed armature the magnetic flux goes almost entirely through the teeth, and during the revolutions of the armature the teeth carry each a tuft of lines of force after the manner of a paint-brush, subjecting the surfaces of the pole-piece to rapidly-varying densities of magnetisation, thereby producing intense eddy currents. This effect is much greater with the straight teeth, and in this form the ratio between grip and tooth is greater than with the T-form. The chief advantage of the straight tooth, on the other hand, seems to be the fact that it permits the use of a machine-formed coil, and very much cheapens the cost of winding the armature, and generally simplifies its construction, and makes more thorough insulation possible. It is certain that the formed coil permits a rapid winding of armatures. By means of these devices it is possible to insulate or wind a 100-kw. armature core complete in less than 24 hours. With any other form this work would take several days at best, and if the old wire-wound types were used several weeks would be required. On the whole, the straight tooth is gaining the day in America in spite of the binding-wire difficulty.

Boston Street-Lighting.—The *Electrical World* gives details of a unique lighting contract between the Boston Municipality and the Boston Electric Light Company to light the streets for a period of 10 years after February, 1899. It provides for a board of arbitration to settle disputes between the parties, and for a change of rates when conditions are favourable. The existing prices for the present number of lights will be charged to begin with, but a material reduction in the cost of lights is provided for on a sliding scale as the number increases. There is a further provision enabling the city to have the price revised by arbitration every 2½ years, so that it shall not yield to the company, after it has met that portion of its operating expenses and depreciation account properly chargeable to its public lighting business, more than the actual return, not exceeding 6 per cent. in any event, which it pays upon the capital invested in its business, whether raised from the sale of capital stock or of bonds; if the company pays a larger dividend than 6 per cent. during the term of this agreement, it will therefore have to come entirely from its profits on private lighting. The difficulty in connection with arbitration of fairly apportioning the expenses of the company between its private and public business has been met by providing for the measurement, under the supervision of the city engineer, of the electrical output for private and public business. On the whole this is thought to be the fairest method of determining the proportion of capital invested, operating expenses, and depreciation which should be charged to the public lighting account. The contract further provides that the lighting company shall substitute enclosed arc lamps for the open arcs now in use. The prices for lighting are as follows: For not less than 2,365 arc lamps nor more than 2,749, 1s. 5½d. per night, £26. 10s. per year. The prices then gradually lower for a larger total of lamps, till for 5,000 lamps the charge is to be 1s. 3d. per night, or about £22 per annum. Under the present contract the town pays £26. 10s per annum per lamp.

The Use of Wireless Telegraphy to Avert Collisions at Sea.—M. Edouard Branly, best known in England as the inventor of the so-called coherer, now so generally used in connection with the transmission of electric signals without connecting wires, has contributed an interesting note on the above subject to the Academy of Sciences. In foggy weather it is obvious that there would be a great gain if ships could make their presence known to each other when still some few miles apart. The use of foghorns is not always efficient for this purpose; M. Branly proposes to use electric signals. It is necessary that each ship should be furnished with both transmitters

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and receivers, and, further, that the transmitters on one ship should be able to affect the receivers on others without disturbing its own receiving apparatus. With powerful radiators and sensitive receivers M. Branly states that metallic screens are ineffectual, unless the receivers are entirely enclosed. It is, therefore, proposed that an arrangement should be adopted by which a receiver is protected from the influence of the transmitter on board the same ship during the time that the latter is acting, being subsequently exposed to the action of transmitters on other ships. It is stated that it is not necessary to enclose the whole of the receiving circuit, the most sensitive portions alone requiring screening. It is further of importance that the bearing of a neighbouring ship, together with its speed and the direction of its motion, should be known. In the first place, a receiver, screened so as to be open to external influences only on one side, might serve to determine the bearing of the ship from which the electric waves are emitted. Further, M. Branly has found that a single spark in a transmitter is capable of affecting a receiver only when the distance between the two is small; to produce effects at greater distances, the number of sparks must be increased. M. Branly has also invented certain forms of metallic envelopes for the receiving apparatus, which permit of the distance of the transmitter being estimated from the intensity of the action of the receiver.

Boosting on a Long Line.—The New York and Sea-Beach Railway, some six miles in length, was taken over by the Brooklyn Heights Railway Company this year, and it was decided to equip the line electrically. Owing to the limited time before the summer season began, an alternate-current system of transmission of power could not be used, as the machinery could not be obtained from stock. The booster system was then adopted as the only alternative, and the method of connecting up the lines, feeders, and boosters constitutes rather a novelty in electric railway practice. It was anticipated that the traffic would be limited only by the capacity of the line, the service to be rendered by 12-bench open double-truck cars, weighing about 10 tons each, running at about 30 miles per hour, and operated without trailers, with a minimum headway of 20 seconds. It was calculated that this would call for a maximum load of about 2,200 amperes. The closeness with which such estimates can be made is well illustrated in this case by the fact that the loads at the maximum periods vary from 2,000 to 2,300 amperes. Three hundred and fifty cars are in service over this route, and this headway has reached a minimum of 14 seconds, but without dangerous overcrowding, owing to the nature of the road and its consequent absence of interference from other traffic. As regards the conductors, the two trolley wires, each ·365in. diameter, are continued from end to end of the line, and are supplemented by a side main ·460in. diameter to increase the area of copper. This side main is continued on to the station as a feeder. Four other feeders are used, one of ·460in. diameter and three of larger diameters. At times of light loads all these feeders are directly connected with the station 'bus bars, on which the voltage rises to about 580 volts above earth, but on Sundays, holidays, and other times of especially heavy loads two special engine-driven boosters are started in the station, the two shorter feeders being fed through one of these boosters and the two longer feeders through the other. Economy of power is of little importance in this service, owing to the short duration of the heavy loads during the year, and hence the feeders were proportioned, not to keep the drop within any predetermined limit, but only of sufficient size to safely carry the currents which it was estimated would be thrown upon them. The boosters, then, were specified of sufficient voltage to overcome the feeder drop with this maximum current, the one requirement of the whole system being the maintenance of 500 volts at all points on the line for speed considerations. The two boosters, which are of a capacity of 1,000 amperes each, can boost up about 350 volts at full load. From the further details appearing in the *Electrical World*, we gather that these temporary arrangements have worked well.

Conduit Lines in New York. — The Metropolitan Street Railway Company of New York started converting their tramways into electric conduit lines only a year ago, and already the change has produced most wonderful changes in the traffic returns. As fast as sections are completed they are being opened for traffic, and the power is being supplied from temporary power-houses. The increased business, due to the improved nature of the service on these lines, has, says the *Electrical World*, been most astonishing. The increase came as a surprise even to the officials of the company themselves, although they have had previous experience in the re-equipment of horse-car lines with cable apparatus. Where small horse cars jogged along with a fair patronage, double-truck electric cars of twice the capacity, twice the speed, and one-third the headway are crowded to their very limits. The company has met the public's demands by constantly adding to the service, putting on cars as fast as they could be built and equipped, and loading up every new generator to its limit as soon as it was ready to run. The improvement in service is so great that the public has insistently demanded the change on other lines, and two such lines reaching the shopping districts are now about ready to go into service. Mechanically and electrically the conduit system on these lines is said to be an unqualified success. Troubles with the ploughs and underground rails are much less frequent than with the overhead pole and trolley wire. The nuisance of the trolley slipping off has no equivalent disadvantage in the underground system, the plough of which requires no attention whatever on the road. It must be confessed, however, that when accidents do occur to conduit apparatus they are likely to be more disastrous than cases of trouble with the overhead trolley. If the latter becomes deranged or broken it is readily pulled down and the car pushed or pulled in by another; but accidents to the plough of the underground system are likely to choke up the conduit or wedge parts tightly in the slot, and to require considerable work to clear the line again for operation. No trouble has been experienced from water or snow, and apparently but little trouble from spreading of the conductor rails or failure to make contact from any cause. An incidental advantage of the conduit system of no little importance is the solidity of the road-bed, due to the depth and massive nature of the concrete conduit walls, which with the yokes form a most perfect foundation for the track. A feature of the switches and crossings from which some trouble might have been anticipated is the necessary break in the continuity of the conductors, cutting off power from the car for short distances at these points. To be sure, this is somewhat of a nuisance at night to passengers who are reading, as the lights go out with annoying frequency on a complicated crossing. The attention of the motorman is also distracted to a certain extent from his other cares at these points by the necessity of turning off the power before his plough reaches each such break and turning it on immediately after leaving the break, and of preventing his car from stopping in the open circuit position, in which case it could not again be started. This requirement, however, seems to give no trouble in practice.

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ON THE ELECTROLYTIC CORROSION OF WATER AND GAS PIPES BY THE RETURN CURRENTS OF ELECTRIC TRAMWAYS.*

BY DR. J. A. FLEMING, F.R.S.

The subject of pipe corrosion by the earth return electric currents of electric tramways has at various times attracted a considerable amount of attention. There is no need to refer to the experience gained in the early days of electric traction, chiefly in the United States, which impressed on engineers the necessity for proper and efficient bonding of the rails in those cases in which they act as the return circuit. The British Board of Trade regulations now in force, under which electric traction is at present conducted in the United Kingdom, prescribe precisely the conditions for the use of uninsulated metallic return circuits, which are intended to prevent injurious electrolytic action on subterranean pipes. Amongst these rules an important one is the sixth regulation, in which the maximum permissible potential difference which may exist between a pipe and a portion of the neighbouring rail return is stated. In the case of an overhead electric tramway working with an earth return in which the current returns to the generating station by the bonded rails assisted or not by return feeders, an electrical survey, made when cars are running, by measuring with a voltmeter the potential difference between the rails and any pipes buried in the earth in the neighbourhood, generally will reveal certain districts over which the tramline rails are positive to the buried pipes in their neighbourhood—that is, are at a higher potential. Certain other regions, usually near the generating station, will be discovered, in which, on the other hand, the pipes are positive to the rails. The Board of Trade regulation 6 (ii.) is as follows:

"If at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in its vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return."

The above, translated out of official language, signifies that if the pipe is negative to the rail the potential difference shall not exceed 4·5 volts, and if the pipe is positive to the rail the potential difference shall not exceed 1·5 volts.

No matter what difference of potential may exist between a pipe and the neighbouring rail, it is well understood that electrolytic corrosion or damage can only ensue at any place under two conditions:

1. The potential difference must create an electric current which leaves the pipe at that place; and

2. The conduction through the surrounding soil, or at least into it, which thus takes place must be electrolytic in character.

Hence, generally speaking, the danger areas are those in which the pipes are positive to the rails, and where a resulting current flows out of the pipe into adjacent electrolysable soil. Assuming, then, that the Board of Trade regulations are obeyed, the chief question of practical interest at present is to determine whether under normal conditions of working a potential difference of less than 1·5 volts between a pipe and the nearest part of an earth return, the pipe being positive to the return rail, is sufficient to cause an injurious action on the pipe by the production of electrolytic erosion. The matter is certainly largely determined by the nature and amount of the electrical conduction which can take place through ordinary soils, specially those which form the subsoil in towns and cities. Information has therefore been collected on this matter.

An experiment made in my laboratory with London clay taken from an opening in a London street made for laying down pipes, on Dec. 14, 1897, gave the following results: The clay was packed into a dry well-varnished wooden box, the interior measurements of which were depth = 27·3cm., width = 18·0cm., length = 61cm. Two clean sheet-iron plates were placed at the ends of the box, the dimensions of each plate being as nearly as possible equal to the cross-sectional area of the column of clay. Wires were soldered to these plates. The resistance of the mass of clay, 61cm. in length and 491·4 square centimetres in cross-section, was found to be 194 ohms when measured with proper precautions in the usual way with the Wheatstone's bridge and two dry cells. Keeping this E.M.F. applied, the resistance soon rose to 277 and then to 283 ohms, indicating a progressive polarisation of the plates and therefore an electrolytic conduction. A checking measurement was made also with the potentiometer, and it was found that a potential difference of 100 volts, created between the plates, produced a current of 0·52 ampere through the column of clay, thus indicating a total resistance of 194·5 ohms. These consistent figures show that the resistance of the clay in its then condition of moisture was approximately 1,566 ohms per centimetre cube, or nearly 17 ohms per yard cube.

The resistance proved, as might be expected, to be immensely dependent on the state of the clay as regards moisture, greatly increasing as the clay dried up.

A mass of damp sand, moistened with water slightly salt, was found a have a resistance approximately of one ohm per yard cube.

Experiments by Dr. St. Lindeck* at the Reichsanstalt, in Berlin, in 1896, showed that cement blocks, after immersion in water for 22 hours, had a minimum electrical resistance of about 14 to 15 ohms per yard cube, but in their normal state a resistance of about 50 ohms per yard cube, and when specially dried by heating for 5½ hours to 100deg. C., a resistance of nearly 270 ohms per yard cube. The same investigator found that concrete (one part cement, five parts gravel), after being immersed for two hours in water, had a minimum resistance of about 25 ohms per yard cube, but after being artificially dried for 4½ hours at 100deg. C., its resistance was of the order of 500,000 ohms per yard cube.

It has been frequently stated that concrete is a very bad conductor or fair insulator, and that rails laid on it are practically insulated, but the considerable decrease which takes place in the electrical resistance of materials such as clay, cement, concrete, sand, and various soils, when impregnated with moisture, and the great increase which takes place when they are artificially dried, indicates that the conduction through them in their normal condition is largely due to the presence of water, and must therefore, in great part at least, be electrolytic in character.

In the average condition of moisture most of the materials forming the subsoil in town and city streets are not likely to differ much in conductivity from the sample of London clay, damp sand, or cement, tested as above described, and will probably have a specific resistance between 15 and 30 ohms per yard cube. Although the above specific resistance is large compared with that of metals, being of the order of 1,000 million times that of copper, yet between extensive metallic surfaces buried in the soil, the actual total electrical resistance may be numerically very small. Between two 100-yard lengths of 6in. clean iron pipe placed in clay ground a yard apart, and, say, 2ft. deep, the actual measured resistance would in general be something of the order of one ohm. It is clear, therefore, that a continuously-applied voltage, not exceeding 1·5 volts, may cause the flow of very considerable quantities of electricity in the course of time between metallic surfaces of large area buried in the soil. Moreover, it is evident that a not inconsiderable portion, and perhaps the whole of this flow, must be carried by electrolytic conduction. In any case, whatever may be the nature of the actual road bed on which the rails rest, the conduction out of the pipe will be in part electrolytic, if the pipe itself is in contact with ordinary soil. Under these circumstances the anode or pipe will be electrolytically attacked. Suppose that two iron plates or surfaces are placed in sand moistened with water, and having in it electrolysable salts, the acid

* Paper read before the British Association at a joint meeting of Section A and Section G at the Bristol meeting, September, 1898.

* See *Elektrotechnische Zeitschrift*, March 19, 1896.

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radicles of which can attack iron. Let a current be made to flow from one plate to the other by creating a potential difference between them, then the passage of one ampere-hour out of the positive plate will remove or dissolve off from that plate 0·6968 grm., or, say, 0·7 grm. of iron, if the metal is removed in the ferric state, or 1·04 grm. if in the ferrous state. Since there are 453·59 grm. in 1lb. (avoirdupois), and since the specific gravity of iron is about 7·8, it is easy to see that one cubic inch of iron may be removed from the positive plate by the electrolytic passage out of it of some electric quantity between 127·7 and 182·5 ampere-hours. This is, very roughly speaking, one ampere-week. The iron so electrolytically removed may pass either into soluble iron salts, or may remain as an adherent layer of hydroxide. If chlorides, sulphates, or nitrates are present in the soil the iron may be removed partly as ferrous or ferric salts, which may be diffused through the surrounding soil, or wholly or in part converted into insoluble and adherent ferric hydroxide by secondary reactions. It is important to know the minimum voltage which will effect this electrolytic corrosion. If the surrounding soil is of a nature to favour electrolysis—that is, if moisture and salts are present in it—a far less difference of potential than the maximum of 1½ volts permitted by the Board of Trade can produce rapid corrosion of an iron anode or plate. To illustrate this fact the following experiment was tried: Two plates of sheet iron were placed in a porcelain box filled with sand slightly moistened with salt water. The plates were kept at a difference of potential of one volt and at such a distance apart that a current of one-twentieth of an ampere passed between them. At the end of 10 days the positive plate was very much corroded; the negative plate not at all. It has been found that the actual weight of iron removed may very much exceed the electro-chemical equivalent of the current passed, due, no doubt, to local action. This is shown by the following experiment: Two iron plates were cleaned and weighed previously to being used, and then placed in moist sand containing a little salt. The plates had an immersed area of 11·4 square inches, and were 4·25in. apart. A difference of potential of 1·5 to 1·8 volts was maintained between them for 23¼ hours. At the end of this period the positive plate was weighed and found to have lost ·039lb., or nearly ⅔oz. The electric quantity passed was only 8·14 ampere-hours. Theoretically this quantity should have removed from 6 grm. to 8 grm., or nearly ¼oz. from the positive plate. The actual loss was nearly three times that amount, and the excess is probably accounted for by the great local action taking place on the iron plate when oxidised in patches and placed in an electrolyte, the acid radicle of which is capable of forming a soluble salt of iron.

In a paper read by Mr. I. H. Farnham before the American Institute of Electrical Engineers in 1894, it is stated that some of the worst cases of pipe corrosion in Boston, U.S.A., occurred when the potential difference of the pipe and rail was only 1·5 volts.

Mr. A. T. Wells, of Chicago, in mentioning some cases of cable corrosion which occurred in Cincinnati, stated that the potential between the rail and cable was never more than one-half and usually less than one quarter of a volt.

Mr. J. C. Lee, of Boston, states he has experimentally caused the corrosion of lead and iron by a difference of potential of one-hundredth of a volt.

I have myself produced in a few days sensible erosion of an iron anode placed in moist sea sand, the difference of potential between it and an iron cathode being less than half a volt and the current passing only ·03 of an ampere.

These experiments and others of a like character showed that quite small potential differences—much less than one volt—between iron surfaces buried in damp soils, especially if soluble chlorides are present, may bring about considerable electrolytic erosion in not very great periods of time, and that there is no absolute security in the limit of 1½ volts as imposed by the Board of Trade regulation No. 6 (ii.). It was felt desirable to try an experiment on a somewhat larger scale and with actual water-pipes buried in the soil. At my suggestion Mr. H. W. Pearson, the engineer of the Bristol Water Company, has carried out at the Bristol waterworks, at Chelvey, an experiment of the following character:

Three rows of new ordinary cast-iron 5in. water-pipe were laid down in the ground, one yard apart. Each row consisted of four lengths of 9ft. pipe, or 36ft. in all. The lengths were jointed in the usual way with lead and the ends of the lengths were capped with cast-iron caps. In each pipe length was screwed a wrought-iron rod about 2ft. 6in. in length.

These 36ft. lengths of pipe were buried in the ground 2ft. deep, just as if they were actual water-pipes in use. The ends of the iron standards projected above the ground, and enabled an electrical connection to be made with the pipes at any length. The pipes when buried were clean new cast-iron pipes. Arrangements were then made to keep two adjacent rows of these pipes at a difference of potential of one volt night and day for six months. This was achieved by the use of a couple of large secondary cells charged alternately, and which were connected through an adjustable resistance with the two adjacent rows of pipes. A low-reading ammeter and voltmeter was provided. The experiment was started on March 1, 1898, and continued for six months. Daily readings were taken of the voltage between the pipes, the current passing between the pipes, and the nature of the weather. The electrical arrangements were placed under the charge of Mr. H. T. Sully.

The arrangement was then as follows: One row of pipes was neutral, and simply laid down for comparison to observe the normal appearance of the pipes at the conclusion of the experiment. The other pair of pipes had a difference of electrical potential of one volt maintained between them constantly. All three rows of pipes were otherwise under similar conditions and buried in soil of the same kind—a non-acid nearly neutral loam or sandy clay. The average current passing between the two active pipes was 0·15 of an ampere, and varied only between 0·1 and 0·2 of an ampere during the whole six months. At the end of the six months the pipes were opened up and carefully examined. The appearance of the pipes was very different. That pipe length which had been connected to the negative pole of the cell was a clean, grey colour, and had scarcely any trace of oxidation on it. It closely resembled the appearance of the pipe when first put in. The pipe length which had been connected to the positive pole of the cell was uniformly covered with a layer of orange-yellow oxide or hydroxide of iron, in some places of quite sensible thickness and easily detached. The pipe which had been neutral was oxidised slightly in places, but by no means uniformly. The experiment lasted 4,416 hours, and 662 ampere-hours had passed from one pipe to the other under a constant voltage difference of one volt. The appearance of the pipes clearly indicated that electrolytic action had taken place. In the case of the negative pipe the clean appearance suggested that electrolytic hydrogen had been liberated against it and preserved it from oxidation by contact with the gases, water, and salts in the soil. In the case of the positive pipe, electrolytic action had clearly assisted or created oxidation. No actual perforations or pitting was found on the positive pipe, probably by reason of the fact that the electrical connections were so made as to facilitate as far as possible a uniform electric flow from one pipe to the other, not specially localised in one place. The actual electric quantity passed—viz., 662 ampere-hours—is theoretically equivalent to the removal of about 3·5 to 4 cubic inches of iron. Since the pipe had a length of 36ft. and a diameter of 5in., its surface is approximately 6,500 square inch or 45 square feet. Hence the oxidation of a comparatively small thickness of the iron uniformly all over the pipe would, electro-chemically speaking, account for the electric quantity passed. The difference between the two pipes amounted in effect to a greater rate of "ageing" of the positive pipe. It is, however, certain that if the electrolytic action, which in this case was tolerably uniformly diffused over the whole pipe surface, had been concentrated at one particular place, the erosion would have assumed a more serious aspect.

In the above-described experiment none of the conditions served to direct the exit of the current to one limited area on the positive pipe.

It is obvious that if under any conditions of electric

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traction there are differences of potential between the portions of a continuous pipe buried in the earth, the production of a current of conduction, and, therefore, perhaps, electrolytic erosion is dependent upon the longitudinal conductive power of the pipes themselves. It has been stated above that ordinary subsoil resistance may be something of the order of 10 to 50 ohms per yard cube. The specific resistance of cast iron is about 100 microhms per cubic centimetre, and would therefore be not far from one-millionth of an ohm per yard cube. It is therefore very easy to see that if it were not for the resistance introduced at the joints of the pipes, and at the surfaces by rust or oxides, the conductivity of a cast-iron pipe would always be much greater than that of the soil which it displaces.

The resistance introduced, however, by bad or oxidised contacts, or by films of moisture, paint, or preservative compound, may altogether overbalance or outweigh the resistance of the mere run of the pipe material. I calculate that if there were no joints at all, the electrical resistance of 5in. cast-iron water-pipe would be about one-fiftieth of an ohm per 100 yards, or, say, one-third of an ohm per mile. If leaded junctions are made in the usual way between fairly clean surfaces the joint resistance may not be large. In the case of the pipe experiment, above described, made at Chelvey, I measured at the end of the six months the total resistance of 27ft. of the 5in. cast-iron pipe, which had been the negative pipe. This length included two leaded joints. The whole resistance was found not to exceed one-twenty-fifth of an ohm.

It is obvious, however, that no general statements can be made. It is a matter of great difficulty to measure the resistance *per se* of a pipe buried in the ground, and it is probable that, whereas in some cases the conductivity of long lengths of water and gas pipes may be fairly small, in other cases oxidised or electrically bad joints will introduce great resistance.

We have, however, to regard the subterranean pipes of all kinds as forming a network of conductors, interrupted more or less at places by junctions of high resistance; but, on the whole, most probably forming an irregular conductor system of greater conductivity than the soil or earth actually displaced by it, or which would occupy the same space if the pipes were not there.

Let us consider next the electrical conditions in the neighbourhood of an electrical overhead system of street railway. In all cases where the uninsulated tramrails are used as a return, it is unquestionable that some fraction—perhaps a large one—of the return electric currents will come back through the earth from the distant or more remote portions of the track to those near the generating station, no matter how well bonded the track may be. The exact distribution of this current flow through the surrounding subsoil it is impossible to determine, but if there is a current at all it involves as a corollary the existence of current flow and orthogonal equipotential surfaces.

When cars are in operation, current is being discharged at various places into the line. One end is therefore at a higher potential than the other end. The Board of Trade regulations permit a maximum of seven volts for this total rail fall. The result will be that through the earth we have a distribution of current-flow lines, terminating on the rails. The terminations of these lines accumulate near the places where the cars happen to be, and move with the cars. Orthogonally to these flow lines, or at right angles to them, there are equipotential surfaces, which are shifting about in the earth as the cars move along. The disposition of the current lines will be modified by the presence of pipes in the ground, in so far as these are conductors, also by the electrolytic E.M.F.'s.

If, then, subterranean pipes exist in the region occupied by this return flow, and if these pipes have their extremities on different equipotential surfaces, it is certain that current flow must take place through these pipes if they have any longitudinal conductivity, and no amount of conductivity in the soil short of infinite conductivity will altogether prevent this from happening. The proof of this is found in a very simple experiment. In a large vessel containing an electrolyte, say dilute acid, two electrodes are inserted, by means of which a current can be passed through the liquid mass. Two lengths of insulated copper wire have their ends just stripped to lay bare the wire, and are then twisted together to within a couple of inches of the ends. These ends are spread out at right angles. The other extremities are connected to a galvanometer. If the spread out bare ends of this galvanometer wire are dipped in the electrolyte, it will be found that a current passes through the galvanometer one way or the other, according to the position of the collecting end. If the spread end is placed so that it is at right angles to the line of the current flow, then no current will flow through the galvanometer. The explanation is, of course, obvious. If the extremities of the exploring wire lie on different equipotential surfaces of the electrolyte when traversed by the current, the galvanometer, of course, indicates a current. If the ends lie on the same equipotential surface, then the galvanometer indicates no current. After the test wire has been employed in this manner it will be found that on stopping the main current the galvanometer gives a transitory reverse current, due to polarisation of the electrodes.

In the case of long electric street railways worked on the rail-return system it is unquestionable that the difference of potential between the different portions of the track when cars are running, involves as a certain consequence the flow of current through the earth, however efficiently the rail bonding may be carried out. Mr. H. F. Parshall has stated (*Proceedings* of the Institution of Civil Engineers, April, 1898) that in tests carried out on an eight-mile track, cutting the rails at the centre and inserting an ammeter, showed that 60 per cent. of the current was returning through the earth itself.

I think it will be agreed that it is exceedingly important, in the interests of other industries besides the electric traction industry, that in those cases where this earth flow occurs we should endeavour to find out where this current is going and what it is doing.

It is a matter of great difficulty to carry out experiments on actual electric street railway lines. We cannot always be cutting rails, and we certainly cannot cut gas and water pipes to ascertain the currents which may be flowing in them. I have therefore directed my attention to making a sort of working model of an electric traction system with an earth return, and of such a kind that pipes or equivalent conductors can be buried in desired positions, and an electrical survey made of the whole arrangement.

The model is made as follows: A large wooden box is provided, best made of paraffined or well-varnished deal. This box may be of any desired size, but is best made square, and of a depth equal to half the length or breadth. This box is filled with sea sand or river sand mixed with a little salt to give better conductivity, and so compensate for limited dimensions, and the whole mass is moistened with water until it is thoroughly and uniformly damp, but without free water on it. The resistance of such a mass will be about one ohm per yard cube between opposed surfaces. On the surface of this sand, which represents the earth, conductors can be laid down to imitate an electric tramline. I have found it convenient to employ rods of plumbago and clay by which the required resistance and current-carrying power is obtained. A pair of these rods connected in parallel by platinum wires may be laid down to imitate the line. A fall of potential along the line may be made equal to, say, seven volts, or to the maximum fall permitted by the Board of Trade, by attaching the terminals to a battery of four or five secondary cells to the ends of the line. If an ammeter is included in this line circuit, it will be found that the total current taken is greater when the rods are laid on the damp sand than when they are bodily lifted up. This difference indicates the earth return current. In order to explore the distribution of current through the mass of the "earth," a galvanometer or voltmeter is provided, having flexible leads, and the ends of these attached to two insulated wires twisted together, the other extremities being bared and splayed out to form a sort of fork.

In the sand, then, can be buried, at a slight depth, thin iron or lead wires or tubes, to represent gas and water pipes, and these can be given any required form and arrangement.

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An electrical survey can then be made with the voltmeter. If a "pipe," or wire representing a pipe, runs nearly parallel to the "line," it will be found that at one end of the line the "line" is positive to the pipe, and at the other that the pipe is positive to the "line." In my own model I have found that the potential differences of such a "pipe" and the line amount to one or two volts, just as they are found to do in the case of real electric street railways, when measurements are made between the rails and a parallel buried pipe.* In the case of the pipes running parallel to equipotential surfaces the potential differences between all parts of the pipe and any one point of the line are nearly the same. By means of the exploring or testing fork it is easy to show that the earth return current flows through the whole mass of the sand, and with a little trouble the general form of the equipotential surfaces can be ascertained.

If the wires representing "pipes" are bent so that they have a loop in them which emerges above ground, this loop can be cut, and a sensitive ammeter or galvanometer inserted, so as to indicate the current flowing through the "pipe." In this manner it can be proved that when a pipe runs approximately parallel to the track, and when it is found to be positive to the rails near the generating station, and negative to the rails at distant points, there is a current flowing in the pipe from the far end towards the station end. If the pipe runs more or less transversely to the line then little or no current will appear in it.

In the case of actual pipes and real street railways it is an impracticable matter to make such tests as shall show whether there is a current flowing in the pipe or not. We can only infer its existence when electrolytic corrosion has made its appearance.

From experiments made with the above model, I am led to believe that if pipes or wires were laid down imitating the form or arrangement of the actual main pipes, and if a track were laid down imitating the plan of the real track, that useful information might be gained as to the localities, if any, in which electrolytic trouble may be expected.

It is, of course, obvious that a model on a limited scale can only very roughly represent the true state of affairs. In any actual case it is an exceedingly difficult, if not impossible, matter to predict the path along which the earth return current will distribute itself. It depends on unknown conditions as to rock and soil conductivity due to moisture, geological formations, subsoil water, infiltrations of sewage, brine springs, the conductive effect of buried pipes, leakage of water, gas, and the nature of the car traffic at the moment. There is, however, a drift of current through the earth from the most distant portions of the line towards that point or points where the negative dynamo terminals are attached to the rails. The question of pipe corrosion is wholly bound up with the degree to which this return current takes advantage of pipe conductivity to help it on its way or is carried by the pipes as well as by the earth. This is not prevented by the fact that the earth resistance, taken as a whole, may be very much less than that of any line of pipe, but it is affected to a considerable degree by the resistance due to pipe junctions, or to the surface resistance afforded by oxidation of the pipes by which the entrance of current into them is hindered. The above statements can be proved by the use of wires imitating pipes badly jointed or partially insulated, and buried in the sand of the model electric railway just described, and a model of the above kind proves itself to be exceedingly useful for lecture or demonstration purposes, in addition to its employment as a means of testing theories.

It appears, then, that the following statements may be taken as correctly representing facts, in the case of electric street railways having uninsulated rails used as a return circuit:

(i.) No amount of bonding of the rails, if uninsulated, will entirely prevent the flow of current through the adjacent earth when there is any difference of potential between different parts of the line, and even with good modern binding, or even continuous rails, a fraction, not inconsiderable, of the whole outgoing current may return by the earth.

(ii.) Some portion of this current will pass through subterranean pipes, the amount being determined by (*a*) the general or local subsoil conductivity; (*b*) the electric conductivity and continuity of the pipe lengths and depending on joints and material; (*c*) the length and disposition of pipe, and its position as regards the average equipotential surfaces in the earth, when the line is working; (*d*) the condition of the pipes as regards oxidation or incrustation with non-conducting oxides or protective covering. The position which seems most likely to be favourable for the passage of current into the pipe is when it extends for some distance parallel with the rails and passes near the point of junction of the return feeder to the power station and the rails, and when it is new or fairly clean and well jointed; all conditioned, of course, by the general earth conductivity.

(iii.) The danger areas are those regions in which the pipe current, if it exists, leaves the pipe to get back into the rails or return feeder or even into the same pipe again, but mere difference of potential between the pipe and the rail is not in itself a source of danger to the pipe. There must be, in addition, electrolytic conduction of current out of the pipe into adjacent soil, which contains electrolysable salts and the necessary moisture.

(iv.) If electrolytic conduction out of the pipe exists at any places there is no absolute security in the Board of Trade limit of 1·5 volts for the potential difference of pipe and rail, except in so far that the less the voltage the less rapid will be the damage. Electrolytic corrosion may take place when only a small fraction of a volt difference of potential exists between the iron pipe and the adjacent portions of the rail return.

(v.) The conditions most to be feared as provocative of pipe destruction are when certain local soil conditions exist near the places where the pipe is most positive to the rail. The presence of soluble chlorides in the soil produced by presence of sewage, brine springs, infiltration of sea-water, if near the sea, solution of chlorides of sodium, potassium or magnesium or other salts present in the soil produced by water due to pipe leakage or natural accumulation by rainfall saturating the soil, set up at once conditions permitting electrolytic conduction, and the resulting liberated acid or chlorine ions attack the cast-iron pipe. In rapidity of destruction under this action, a new clean pipe may possibly succumb even sooner than an old one protected by a dense adherent coating of oxide, which is a not very good conductor. The time which any such action takes to reach a stage destructive to the pipe will be obviously less the more the electrolytic action is concentrated on a limited area of pipe surface.

In designing an uninsulated rail-return traction system, the probability of the above-mentioned conditions occurring should not be ignored. Even if actual perforation of the pipes does not occur there may be an "ageing" action which shortens the life of the pipe.

(vi.) As the conditions determining possible pipe corrosion are numerous, and not all easily predetermined, it is important, in the case of every electric traction system with uninsulated earth returns, that an electrical survey should be made at intervals, setting down on a plan showing rails and pipes, the potential differences between them at various places. Within the danger area a close watch can then be kept, whenever the ground is opened up for any purpose, for evidence of destructive electrolytic action on buried pipes.

In the above short summary of the causes and conditions of pipe electrolysis, no reference has been made to the question of remedy when it is found to exist. To deal with this portion of the subject properly would require more time than is at present at my disposal. All that has been here attempted is to show that, even working under Board of Trade regulations, it must not be assumed that the danger does not exist.

* If the "rails" in the model are made of carbon, and the "pipes" are made of iron wire, there will be a constant potential difference between them of about one volt, due to the carbon, damp sand, and iron forming a voltaic couple. This constant potential difference, however, can be taken into account in measurement, and does not interfere with the detection and measurement of those potential differences set up by the flow of current through the sand, which is originated by the external E.M.F.

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A COMPARISON BETWEEN CHARGING A SECONDARY CELL AT CONSTANT POTENTIAL AND AT CONSTANT CURRENT, MORE ESPECIALLY AS REGARDS EFFICIENCY.*

BY A. A. CAHEN AND J. M. DONALDSON.

Introduction.—Till a short time ago, it has been the custom to charge secondary cells with a constant, or approximately constant, current, but lately the experiment has been tried of charging at constant potential, thereby reducing considerably the time needed for charging. The saving of time thus effected is often of very great importance, but in other particulars the method may be inferior to the more usual one—namely, that of charging at constant current. It was in order to compare the efficiencies (more especially) obtained with the two methods, that the following series of tests were carried out in the laboratories of the Central Technical College, South Kensington.

The same cell was tested by the two methods, in order to afford a just comparison. It was charged, in the first series of tests, at constant P.D., and discharged at constant current; in the second series it was charged at constant current, and discharged at the same constant current as in the first series.

Cell Used.—The cell made use of was of the Tudor type, known as No. 11 L. A., and had five plates, two positive and three negative, the former being unpasted and the latter pasted.

Its capacity was listed thus	Capacity (amp.-hours).....	140	120	108
	Discharge current (amps.).	14	24	36
	Charging current (amps.)..	20	20	20

Its outside dimensions were: length, 9½in.; width, 5½in.; height, 18in.

The plates were kept about ½in. apart by glass tubes.

It must be mentioned that the cell had been subjected to a number of charges at constant P.D. before the present tests were carried out.

Experiments Performed.—Below are given the tests made on the cell in the order in which they were undertaken. In using each method the cell was repeatedly charged and discharged without intermission until it had arrived at a "steady state"—that is, until precisely the same results were obtained in successive cycles. This was shown by the charge and discharge curves for successive cycles becoming coincident.

When this was the case, it was certain that the cell had ceased to draw upon any store of energy put into it during chargings preceding the tests, and was, during discharge, simply converting the chemical energy put in during the previous charge into electrical energy again.

On Feb. 24, 1898, after a preliminary discharge, the cell was charged at a constant P.D. of 2·508 volts, and charging was continued until the current had fallen to 10 amperes. The cell was then discharged, at a constant current of 36 amperes, until the P.D. had fallen to 1·815 volts. The interval between charge and discharge was usually only one minute and seldom exceeded two minutes, being sometimes as little as half a minute. Any recuperative effects were thus practically eliminated. In all 50 charges and discharges within the same limits as the above were carried out, the fifty-first charge being given on March 4, and the cell left charged.

On March 7, 1898, after a preliminary discharge, charging at constant current was begun. The charging current was kept constant at 20 amperes, and charging was continued until the P.D. at the terminals of the cell had risen to 2·508 volts. This point was decided upon chiefly because the rise of P.D. was here most rapid, and so the precise moment for stopping the charge could be most accurately obtained. Discharge took place with precisely the same limitations as after a constant P.D. charge—namely, the current was kept constant at 36 amperes, and discharge was continued until the P.D. had fallen to 1·815 volts.

However, as the watt-hours that could be put into the cell when charging at constant current were only about 137, as compared with 230 put in by a constant P.D. charge, it was decided to charge still further; therefore in the twenty-third and all following charges the P.D. was let rise to 2·58 volts before charging was stopped. This increased the watt-hours that could be put to about 150—still a small value compared with that obtained by the constant P.D. method. It was not thought advisable to charge to a still higher limit, because the plates were at the end of the charge gassing very violently, and though the discharge capacity might have been increased by going higher, yet it would have been at the sacrifice of efficiency.

This small capacity caused us to surmise that the large currents that flowed during the early parts of the constant P.D. charges had damaged the cell, and so, when it was thought that the cell had arrived at the steady state, at the end of charge 46, charging at constant P.D. was again started after an interval of 25 minutes, the cell having been discharged previously almost to the limit. A very few tests were enough to show that the capacity obtainable by this method had not appreciably diminished, and, after seven charges and discharges, a final charge was given, and the experiments were brought to an end on March 18, 1898.

The cell at the time of the tests showed no outward signs of deterioration. The plates were quite straight, and the amount of sediment at the bottom of the cell had not notably increased.

Instruments and Experimental Methods.—The cell was charged from six pairs of accumulators all in parallel. During the constant P.D. charges very large currents flowed at the beginning of the test, and it was found convenient to use two ammeters in parallel. Of these, one was an Evershed instrument reading up to 150 amperes, and the other was a Weston reading up to 100 amperes. In a constant P.D. test the two were in parallel at the start, but when the current had fallen below 100 amperes the circuit of the Evershed was broken and the Weston only was used. In the discharges and in the constant-current charging the Weston ammeter was used alone.

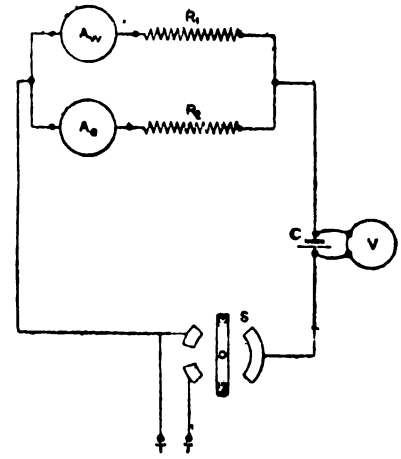

FIG. 1.

The following letters refer to Fig. 1:

A_e, Evershed ammeter, with R_2, a carbon resistance, in series.

A_w, Weston ammeter, with R_1, a carbon resistance, in series.

S, a two-way switch for changing from charge to discharge.

T T, the terminals to which the charging cells were joined.

V, a Hartmann and Braun voltmeter reading up to three volts and connected permanently with the terminals of the cell, C.

C, the Tudor cell under test.

Density.—Density readings were taken on a hydrometer which it was not easy to read accurately, owing to the narrow space in which it floated. The instrument was liable to be sucked either against the plates or against the sides of the cell.

E.M.F.—Readings of the E.M.F. were taken at the end of the charges and discharges, but it was very difficult to discriminate between the natural swing of the voltmeter pointer and the effect caused by the rising or falling E.M.F. immediately after the circuit was made or broken. After

* Paper read before the British Association, Section A.

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a charge at constant P.D., the pointer usually fell in a series of jerks, and the reading taken was that after the first rush down was over.

RESULTS OF TESTS.

Charging at Constant Potential.

Efficiencies and Capacities.—After the first 12 charges and discharges of the first series of tests, the cell seemed to have settled down into a more or less steady state, but the efficiency varied from test to test in a somewhat unsteady way. This was, no doubt, partly due to the difficulty in determining the exact minute of the discharge when the

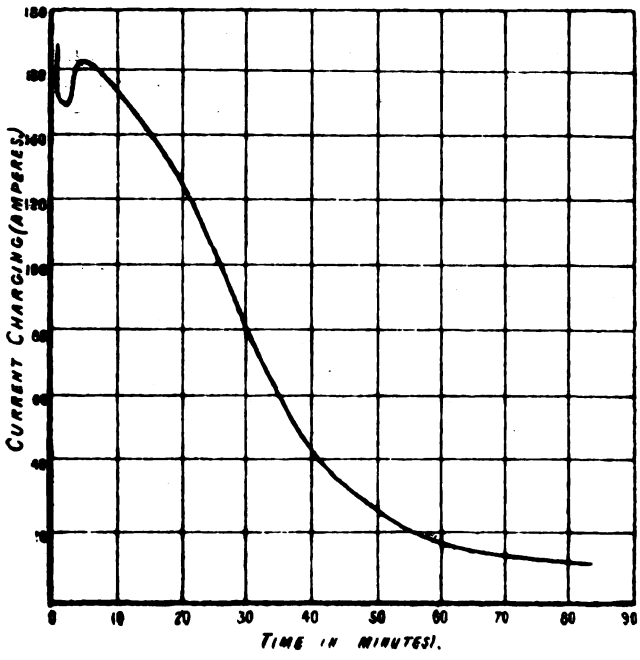

Fig. 2.—Tudor Cell. Charging at Constant P.D. of 2·508 volts. First Set of Tests. Charge 44 × Charge 45 o.

P.D. had fallen to 1·815 volts. An error of a minute is quite easily made, and when discharge takes place at 36 amperes, this means a mistake of 0·6 ampere-hour in the capacity. Hence, if the discharge is stopped one minute too soon, the efficiency for that test will be lower, and for the next higher than what it really should have been.

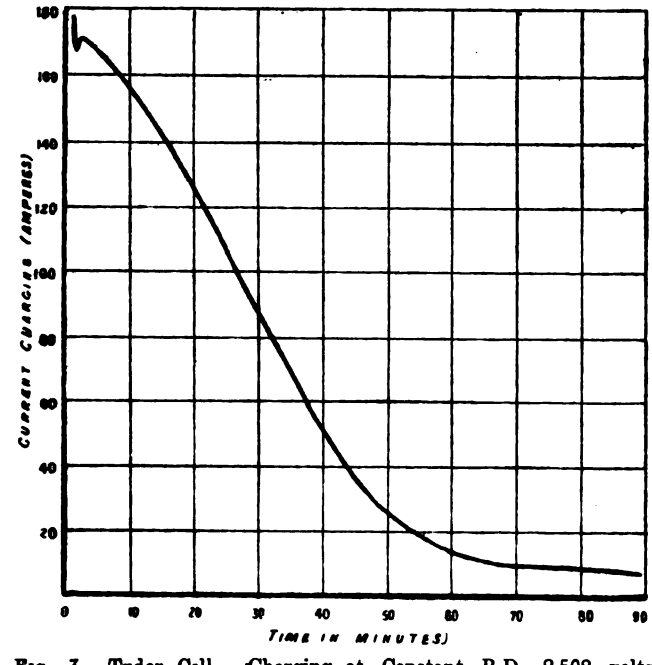

Fig. 3.—Tudor Cell. Charging at Constant P.D. 2,508 volts. Second Series of Tests. Charge 6 × Charge 7 o.

Fig. 2 shows the curves connecting current and time for charges 44 and 45 of the first series, and Fig. 3 the same curves for charges 6 and 7 of the second series of constant P.D. tests. Fig. 4 gives the discharge curves for experiments 6 and 7 of the second series. It will be seen that the two sets of points lie practically on the one curve, showing that the cell had attained to a steady state.

The results of tests 37-46 (inclusive) of the first series were averaged out to get the mean efficiency, and the results of tests 6 and 7 of the second series were also averaged. The results of tests 13-49 of the first series gave an average efficiency very nearly the same as the former, and all the three sets of efficiencies and capacities are set forth below :

Tests.	Ampere-hours put in.	Watt-hours put in.	Ampere-hours taken out.	Watt-hours taken out.	Quantity efficiency	Energy efficiency
1st series 37-46	91·89	230·4	86·07	163·5	93·7 %	71 %
1st series 13-49	91·97	230·7	85·99	163·2	93·48	70·76
2nd series 6-7	93·6	235	85·2	161	91·01	68·52

Density.—The density of the acid was high (1·185-1·196) n the first few tests, but by the ninth it had fallen to

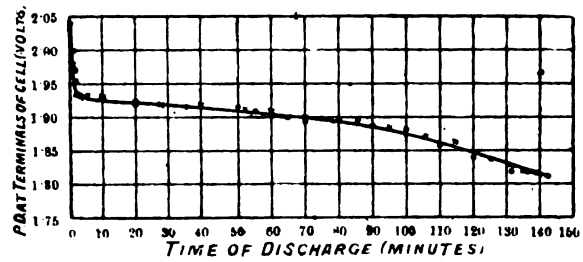

Fig. 4.—Tudor Cell. Discharging at Constant Current of 36 amperes after a Charge at Constant P.D. of 2·508 volts. Second Series. Discharge 6 × Discharge 7 o.

(1·159-1·175) and remained so afterwards until the end of the series. In the second series the density was (1·154-1·174).

The manner of variation is shown in the curves. Fig. 5 is for charges 6 and 7 (second series), showing how the density rises as charging proceeds, and Fig. 6 connects time

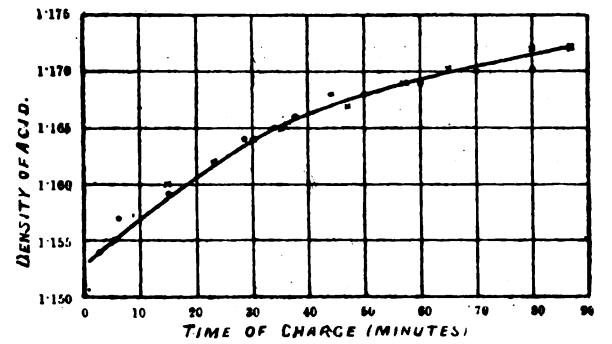

Fig. 5.—Tudor Cell. Charging at Constant P.D. Density of Acid and Time. Second Series. Charge 6 × Charge 7 o.

and density for discharges 6 and 7 (second series). From these it is seen that the fall of density during discharge is nearly proportional to the quantity taken out, and that the rise of density during charge is probably proportional to

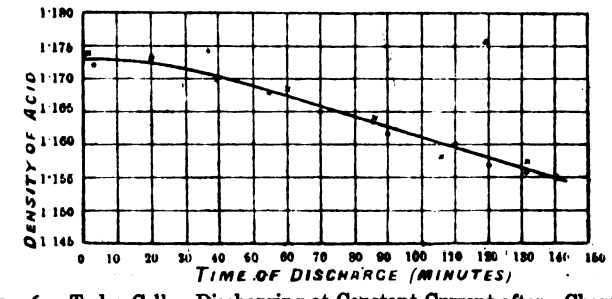

Fig. 6.—Tudor Cell. Discharging at Constant Current after a Charge at Constant P.D. Density of Acid. Second Series Discharge, 6 ×. Discharge, 7 o.

the quantity put in, as the curve connecting time from the beginning of the charge and density rises steeply at first, and has a tendency to become flat at the end, corresponding with the rapid rate of charging at the start, and the greatly diminished rate at the end of the charge.

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"Gassing" (by which is meant evolution of hydrogen bubbles at the negative plate) was found to occur when the rapid fall of current had ended—that is, when the current and time curve had begun to bend round so as to become nearly asymptotic to the axis of time. The current at this point is about 20 amperes, and it occurs when about two-thirds of the charging time has elapsed.

In the last charge it was noticed that, quite at the beginning, minute bubbles of gas (presumably oxygen) were freely liberated at the surface of the positive plates. This action became very small at the end of the charge, and was at no time at all comparable with the evolution of hydrogen.

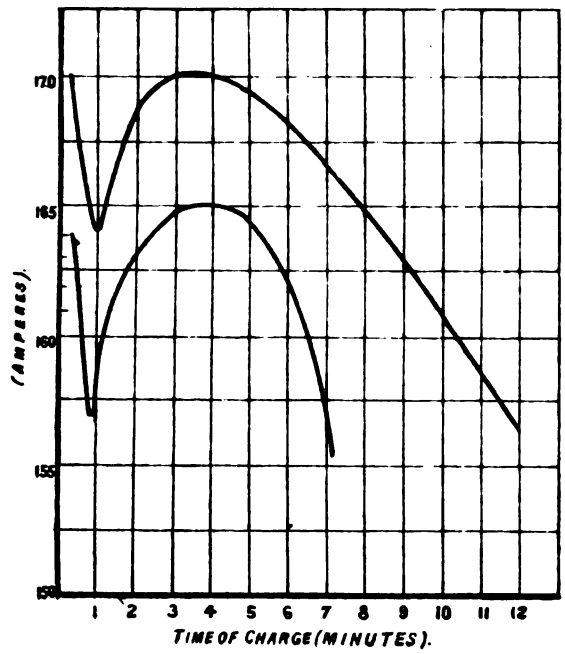

FIG. 7.—Tudor Cell. Charging at Constant P.D. Initial Portion to an Enlarged Scale. Charge 41 ×. Charge 50 o.

Resistance.—As before mentioned, it was not easy to find out the true E.M.F. of the cell at the end of charge and of discharge. In the one case it would be read too low and in the other too high, giving too large a value for the resistance in each case. Again, at the beginning of the charge and discharge, although the E.M.F. is read easily enough, yet in the one instance the initial current cannot be found with any degree of certainty (especially as two ammeters have to be read), and also the P.D. will not, as a rule, be 2·508 volts on first switching on; and in the other case the P.D. of the cell alters so rapidly that it is hard to read, and also the current will not be 36 amperes, as a rule, when the circuit is made.

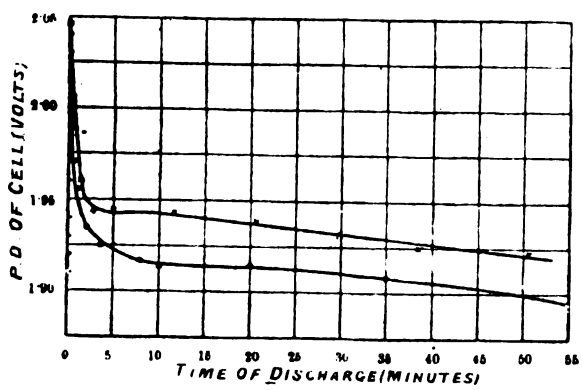

FIG. 8.—Tudor Cell. Comparison of Initial Parts of Discharge Curves. × Discharge 43 after a Constant P.D. Charge. o Discharge 45 after a Constant Current Charge.

The resistances during the last few tests of the second series are roughly:

At beginning of charge, 0·0033 ohm.
At end of charge, 0·01 ohm.
At beginning of discharge, 0·0043 ohm.
At end of discharge, 0 0033 ohm.

Shape of Curves.—The way in which the current falls as charging proceeds may be seen in Figs. 2 and 3. Neglecting for a moment a curious initial feature of the curve, it may be seen that the current at first remains for about five minutes at a high value, and then falls at a very rapid rate till the charging time has about half elapsed. After this the fall in current is much more gradual, and the curve shows a tendency to become asymptotic to the axis of time.

On most occasions it was noticed that the current rose from its initial value before beginning to fall, but it was not until the latter part of the test that it was found that the current first fell, and then rose again to a maximum before the rapid fall started. Unless frequent readings are taken it is easy to miss this point.

To illustrate this curious behaviour more clearly the initial parts of the charge curves for tests 41 and 50, first series, are shown to an enlarged scale in Fig. 7, and here the swift falling and rising again are plainly seen. This drop was usually about 15 amperes, and was all over by the first three minutes.

It was thought that this fall might be due to the evolution of an enormous quantity of hydrogen, more than was needed for the reduction of the lead sulphate, and that this increased the resistance of the cell or introduced a high back E.M.F. When the surplus gas had been taken up this resistance or E.M.F. would fall, and the current would, of course, rise, but would fall again as the E.M.F. of the cell increased as charging was continued.

To test this theory, during charge 50, first series, air was

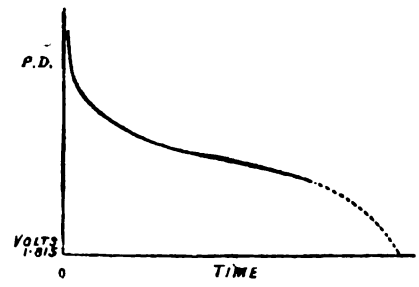

FIG 9.

blown into the cell through five tubes; but no difference in the curve (see Fig. 7) was noticed, the jets of air having probably been too coarse to expel the hydrogen, this latter being the object of the operation.

There is a notable difference between the shapes of the discharge curves after a charge at constant P.D. and after a charge at constant current. In Fig. 8 are shown, side by side, discharge curves as given by the two systems. After a constant P.D. charge the initial fall of P.D. during discharge is all over in five minutes, and the P.D. remains nearly constant for some time after. But after a constant-current charge the initial fall of P.D. is not so abrupt, and extends over nearly 10 minutes, and after this drop the P.D. falls continuously without a level portion.

CHARGING AT CONSTANT CURRENT.

Capacity.—As mentioned before, charging was at first carried out at 20 amperes, and was continued until the

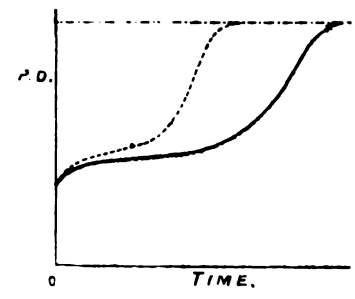

FIG. 10.

P.D. at the cell terminals had reached 2·508 volts. This gave such a very low capacity that it was decided to charge to a still higher P.D. The range of discharge it was not thought advisable to alter, as it had given satisfactory results in the constant P.D. tests. Charging, therefore, was carried out until the P.D. had reached 2 58 volts. This had the effect of increasing by about 10 per cent.

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the energy that would be taken from the cell, but even this was comparatively low. It did not seem probable that charging still further would have increased the "useful capacity," as "gassing" at a P.D. of 2·58 volts was considerable, and the curve connecting P.D. and time from the beginning of the charge was turning over and becoming nearly horizontal, showing that the back E.M.F. of the cell was nearly constant. The increased capacity after charge 23 (when the range of charging was altered) lasted only until the end of charge 28, when it fell. But it recovered its old value at experiment 40, and remained fairly constant thereafter.

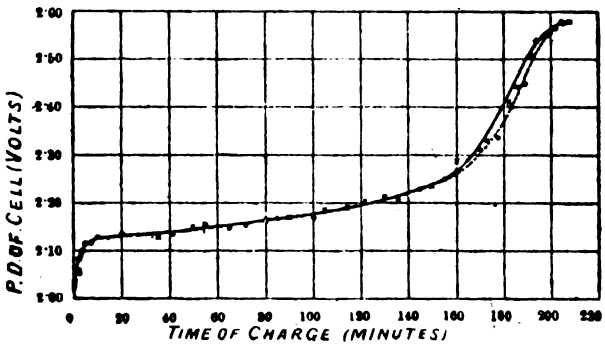

FIG. 11.—Tudor Cell. Charging at a Constant Current of 20 amperes. Charge 44 ×. Charge 45 o.

On two occasions the discharge was stopped too soon. This produced a somewhat curious effect upon the next charge. Fig. 9 shows how the charge was prematurely broken off, where the full line stops, and Fig. 10 shows (dotted) how the following charge was of much shorter duration than the normal, which is shown full. The short charge was followed by a normal discharge, and this made the efficiency for this pair of experiments high, whereas for the pair in which the short discharge took place the efficiency was, of course, low. However, the mean of these two efficiencies was near the normal, and the short discharge did not seem to have interrupted the "steady state" of the cell.

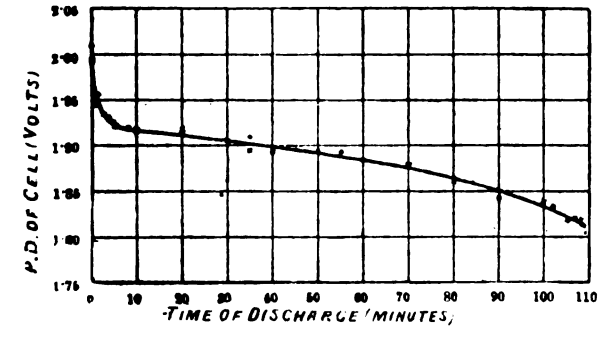

FIG. 12.—Tudor Cell. Discharging at Constant Current of 36 amperes. After Constant Current Charge at 20 amperes. Discharge 44 ×, Discharge 45 o.

Efficiencies.—It was evident from the curves of charge and discharge that the energies put into and taken out of the cell had become practically constant during the last three or four experiments. Figs. 11 and 12 show charge and discharge curves for experiments 44 and 45, and the mean results of these two were taken as representative working values. They are given below:

Ampere-hours put in.	Watt-hours put in.	Ampere-hours taken out.	Watt-hours taken out.	Quantity efficiency.	Energy efficiency.
68·35	152·1	65·25	123·1	95·4 %	80·95 %

Taking the ratio of the total energy put in to the total energy taken out, from experiment 23 to experiment 45, we get the "average efficiencies" given below:

Average quantity efficiency, 95·08 per cent.
„ energy „ 81 02 „

Density.—The range of density was, on an average, 1·155-1·167, being less than it was in the constant P.D. tests. This was to have been expected, seeing that in the latter case the capacity was larger, indicating that chemical action had proceeded further. Fig. 13 shows how the density rises during charging, and Fig. 14 shows how it falls during discharge. In the former case the rise was uniform, but in the latter the charge of density was less rapid at first. "Gassing" took place when the P.D. during charging had risen to about 2·4 volts. This happened about three hours from the beginning of the charge, and a point of inflection occurs on the curve at this point.

Resistance.—Appended are approximate values of the resistance of the cell at the beginning and end of the last few charges and discharges:

Beginning of charge, 0·0038 ohm.
End of charge, 0·0077 ohm.
Beginning of discharge, 0·0041 ohm.
End of discharge, 0·0034 ohm.

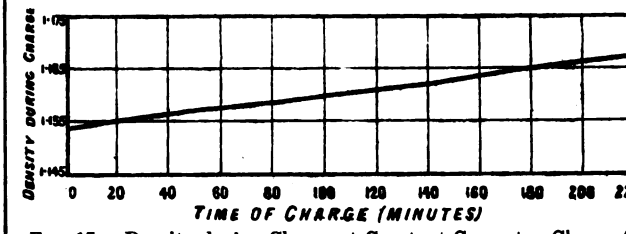

FIG. 13.—Density during Charge at Constant Current. Charge 43.

Shape of Curves.—The shapes of charge and discharge curves are too well known to need much comment. In charging, the P.D. rises rapidly during the first two or three minutes, and then increases slowly and uniformly until the end is nearly reached, when it suddenly begins to rise rapidly, shortly afterwards bending over and tending to the horizontal. In discharge, after the first rapid drop, the fall is slow and uniform, but towards the end the drop becomes more rapid, and the curve is just beginning to turn down steeply when discharge is stopped.

COMPARISON OF THE TWO METHODS.

The physical characteristics of the two methods of charging have already been compared, and it now remains to contrast what may be called the "commercial" results. For the same cell, charged by two methods, the chief points we have to consider, in order to get a fair estimate as to relative merits of the systems, are:

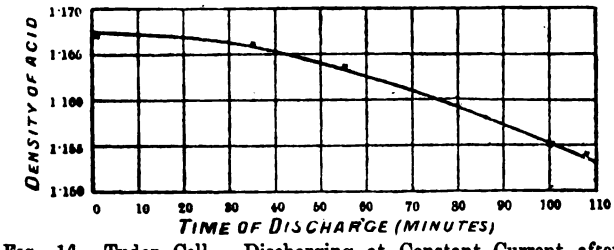

FIG. 14.—Tudor Cell. Discharging at Constant Current after a Constant Current Charge Density of Acid. Discharge 43 ×.

(i.). The discharge capacity, or the energy that can be got out of the cell.

(ii.). The time needed for charging.

(iii.). The storage efficiency, best taken as the ratio of the watt-hours taken from the cell to the watt-hours given to the cell.

(iv.). The constancy of the P.D. during discharge.

(v.). The life of the cell.

The first three matters are best compared in the table given below:

Method of charging.	Time of charging.	Ampere-hours taken out	Watt-hours taken out.	Quantity efficiency.	Energy efficiency.
Constant current	206min.	65 25	123	95·5 %	81 0 %
Constant P.D. ..	82min.	86·0	163	93·5 %	70·5 %

From this it is seen that by charging at constant P.D. the time of charging is less than half that required to charge

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at constant current. The capacity obtained in a constant P.D. charge is about 30 per cent. greater, the energy efficiency being, however, 10 per cent. less than that from a constant charge. This loss in efficiency is due in all probability to the excessive heating caused by the large initial charging currents.

With regard to article (iv.), it has already been pointed out that the discharge after a constant P.D. charge takes place at a much steadier P.D. than is the case in a discharge after a constant-current charge.

Finally, with regard to the life of the cell, it remains to be seen whether or no constant P.D. charging will injure the cell. A long-life experiment on some cells, charging by the constant P.D. method, is needed to make this clear. All that we are in a position to say is that after 50 charges at constant P.D. the cell had not been noticeably injured.

A month or two before our tests were begun a number of charges at constant P.D. were executed on the cell, but the experiments were not carried out continuously. In these the discharge capacity was about 157 watt-hours and the energy efficiency about 68 per cent., both of which values are lower than those obtained by us.

A few isolated charges and discharges were undertaken after our observations, but were not sufficient to afford any evidence, one way or the other, of deterioration.

The conclusion to which our experiments have led us is that charging at constant P.D. affords a very speedy method, and enables one to store more energy in the cell than if a constant-current charge were employed. After a constant P.D. charge the P.D. remains more nearly steady than after a constant-current charge, but one loses somewhat in efficiency by the former method.

In conclusion, we beg to acknowledge here our indebtedness to Prof. Ayrton and to Mr. Mather for help and advice during our experiments, and to Messrs. Miller, Cunningham, Nicholson, Porch, Turquand, and Sawers, second-year physics students at the Central Technical College, for having carried out many of the charges and discharges for us.

MUNICIPALITIES AS TRADERS.*

BY G. PEARSON.

In writing this paper I have felt that this meeting does not require from me a long explanation of my own municipal dogmas, but would prefer that I should review the present position of municipalities as traders, and the progress made in municipal trading; and I am inclined to think that that course will best serve as a peg on which to hang the discussion to-day. We are long distant from the so-called "good old times," when it could be said "if each man swept his own doorstep, the village would be clean." Individual performances of cleansing duties such as these, to say nothing of the still more important duty of sewage disposal, has long since ceased to be possible, and, further, the days when citizens "paid their scot and bore their lot" have also long passed, and the performance of duties at the public expense which were formerly looked upon as the duties of the private individual has been accepted as reasonable and proper; and, proceeding one step further, the public provision of a water supply, and also of the supply of light, and, lastly, of a cheap, frequent, and regular mode of locomotion, has become so common as to cease to surprise; and now the suggestion of a dweller in any city providing his own separate system of cleansing, sewage disposal, water supply, or light would be regarded as a stupid waste of private energy. Drainage was first recognised as a public duty forced on municipalities by the density of the population, to be followed by a public system of cleansing; but at a comparatively recent date a municipal water supply was looked upon as a first step in a downward course leading to the pit of socialism, but few at the present time regard it in this light. The provision of light at a more recent date stood in the same position, but the advocates of the purchase of the gas and electric light undertakings form a majority in most of the municipal councils at the present time; but to-day the man who publicly advocates the provision of a tram system by a corporation is called "very advanced" in his views, to say the least, and by the older members of the corporation he would be looked upon as really a dangerous man, leading a confiding public to the abyss of municipal socialism. Personally, I have no dread of a name, and any scheme bearing on the face of it the impress of commonsense would not be rejected by me because its opponents called it by a disagreeable title, and to hear a scheme in which I am interested called "socialistic" has no terrors for me.

Let us consider for one moment the growth of municipal trading, which will be best seen from the growth of municipal indebtedness, by means of which municipal trading has been rendered financially possible. The loans to municipalities outstanding in the year 1875 amounted to £92,820,100. These outstanding loans had grown in the year 1895 to £235,335,049, an increase of £142,514,949, being an increase at the rate of 153·5 per cent. in the 20 years. The National Debt was in the year 1875 £768,945,757, and it had decreased in the year 1895 to £656,998,941, or a decrease of £111,946,816 in the 20 years. It will be seen from these figures that the increase of local indebtedness exceeds the decrease in the national indebtedness by £30,568,133. Local indebtedness represents loans due in respect of:

Waterworks	£43,970,490
Harbours, piers, docks, and quays	32,777,992
Highways, street improvements, and turnpike roads	30,143,979
Sewerage and sewage disposal	23,734,738
Schools	22,970,555
Gasworks	16,931,943
Poor-law purposes	7,773,504
Markets	5,775,076
Parks, pleasure grounds, commons, and open spaces	5,051,092
Public buildings	4,958,954
Artisans' dwellings, improvements	4,351,532

There is also a long list of loans in respect of other public works, in respect of each of which a debt approaching £4,000,000 now exists, the list being too long for quotation here. The figures I have read show the extent to which public funds have been used by local authorities in municipal trading. Taking gas, water, dock works as three of the largest classes of municipal trading concerns, we find that the debt now existing (not the sum originally raised, which would, of course, be much larger, the present reduced figures being brought about by the operation of the sinking fund arrangement made in respect of each of these loans) shows the indebtedness at £93,680,425, being about £860,325 more than the total local indebtedness in the year 1875. The foregoing figures show the great growth in municipal trading, by showing in some degree the growth of the municipal capital invested in it during the last 20 years, and these figures do not remain stationary. I have been unable to obtain the report of the Local Government Board for this year, but I have, by the courtesy of the secretary of the Local Government Board, obtained the figures of the national and local indebtedness for the year ending 1896. The National Debt has sunk to £648,474,143, as against £656,998,941 in the year 1895, a decrease of about £8,000,000 in the year, whilst the local indebtedness has grown to £243,209,862, as against £233,335,049 in the year 1895, being an increase of about the same amount. The electric light figures are very instructive, and show the growth of municipal trading in electric current. Up to the year ending March, 1895, £1,378,818 only had been invested in these undertakings by local authorities, whilst I find from the tables published in *Lightning* that 50 local authorities own their electrical undertakings, and from the figures there given, I estimate the capital invested up to the year ending March, 1897, at £4,000,000, and think by this time this sum must have grown to nearly £6,000,000.

Having shown the growth of municipal trading as evidenced by the growth of the capital account, let us consider for one moment the extent to which it may be extended to the advantage of the public. I think that municipal trading should be confined to the provision of those necessities of civilisation which are so large as to be beyond the power of individual effort to supply and which do not form part of any Government department. The effort of the individual will generally produce more

* Paper read before the British Association at Bristol.

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economically than either a company or local authority, but as between a company and a local authority there is, economically speaking, very little to choose, and corporations can claim to be free from the misappropriations of capital which appear to be incident to the formation of so many of the companies which from time to time come under our notice; and therefore the cheapness of the price of money when raised on the credit of a local authority as against the dearness of money when raised by a company must always enable a local authority to trade on a smaller gross profit than a company, and, therefore, requires less to be abstracted from the pocket of the consumers to secure success to the undertaking, whatever it may be. I am therefore of opinion that the supply of water, gas, electrical energy, and trams should be in the hands of the local authority. Cleansing, ashing, and watering should also be done without the aid of a contractor, but I would not suggest, except under exceptional circumstances, that all municipal works, such as erection of buildings, and other matters of that kind, should be undertaken by the municipality, but where for any reason whatever—and there are many reasons I know—there is a lack of outside competition, then these works can be done generally more economically and always better by the municipality than by a contractor. There is another point which has to be considered—viz., the formation of "rings" and "trusts" formed with the object of keeping up prices to artificial levels. The only way to meet combinations such as these is for local authorities to face the position and do the work themselves.

On the other side of this question is to be found the question of labour. Local authorities popularly elected are liable to pressure from without, to which the directors of public companies and private individuals are relatively free. Working-men have votes, and will use them to serve their own ends, precisely to the same extent as other people, and labour questions raised just before a November election put the independence of a candidate for a seat in the council to a severe test; but this, in my opinion, is a "nettle to be grasped" by a straight refusal on the part of the candidate. It is seldom when this is done that the labour combination is successful. I cannot claim a very long experience in the management of large bodies of men, having only had a few years' experience as a member of the Sanitary Committee of Bristol. This department pays about £2,000 per week in wages, but the experience I have had as a member of that committee shows me that a position of absolute neutrality in respect of all trade combinations, and the acceptance of the services of any competent workman, whether unionist or not, extorts a respect even from those who may be violent partisans either on the one side or the other.

There remains one other enterprise which appears likely to be placed within the reach of any enterprising municipality. I refer to the "telephone." The recent report appears to contemplate municipalities undertaking this work. Personally, I would rather be without it. I have no more faith in a municipal telephone than a municipal telegraph or municipal post office. In my opinion, telephonic communication should be provided by the Imperial Government and not by the municipalities. If this is done, we can do without the competition in telephone supply, of which we have lately heard so much, and the sooner the better this is done. If it is long delayed it will have developed into a large undertaking with a large goodwill built upon the basis of the grants made by municipalities of the use of the public street at a nominal cost, or, perhaps, at no cost at all to the company. If we are to have the nuisance of underground telephone wires, and the still greater nuisance of overhead wires, the quicker the better it will be for the Government to secure from that nuisance some profit for the public who have to submit to it. The longer the present companies live the tighter will they fix themselves on the public shoulders, and the more expensive it will be to remove them, as removed they must be sooner or later at any costs. There is one other question now being prominently raised, and it is discussed in the recently issued report of the Telephone Committee—viz., ought municipalities to trade for a profit. In my opinion they ought. Speaking as a municipal man, I should have very little inducement to trade at all but for the hope of success with its usual accompaniment—profit. Birmingham trades, Manchester and other towns trade, at a profit, and I fail to see why they should not—subject only to the condition that they do so on the same lines as ordinary individuals and companies, and that they do not secure a profit by charging at a rate higher than would be charged by a company. Take the case of Bristol as an example, and I think ours is a fair sample of the average of cases of the kind. We have in Bristol 60,000 ratepayers, and under 1,000 users of the electric light. The luxury of private lighting to the few is rendered possible by pledging the credit of the many, and why should not the many reap some benefit from the risk they run, to say nothing of the actual loss which attended the early years of our undertaking, which was paid out of the rates levied upon them. I think Parliament will be wise not to put such restriction as to profit-making as are shadowed forth by the report of the Telephone Committee. They may well leave the question of the amount of the profit to be settled by the natural law of supply and demand. The moment a municipality charges more for an article than it is worth will be the moment the public will refuse it.

If we review the result of municipal trading, I think its advocates (of which I am one) have little to fear. Birmingham, Manchester, Glasgow, and other large towns have shown a very good lead, which it remains for others only to follow. Failures are very seldom reported, and having regard to the "fierce light" which surrounds all municipal trading, I think the fact that few failures are reported is caused by the fact that there are few failures to report. There is one other risk which it is impossible to omit to notice. There may be dishonesty in the official, or, still worse, there may be dishonesty in the council, but I think the risk is small in each case. So far as officials are concerned, business-like regulations may be made which, if powerless to actually prevent fraud, will most assuredly detect it, and I think the personal character and position of the members of the various representative bodies, coupled with the fact that more than one or two must be "in it" to secure success, will prevent any serious malpractices by the representatives, even if they were so minded.

RECTIFICATION OF MUNICIPAL FRONTIERS.*

BY W. M. ACWORTH.

The title is, of course, used metaphorically by the author to refer to the boundary between municipal socialism and private enterprise. Readjustment may be anticipated in the near future, consequent on new developments of science. Gaslight is becoming less and less a necessity; it is exposed to competition with petroleum, electric light, etc. On the other hand, gas is becoming more and more important as a source of power, even on a large scale. The water supply is practically already in the hands of the public, so that the question of frontier is rather between the conflicting claims of rival public authorities. Concerning telephones, a suggestion has been made by a Parliamentary Committee that municipalities should be allowed to compete with the National Telephone Company, and Edinburgh and Glasgow have already proposed to do so. As far as electric lighting is concerned, municipalities are already beginning to compete with companies in possession, and companies in return propose to compete with municipalities. It has further been proposed that the distribution of electrical energy should be effected on a vast scale from central stations over great distances. The position of local authorities in reference to such undertakings was considered by the author, especially with respect to the right to compulsory purchase. The stunted development of tramways under municipal despotism was dwelt upon. Another question arises in regard to electric traction through lines between adjacent towns: what public authority can work such lines? In conclusion, a readjustment of frontier seems to be inevitable, and probably will be in the direction of widening rather than further contracting the area of private enterprise.

* Abstract of paper read before the British Association.

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TO CORRESPONDENTS.

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ELECTRIC TRAMWAYS.

The interesting discussion at Bristol on the "Magnetic and Electrolytic Action of Electric Railways" only suffered from the want of tramway engineers to state their side of the question. The most valuable communications received at the discussion were those by Prof. A. W. Rücker and Dr. J. A. Fleming respectively. In the remarks of the first-mentioned much is to be learned as to the means by which a direct-current system of tramways may be prevented from disturbing a magnetic observatory near it. Instead of the too usual generalisations published as to minimum distance allowable between the line and the observatory, which neglect many essentials, such as the relations between the line of route and the magnetic meridian, Prof. Rücker gave facts obtained in London as to the disturbances set up by the City and South London Railway. He then proceeded to give the regulations by which he hoped to keep the Kew Observatory free from such disturbances when the projected electric lines near it are constructed. These regulations are most valuable, as being the results of experiment. The most costly requirement of these regulations is the insulated return conductor which is to replace the earthed rails. It was shown by several speakers that the leakage current from this earth return causes the most serious magnetic disturbances, and again, Prof. Fleming pointed out most clearly the electrolytic damage which may arise from the same cause. A few speakers gave a somewhat faulty view of the traction engineer's object in using the present earth return, and suggested that the conductivity of the earth was an inducement. This is hardly the case, as there is no appreciable advantage derived from the current return through the earth. The real advantage lies in the single conductor overhead and the use of the rails as the other conductor, with the wheels as collectors. These rails, when well bonded, as required by the Board of Trade, give all the conductivity required, and, as a rule, have a greater conductivity per given length than the outgoing conductor. That the conductivity of the earth does induce a certain amount of current to return outside this circuit is a misfortune, not an advantage, and the amount so returned is largely increased by the other conductors in the soil, such as gas and water pipes. Prof. J. A. Fleming's paper, being the outcome of practical experiment, is most valuable, as showing how far these subsidiary conductors are likely to suffer. Unfortunately, here again, as the author pointed out, generalisation is of no real service, as local conditions determine the distribution of current. Thus a certain length of pipe might last for years with a definite current passing out from it, provided the current is distributed evenly over the length. But if, on the other hand, the proximity of another conductor concentrates that current to a comparatively small portion of the length, the metal may be eaten through in a short space of time. Electric traction experience in England has not up to the present shown such bad examples of electrolytic

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damage to pipes as has been noted in America, but Prof. Fleming raises at an opportune time the question as to whether it does not pay tramway engineers to keep well within the Board of Trade limits, because the monetary damage which would otherwise result is greater than the additional cost of construction. Without a doubt, the insulated return is the solution of the problem, but the design of a cheaper and durable insulated return has yet to be brought forward. For railways, and especially for the new underground railways, the problem is less difficult, as the space between the rails is not used for other traffic. In such cases the whole track can be insulated to a very fair degree by the wooden sleepers, as has been done in the Waterloo and City Railway. The three-phase system, as used in Switzerland, does prevent the electrolytic trouble, but such a system is too inflexible for regular tramway service with many stops and starts. For a mountain railway, on the other hand, it has great advantages, as the motors themselves act as automatic brakes for ensuring approximate constant speed when descending.

MAGNETIC AND ELECTROLYTIC ACTIONS OF ELECTRIC RAILWAYS.

The joint discussion on the above subject held at Bristol last week in connection with the British Association, in which Sections A and G met the members of the International Magnetic Conference, was most interesting. The proceedings were opened by a few remarks from Dr. Schott, the United States delegate, who gave experiences which had been obtained on that side of the Atlantic.

Dr. SCHOTT referred entirely to the effects of electric railways on magnetic observatories. He showed several curves recording the components of the earth's magnetic field in which the lines were always thickened due to vibration caused by electric tramways. This thickening of the line was sufficient to entirely mask the very small alterations due to the moon. Apart from this thickening action on the recording line, there were many abrupt changes due to the electric lines, which rendered the record almost valueless. Three magnetic observatories had been rendered useless in America by electric tramways. The first was at Washington, where two trolley lines passed, one 1½ km. to the west of the observatory and the other 5 km. to the east. These two lines nullified the careful work of four years. All three magnets were affected, but that recording the vertical components suffered most. The second observatory was in Texas, and here the nearest line ran east and west at a distance of about 300m. only. The final example quoted was Toronto. Dr. Schott deplored the fact that magnetic records were thus made discontinuous, and urged that the new observatory to replace the one at Toronto should be built as near to the old site as possible in order to get the records somewhat comparable with those of past years. He considered that four miles was the shortest distance which should be allowed between an observatory and an electric railway.

Prof. A. W. RUCKER then described a series of experiments he had made after the opening of the City and South London Railway. The first curve shown was taken in a house half a mile from the line and some way from a public street, so that traffic disturbances should not be felt. This curve showed the thickening effect mentioned by Dr. Schott, and also a lot of larger disturbances, which ceased when the line was shut down at night. Three other curves were also shown, the first being taken at Chelsea, 2¾ miles from the line. The second was taken at South Kensington, and the fourth at Greenwich. The gradual diminution of effect with distance could be seen, but in all the above curves the disturbance caused by the railway was larger than the small variations from natural causes which are found in the records of the magnetic components. The earth currents set up by the South London line were very serious in places. He had found in his experiments that the vertical component of the earth's magnetic field was most affected. As regards the prevention of these disturbances, the question of distance was not the best way of looking at the subject. Prof. Rücker then stated that he did not dream of stopping electric tramways, as scientists must recognise the great social advantages they conferred. Still, there were means of preventing the disturbance, and he had found the tramway engineers and companies most willing to do all they could in this respect. Thus, to protect the Kew Observatory, certain clauses had been inserted by request in the Bill (Hounslow and Uxbridge Tramways Bill). These clauses provided that insulated returns should be used to prevent earth currents. It was also provided that the two conductors (lead and return) should not at any point be further apart than one-hundredth of the distance of that point from the Kew Observatory. Prof. Rücker said he had experimented with 500 amperes on two wires 30ft. apart, placed 1 km. from the observatory, and had found that the fifth place of decimals only was affected. In conclusion, the speaker again referred to the very fair way in which technical engineers had met them in the matter.

Dr. ESCHENHAGEN, of Potsdam, was the next speaker, and gave details of the troubles he had found with magnetic measurements near Berlin. There were some eight electric lines in and round Berlin, and the heavy line running out to Spandau was particularly liable to cause magnetic disturbances. He had found the disturbing effects 8 km. away. The earth currents caused by the lines were most to be feared, and were complicated by alterations with the moving of the cars. A regular insulated return conductor was the best method of getting over these, but this idea did not find favour with German engineers. The speaker finally predicted that in a few years any researches on earth currents on the Continent will be impossible.

Mr. W. H. PREECE remarked that up to then the views of observatory experts had been given. He proposed to consider rather the vested interest of the telegraphs and telephones in the earth as a conductor. Thus telegraph engineers had used the earth for 60 years. In the interest of the Post Office telegraphs he had had to watch the City and South London Railway. The disturbance might be produced in three ways: by induction, by moving masses of magnetised iron, and by earth leakage. The worst disturbances, as far as he was concerned, produced by the City and South London Railway were due to earth currents. Mr. Preece then showed a curve of voltage set up in a certain telegraph line by the railway. The voltage was varied frequently between three and eight volts, and the maximum reading was about 10 volts. Still, he held that no faults as yet had been caused which were not capable of remedy. The use of the iron tube of the railway as a return was largely responsible for the leakage, especially as at first these tubes were not connected together at the stations. The above railway was the only one constructed before the issue of the Board of Trade regulations, and due to these the new lines would be less troublesome. Good bonding of the rails and cross-bonding of the tracks was necessary, and even then on long lines it was not easy to conform to the regulations. Of this they had an example at Bristol, where the seven-volt drop was exceeded, until the negative booster suggested by Major Cardew, and designed by Mr. Parshall, was introduced. This booster reduced the leakage voltage on a Post Office line to below 1½ volts. On the Metropolitan and District Railways, where experiments on electric traction were shortly to be made, a complete metallic circuit would be used. Two copper conductors would be laid on a central sleeper, devised so that the ordinary traffic was not interfered with. In conclusion, Mr. Preece said that the vested interests of others in the earth as a return must not be ignored by traction engineers, and that the public rights must be respected.

Signor D. L. PALAZZO described an arrangement he had

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devised for preventing the small and rapid disturbances from affecting the magnet needles of observatories.

Dr. FLEMING then proceeded to read his paper on "The Electrolytic Corrosion of Water and Gas Pipes by the Return Currents of Electric Railways" (which appears elsewhere in this issue), after which

Prof. S. P. THOMPSON said he regarded the trolley system with an overhead conductor as only a transitory stage of electric traction, and that many of the disturbances now complained of would not be found in future types. Thus, as regards Prof. Rücker's regulation, that the distance between the lead and return conductor should not be more than $\frac{1}{100}$th of the distance of track from the observatory, he (Prof. Thompson) had described in Section G a tramway with street surface contacts in which this distance was very much smaller than that found where the overhead trolley was used. He considered that the polyphase system such as was now being used in Switzerland, at Lugano, and up the Jungfrau, was a much better one than the direct-current system, as far as magnetic disturbances were concerned, if earth returns were not employed. Prof. Thompson was so impressed with the polyphase system that he concluded by saying: "Gentlemen, you are fighting a phantom."

Prof. A. W. RUCKER said that Prof. Thompson must give them credit for knowing that the alternate currents were less troublesome, but the regulations and provisions had to be made for the system of traction actually in use.

Prof. W. E. AYRTON, speaking from the chair, said he regretted that no tramways engineers were present to take part in the discussion. He thought the regulations which Prof. Rücker had detailed would be of advantage to all. He had always advised the use of an insulated return conductor for tramways. With such an insulated return the conductor might be kept of much smaller section if a three-wire system of distribution was used, the return being always the middle.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

ERRATA.

SIR,—I beg to point out a printer's error which appears in my answer to Question No. 92 in the last number of the *Electrical Engineer*: "The other half of switchboard has two *boosters*, which are joined together at the ends."

This should read: "The other half of switchboard has two *'bus bars*, which are joined together at the ends."

The error in printing entirely alters the sense of it.—Yours, etc.,

J. E. DONOGHUE.

OBITUARY.

We regret to report the death of Mr. James Morton, the much respected business manager and secretary of Messrs. W. T. Glover and Co., Limited, at Salford, Manchester. The deceased, whose health had recently been impaired, was returning to his home late on Friday night by a rough footpath through some brickfields when he apparently missed the path, and, stumbling head foremost into a pool of water, was so stunned that he was unable to recover himself. His body was found next morning, face downwards, and partially immersed in the water.

Mr. Morton, who was one of the oldest officials of the firm before its conversion into a limited company, and who had been for the last 15 years in the same employment, was at once an intimately trusted servant of his employers and a friend to all those beneath him. The funeral, which took place at Kersal Church on Wednesday afternoon, was attended by the directors, the staff, and most of the employés of the company, besides a large concourse of friends and of the general public.

ELECTRICAL PUMPS FOR MINE DRAINAGE.

BY E. B. MARTEN AND EDMUND HOWL.

At the recent meeting of the Institution of Mining Engineers at Birmingham the following paper was read by the above-named on "The South Staffordshire Mines Drainage Scheme, with Special Regard to Electric Power Pumping."

The authors said that anyone who was familiar with the Black Country some 30 or 40 years ago must have wondered at the number of large pumping engines required to keep the mines free from water, and could not fail to notice the manner in which the taking out of the remarkably thick coal seams for which this district was famous had broken the surface of the ground, and so sunk the beds and banks of the rivers and watercourses in all directions as to create large sheets of water in numerous places where water ought not to be. Pumping the water at one mine to let it down into another near it was so obviously unscientific that much effort was made to find a remedy. Under the auspices of the British Association, who visited Birmingham in 1865, statistics were gathered showing that about 50,000,000 gallons of water were raised from the mines daily, and the calculation soon proved that the pumps were lifting the same water over and over again. The state of the public rivers and streams was found to be deplorable, and the canals and canal basins were also so much pulled about by mining as to overflow, and so contributed much water to the mines. In times of flood from heavy rain large areas were so covered with water that the streams and canals could not be distinguished. Parliamentary powers were sought in 1872, and such was the general fear of the loss of such quantities of coal as were threatened with hopeless inundation that the necessary powers were readily granted, the first South Staffordshire Mines Drainage Act being passed in 1873. Help came from many quarters, and some rather unexpectedly. The canal companies, although much affected by the powers sought, gave general support, with the hope that with the measures that would be taken the frequent and expensive litigation as to flooding of mines would cease. The paper dealt more especially with the surface (75 square miles), and more particularly those 32 square miles of it called the Tipton district, where electric power is proposed to be used. In this district there were raised from the 32 square miles 36,000,000 gallons of water per day by 120 engines. Very little progress was made while the old pumping engines, over which the Commissioners had only limited control, were worked, but when they put and also acquired a few of the best of the old ones direct control made more economic working possible. Since 1873, thanks to the surface works, the mass of water to be dealt with had so decreased that the daily quantity has been reduced to 9,000,000 gallons, or only one quarter of what it was at the commencement. This 9,000,000 gallons, however, did not come to the pumps sufficiently freely to drain the mines to the level of the coal to be worked. It was desired so to further improve the surface works in extent and efficiency as to reduce the "come" from the mines to only 6,000,000 gallons per day, and to pump from some of the drowned pounds by means of a few smaller and semi-portable engines. As the collieries began to be worked, after being freed from water, underground connections would be made. Thus the original plan for concentrating the water would become effected in a natural way, and the water would be brought to the present pumping engines, which were fixed in exactly the right places, and were fully equal to the work. In 1895 a combined scheme for draining the mines and the surface was brought out. It proposed the establishment of two main pumping and hydraulic power producing plants, underground levels, and a hydraulic power distribution main, which power was not only to be used for working semi-portable deep pumps, but also to be made available for the actuating of surface pumps situated in the low-lying areas A large proportion of that part of the scheme which referred to the driving of the underground levels had been carried out. The Commissioners were faced with the difficulty of either having to make an underground level from the pumps to every colliery in the district which was

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required to be worked, or to revert to the original state of affairs of having a pumping station in almost every colliery. This was altogether a position which it was impossible to contemplate either from an engineering or financial standpoint. Twenty-two tons of water were pumped in 1873 to one ton of coal or other mineral, and in 1898, notwithstanding the great reduction in the water, the Commissioners' engines were pumping 24 tons of water to one of mineral, while if the water raised by pumping engines were added the proportion was 28½ tons. The only way to bring down the cost of working an increased number of stations within the range of the revenue was by some means not before available, to diminish the quantity of water that daily found its way to the mines from the surface. Having secured, through the Midland Electric Corporation for Power Distribution, the prospect of an early supply of electric energy at a cheap rate, the scheme for the extended drainage of the low-lying portion of the surface became feasible. All the area of the Tipton district had been re-examined for suitable places for surface pumps, and 50 sites had been selected and surveys made for delivery channels to convey the water pumped to some existing watercourse. Although the quantity of surface water to be diverted from the mines was 3,000,000 gallons per day on the average, the pumps proposed should lift on emergency 25,000,000 gallons per day in storm time, when their help would be of the greatest advantage. The exact pattern of these pumps had not been settled; but now that centrifugal pumps were made to run at very great speeds, there should be no difficulty in obtaining a pump and motor of such simple construction that it could be set at work by the throwing over of a lever when the water in the receptacle rose to the arranged height, and shut off when the receptacle was empty. These pumps would be required to raise water only to heights of 10ft., 15ft., or 20ft., and it was impossible to over-estimate their value, especially in storm time, in preventing water from going down into the mines, to be lifted thence to heights of 400ft. or 600ft. The water which travelled out of sight, frequently for great distances, between the level of the original surface of the country and the top of the artificial mounds which had been thrown up by the collieries and ironworks, would now be intercepted by the proposed electric pumps, and the drains connected with them, before it found places where it could get down into the mines. Water also flowed into the Tipton district from the high ground beyond the district boundaries. Where there were at present steam-pumps, pumps worked by electricity would be substituted, and in consequence each place would produce greater effects than with the present steam-pumps, as the electric pumps would be automatic, and might all be set to work simultaneously after a storm, instead of waiting, as with the steam-pump, until the attendant could work them in turn. They might also continue at work night and day for some days together. The stations now used for periodical visits of portable pumps would also be fitted with automatic electric motors and pumps and the swags near them would be kept permanently low instead of being visited only at considerable intervals of time, and thus the percolation of water into the mines would be more effectually prevented. Other stations would be placed where the old surface was still visible, between the pit mounds, or known to exist under the pit mounds, and to be reached by shallow pits, or where old pits now letting in the surface water could be filled up to the place where the water entered, and an electric pump fixed at that level. There were old limestone quarries in the high ground south and west of the Tipton district which were drained, when worked, by special engines or by waterworks engines now disused; and these quarries now formed funnels of large extent to catch the rainfall. Much of this water found its way through lower outlets into the mines. These would be most awkward places for steam-pumps and for the formation of roads to them for the delivery of coal or other fuel, but comparatively easy and simple of access for electric pumps. Many clayholes existed, and also coal openworks for shallow seams and stone quarries, all of which formed collecting funnels for rainfall, and if, as was often the case, old pits existed in the bottom of them, these emptied themselves direct into the mines. Having given several other instances in which electrical power might be economically and advantageously used, the paper gave several other cases in which the electrical pumps would prove advantageous and economical, and concluded by emphasising the great gain to the mines and in economy of pumping by dealing at once with any water that could be dealt with at the surface. The near approach of electric power available for such a purpose seemed to offer a reasonable, safe, and ready help.

The CHAIRMAN, referring to some particulars that were given as to the cost of electricity, said that the paper was interesting not only with regard to the drainage question, but with regard to the possibility of having large generating stations in colliery districts from which power could be electrically transmitted to different collieries not only for pumping, but for general mining purposes. The price per unit quoted for the current, which was shortly, he understood, to be reduced to 1d., was an important point, seeing the price charged to ordinary consumers.

INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY.

The following is the presidential address delivered at this conference by Prof. A. W. Rücker:

The president of the section of mathematics and physics has already expressed the pleasure with which British physicists welcome the distinguished band of visitors who have assembled to take part in the International Conference on Terrestrial Magnetism. None join in that welcome with more cordiality than those who are especially interested in the science with which the conference will be occupied. To us it is a source both of gratification and pride that the International Committee, to whose action this meeting is due, should have allowed us to play the part of hosts to the eminent men from many lands who have responded to their call. Some, whom we would gladly have seen here, but who have been prevented from attending by various causes, have nevertheless shown the interest which they take in our proceedings by sending written communications. Thus our meeting is as fully representative as we could have hoped.

It may be interesting to those who are unaware of the fact if I remind the conference that this is not the first occasion on which students of terrestrial magnetism have taken counsel together during a meeting of the British Association. Fifty-four years ago the then president of the association, the Very Rev. George Peacock, Dean of Ely, stated in his address that the period was drawing to an end for which a series of magnetic observatories had been established by international co-operation. "Six observatories," he stated, "were established, under the zealous direction of M. Kupffer, in different parts of the vast empire of Russia, the only country, let me add, which has established a permanent physical observatory. The American Government instituted three others—at Boston, Philadelphia, and Washington; two were established by the East India Company—at Simla and Singapore; from every part of Europe, and even from Algiers, offers of co-operation were made." The observations thus provided for were to be carried out for three years only, but as nearly the whole of that time was spent in preparation, the period was doubled. When the term thus fixed drew to an end, the question arose as to whether it was desirable to extend it further, and M. Kupffer (director-general of the Russian system of magnetic and meteorological observations) addressed a letter to Colonel (afterwards Sir Edward) Sabine, suggesting the propriety of summoning a magnetic congress to be held at the next meeting of the British Association. In accordance with that suggestion the congress was held during the meeting of the association at Cambridge in 1845. The number of distinguished foreigners who attended in person was considerable in spite of the difficulties of travel 50 years ago. Amongst those who were present was M. Kupffer; Dr. Erman, of Berlin, the celebrated circumnavigator and meteorologist; Baron von Senftenberg, the founder of the Astronomical and Meteorological Observatory of Senftenburg in Bohemia; M. Kreil, the director of the Imperial Observatory at Prague; Dr. von Boguslawski, the director of the Royal Prussian Observatory at Breslau; Herr Dove, professor of physics in the University of Berlin, and Baron von Waltershausen, a gentleman who had taken part in the magnetic observations of Gauss and Weber at Göttingen, and had executed a magnetic survey of portions of Italy and Sicily. In addition to these a number of well-known British men of science were invited to be present, amongst whom I need only mention the Marquis of Northampton (president of the Royal Society), Sabine, Sir John Herschel, Lloyd, Airy, Brown, and Sir James Ross, then recently returned from his celebrated expedition to

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the Antarctic seas. Letters were also received from Wilhelm Weber, Gauss, Loomis, Lamont, Quetelet, A. von Humboldt, and others. The principal question which this conference had to decide was whether "the combined system of British and foreign co-operation for the investigation of magnetic and meteorological phenomena, which [had then] been five years in progress, must be broken up." I will not trouble you with a recapitulation of the recommendations of the congress, some of which have been carried out, while others have not yet been realised; but one resolution will, I am sure, so exactly express your own sentiments that I venture to quote it—viz., "That the cordial co-operation which has hitherto prevailed between the British and foreign magnetic and meteorological observatories having produced the most important results, and being considered by us as absolutely essential to the success of the great system of combined observation which has been undertaken, it is earnestly recommended that the same spirit of co-operation should continue to prevail." Whatever changes half a century may have wrought in the problems which press upon magneticians, and in the difficulties which confront them, there can be no doubt that they are still of the same spirit as that in which this resolution was framed.

It is true that we sometimes meet with the objection that international conferences of all kinds are now too numerous, and that their decisions from their number and complexity cease to attract attention or to command respect. Admitting that this objection is not without weight, it may be answered by two remarks. The closer union between scientific workers in different countries which these meetings encourage, the strengthening of the ties of intellectual sympathy by those of personal friendship, are in themselves good. It is surely a hopeful omen that science as she reaches her maturity forgets or ignores the political and geographical boundaries which sometimes seemed so important in her youth, and that workers for the common good are more and more learning that it is good to work in common. But there are special and cogent reasons why the science of terrestrial magnetism should be cosmopolitan. The advance of some sciences is most easily achieved by the methods of guerilla warfare. In a hundred different laboratories widely separated workers plan independent attacks on nature. In different universities and colleges little groups are devising stratagems and arranging ambuscades in the hope of wresting from our great opponent some of the treasures which she yields only to the violent, who take them by force. But for those who would unravel the causes of the mysterious movements of the compass needle concerted action is essential. They cannot, indeed, dispense with individual initiative, or with the leadership of genius, but I think that all would agree that there is urgent need for more perfect organisation, for an authority which can decide not only what to do, but what to leave undone. The advance of the science of terrestrial magnetism must depend upon the establishment, the maintenance, and the utilisation of the records of observatories. The bulk of the material to be dealt with must in any case be vast, and every needless addition to it, every obstacle in the way of its being readily comprehended and easily used, is a drawback which proper organisation should prevent. Thus it is wasteful to devote to the multiplication of observatories, in regions of which we know much, energy and funds which would be invaluable if applied to districts of which we know little or nothing. I take some credit to myself in that within the last few months I have assisted in checking well-intended but mistaken proposals to add to the number of the magnetic observatories which we already possess in this country. Again, it is desirable that the records of the observations should be so published as to be ready for application to the problems the solution of which they are intended to subserve, and that the individual worker should not be harrassed by petty differences in the methods of presentment, which often entail on him labour too enormous to be faced. On this point something has already been done by international co-operation, and we may hope that this meeting will do much to complete the task. Lastly, there are many investigations which are now undertaken independently at irregular intervals which would be far more useful if planned in common. Thus there has of late been a great outburst of energy in Europe devoted to magnetic surveys more detailed than have ever before been accomplished. Is it too much to hope that when the time comes for these to be repeated they may be carried out simultaneously and reduced by the same methods, so that we may have a magnetic map of Europe in which no uncertainty as to the accuracy of details is introduced by the necessity for correcting for the secular change over long intervals of time?

Taking it then for granted that international co-operation is desirable for purposes such as these, I come next to the question of the nature of the machinery by which it shall be secured. And here I may at once state that the arrangements under which we are meeting to-day are in some respects abnormal, and that plans for the future will have to be formally or informally considered before we part. Meanwhile, it is desirable that I should state precisely the circumstances which have brought us together. The last meeting of the International Meteorological Conference was held in Paris in September, 1896. It was attended by several men of science specially interested in terrestrial magnetism, and perhaps on this account a new departure was taken by the International Committee in the appointment of a "permanent committee for magnetism and atmospheric electricity," to which certain specific questions were referred. Eight gentlemen were nominated as members of this committee, with power to add to their number. We in turn co-opted eight other magneticians, taking care that as far as possible all countries in which terrestrial magnetism is specially studied should be represented. About the same time, and, as I believe, in ignorance of the establishment of this committee, a suggestion for the assembling of an international conference on terrestrial magnetism was made in the journal of that name by Prof. Arthur Schuster. It appeared to me and to Prof. Schuster himself that it would be a great pity if this suggestion resulted in the establishment of a rival organisation, and I at once submitted to the committee the question whether, in their opinion, it was desirable that we ourselves should take the responsibility of summoning an international meeting, with the view of obtaining a wide discussion of the points submitted to us by the Meteorological Conference. This suggestion was approved, and as the British Association was willing to allow us to organise the conference as a branch of Section A (Mathematics and Physics), to undertake the expense of sending out the necessary notices, to print our papers in its report, and to extend to foreign members of the conference all the privileges of foreign members of the association, it was also determined that so hospitable an invitation should be accepted with the gratitude it deserved. But although the main result has been achieved, and a representative gathering of magneticians has assembled in Bristol, it cannot be denied that our relations to the various bodies with which we are connected are somewhat complicated, and that our constitution is devoid both of simplicity and symmetry. I take it that these facts are signs of health and vigour rather than symptoms of decay. Terrestrial magnetism has been attracting far more attention of late years than in the not very distant past. The necessity for meeting, for common action, for common publication, has been forced upon us. We have cared more for meeting than for the terms on which we were to meet, more for acting together than for drawing up an elaborate deed of partnership, more for the promotion of science than for an orthodox paper constitution. Thus, and, in my opinion, most wisely, we have sought to attain our ends, not by starting a brand-new international association, but by making use of machinery which is already in existence, which has stood the test of time, and is, as I believe, capable of being put to new uses of meeting our wants and supplying our deficiencies. I confess, however, that in this arrangement we have been compelled to pay scant attention to the simplicity, and even to the logical consistency of our schemes. We are an international conference on special subjects—terrestrial magnetism and atmospheric electricity—summoned by a committee owing its authority and bound to report to another international conference of wider scope, which regards our sciences as branches of meteorology. On the other hand, this committee is for the moment a part of the committee of the Section of Mathematics and Physics of the British Association, though it retains its right of separate meeting, more especially for the discussion of its report to the International Meteorological Conference. It is evident that here there is plenty of opportunity for collision between rival authorities, for confusion between conflicting jurisdictions, but to all questions as to the precise limits of authority and jurisdiction it is sufficient to reply in the most general terms. The whole of the arrangements are temporary to meet an immediate pressing need. The work of the conference will be conducted like that of a department of the British Association. The members of the International Committee will act as the committee of the department, but some of their work will be done on the General Committee of Section A, of which other magneticians will also be members. Should it be necessary, they will hold some separate meetings, and some such meetings will certainly be necessary to discuss and then report to the International Meteorological Conference. These general regulations will probably suffice for all practical purposes. If cases occur which they do not cover, we must deal with them as they arise.

(To be continued.)

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE III.

(Continued from page 374.)

Guttapercha cores which are intended to be used in deep water are, at these works, also subjected to a great water

* Cantor Lectures delivered before the Society of Arts.

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pressure before being electrically tested. The greatest depth of the North Atlantic Ocean is about 3,000 fathoms, and consequently the pressure of the water at the bottom is 530 atmospheres, or 3½ tons per square inch. The pressure used at Messrs. Siemens Bros. and Co.'s works for Atlantic cores is four tons per square inch, and the plant used for these tests is shown in Fig. 52. The guttapercha-covered wire is wound on a drum, D, which is then lowered into a strong cylindrical tank, T, of compressed steel, which can be closed by a screw stopper, L, in the same way as is done with breech-loading guns. The large weight of the hydraulic accumulator, A, having been raised by means of the force-pump, P, communication between the accumulator and the tank is established by means of the pipes, *p*, and the pressure allowed to act on the core for 15 or 20 minutes, care being taken to allow all air to escape from the tank at the beginning of the operation. Any slight mechanical defect of the core, which would ordinarily elude detection, will by these means be made apparent during the subsequent electrical tests.

In order to give you an idea of the enormous pressure used for these tests, I will mention that in December, 1883, our steel tank broke at a pressure of four tons per square inch, and the upper part, weighing over 13 tons, was projected vertically through the roof to a height of about 25ft., and, curiously enough, it fell down again into its old position. The thickness of wall of this cylinder was 7in.; that of the new one was therefore increased to 12in., and this has hitherto withstood the pressure. We had the fractured tank photographed, with one of our men standing at its side to show the dimensions, and I will throw this photograph on the screen.

TABLE XV.—Submarine Cables.

No. of group.	Description of cables.	Approximate length of core. Nautical miles. (Knots).	Approximate weight of guttapercha. Tons.
I.	Trans-oceanic	42,000	6,000
II.	Round coasts of America	41,000	2,600
III.	Round east and west coasts of Africa	18,000	1,200
IV.	Round coasts of Europe and Asia, and to Australia.....	83,000	6,200
	Total	184,000	16,000

I will now throw a map of the world on the screen, which gives the various submarine cables at present in existence; but I must tell you that the total length of 184,000 knots given in the above table (which would be sufficient to pass more than 8½ times round the equator) includes the cores of all cables laid, whether they are still in existence or not; my object being to ascertain the total quantity of guttapercha used for electrical purposes. To the length given in Table XV. another 100,000 miles remain to be added, being the cables which have been laid by the various Governments and States for military defence, so that a total estimate of 24,000 tons of guttapercha used for submarine cables alone is probably not too high. To the latter figure a further allowance for underground cables, street wires,

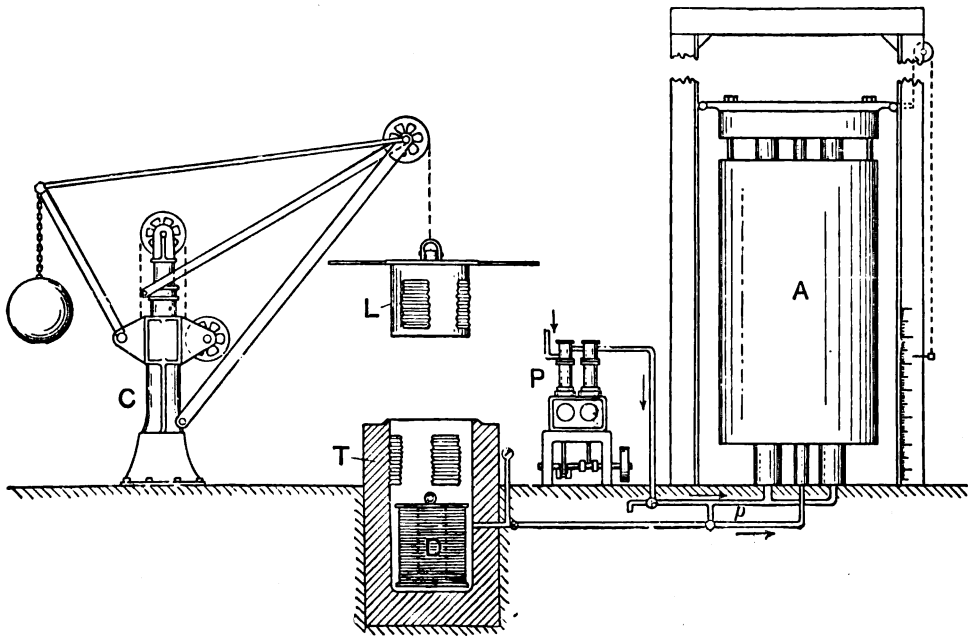

FIG. 52.—Hydraulic Pressure Plant.

In our last lecture I mentioned that I found guttapercha very permeable to the X-rays, and Mr. Alexander Siemens proposed to utilise this property to examine the guttapercha-covered wires with the cryptoscope for the detection of any defects in the copper conductor, particularly in "joints," or for finding air bubbles. I will show you on the screen a set of guttapercha-covered wires, mounted on a card, which was photographed in March last year by means of the X-rays. I have also brought some joints and a coil of Atlantic core with me, which you can examine with the cryptoscope after the lecture.

I shall now give you some figures as to the quantity of guttapercha hitherto used for electrical purposes, by far the largest amount of which has been used for submarine purposes.

Guttapercha-covered wires, which have to be laid in the sea, must be suitably protected against mechanical injury. For that purpose they are surrounded with a serving of hemp or other fibrous material, and then provided with a sheathing of iron or steel wires, or a metal ribbon; the whole is then termed a submarine cable. There are some interesting specimens of such cables on the table, exhibited by the Gutta Percha Company and by Messrs. Siemens Bros. and Co. Amongst the latter you will see sets of the various types of the Direct United States and the Commercial Cable Company's Atlantic cables, of the Dover-Calais telephone cable, and others.

I have calculated the weight of guttapercha used for insulating the cores of all submarine cables manufactured and laid up to the end of 1896, from their length and type, and when these particulars were not available, I estimated them as nearly as possible. For the sake of convenience, I have divided the cables into four geographical groups, as shown in Table XV.

etc., would have to be made, which amounts probably to another 8,000 tons. As we shall presently see, the total consumption of cleaned guttapercha in the United Kingdom from its beginning in 1845 till the end of 1896 amounts in round figures to 48,000 tons. I believe therefore that I am not very far wrong in saying that at least two-thirds, and probably more, of all the guttapercha used in this country has been employed for electrical purposes.

With regard to the quantity of guttapercha used by the Postal Telegraph Department, I am able to give you some very interesting figures, kindly supplied to me by Mr. Hookey, who informs me that the total length of guttapercha-covered wires in use by this department in 1896 was 30,000 statute miles. I calculate that about 660 tons of guttapercha have been used for their manufacture. The total length of guttapercha-covered wires under the streets of London and its suburbs at the present moment is no less than 17,000 statute miles, corresponding to 375 tons of guttapercha. In 1875, Mr. Charles Fleetwood stated before the Society of Telegraph Engineers that the total mileage of guttapercha-covered wire under the London streets was 3,500; the length is therefore now nearly five times what it was 22 years ago.

Before passing on to the next subject, I should just like to refer to an observation made by Dr. Werner von Siemens with the first underground wires insulated with guttapercha—viz., that they became electrostatically charged like a Leyden jar when one end of the conductor was brought into contact with one pole of a battery, whilst the other end was insulated, and the opposite pole of the battery connected to earth. To this property is due the fact that a momentary electric impulse, such as is used in signalling, imparted to the insulated wire,

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takes an appreciable time to arrive at the other end, if the wire is of any length. In this respect an underground line compares unfavourably with an overhead one of equal length, supported on porcelain insulators in the usual way. The extent of the retardation depends on the resistance of the conductor and on the inductive capacity of the insulator—*i.e.*, the guttapercha covering—per unit length, and I have a number of curves here which have been kindly sent me for exhibition by my colleague, Dr. Frölich, of Berlin, showing the results of experiments, on the propagation of electric impulses through a cable under varying conditions.

Home Consumption of Guttapercha.

I should now like to call your attention for a moment to diagram Fig. 55, which gives the home consumption of guttapercha for each year, from 1855 to 1896. The home consumption of the raw material is shown by a continuous line, and I have added the annual import of raw guttapercha into the United Kingdom during the same period, represented by a dotted line, for direct comparison; the latter curve is reproduced from diagram Fig. 17 of the first lecture. Prior to 1878 the two curves are close to each other, but after this they diverge more and more, and this tendency, indicating an increasing export to other countries, is well sustained during the last five years.

The third curve in Fig. 55, composed of dots and dashes, represents the annual consumption of cleaned guttapercha, and is deduced from that of the raw material on the assumption that the average loss on cleaning has been equal to the average obtained by us during the last 20 years—viz., 33⅓ per cent.—which is, of course, not strictly accurate, but sufficiently so for our purposes.

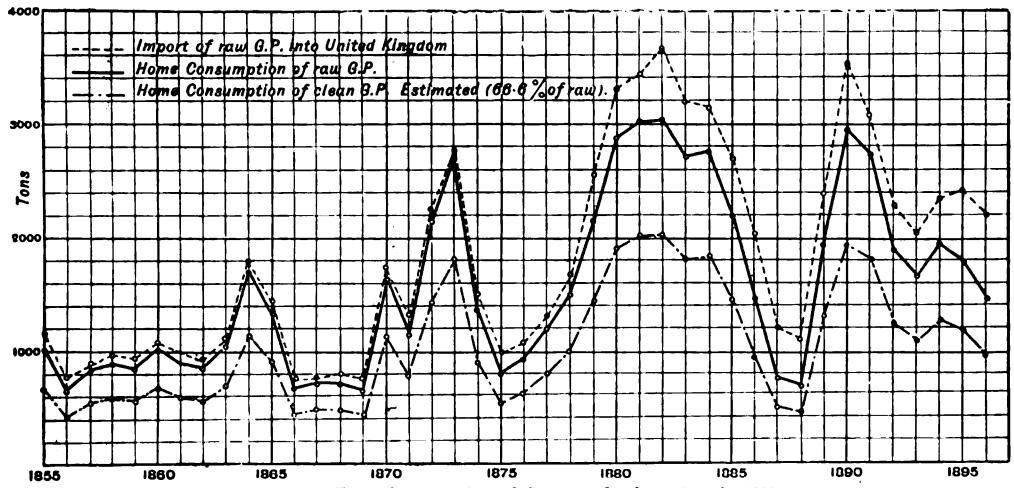

Fig. 55.—Home Consumption of Guttapercha from 1855 to 1896.

In my first lecture I stated that the total import of raw guttapercha into the United Kingdom from the beginning up to the end of 1896 was 82,607 tons, or in round figures 83,000 tons, and I may now add that I have since been informed that almost half that quantity was imported by the Gutta Percha Company. The re-export of raw guttapercha during the entire period in round figures amounts to 11,000 tons, or 13¼ per cent. of the total import.

The total home consumption of raw guttapercha from 1885 to 1896 amounts to	65,467 tons.
To this the total import from 1844 to 1854 must be added—viz.	6,466 ,,
Giving a total home consumption of raw guttapercha from 1844 to 1896 of	71,933 ,,
Or of cleaned guttapercha (allowing 33⅓ per cent. waste)	47,955 ,,

i.e., in round numbers 48,000 tons, as before stated.

Use of Hardened Guttapercha.

Guttapercha hardened by the extraction of its resin, either from the raw or cleaned material, is now chiefly used for the manufacture of golf balls, and although the estimate given in the prospectus of the Gutta Percha Corporation—viz., that 500 tons of guttapercha, which would correspond to nearly 12,000,000 balls, are annually consumed in manufacturing them, is perhaps overstated, yet the quantity used for that purpose is certainly very large, and probably still increasing. The guttapercha used for golf balls has to fulfil certain conditions, and it may be useful to mention them here—viz., it should be tough, elastic, and not brittle at low temperatures; it should also be specifically lighter than water, so that the balls do not sink if accidentally dropped into a ditch or pond.

In order to obtain all these good qualities, it is requisite to start with the proper kind of raw material and to extract the resin as completely as possible. For testing the elasticity I devised an apparatus some years ago, resembling an Atwood's machine, and which I have already used to-night for the experiments on the stretching of guttapercha. Referring to this machine, which is illustrated in Fig. 47, the tall stand, S, is provided with a scale, *s*, divided into feet and tenths, the entire distance between the clip, C, at the top (shown in plan), which carries the golf ball, and the stone plate, P, at the bottom, being exactly 10ft., so that per cents. of the total height can be read off directly.

I will now show you some actual tests of golf balls with this apparatus, to which I have given the popular name of bounceometer. The first ball I am going to show you is a bad one, having had its resin only partially extracted, and still containing about 25 per cent. I place it in the clip and now let it drop on to the stone—you see it rebounds and reaches the point of the scale marked 30. The guttapercha from which the next ball is made has had the resin more completely removed, but not sufficiently, as it still retains 10 per cent. You see this ball rebounds to about 45 divisions of the scale. The third ball, which I shall test, is of excellent description, having only a very small percentage of resin; it rebounds to 60 divisions, the highest rebound hitherto observed by us. Here is a ball, made of balata, from which the resin has been completely removed—it bounces about 59 per cent.; and this other ball, made in August, 1896, from guttapercha extracted from leaves by my process, and not further treated with petroleum spirit like the previous materials, is quite equal, if not superior, to the latter.

In these days of Arctic exploration, I may perhaps be allowed to make a suggestion for the application of hardened guttapercha to another purpose—namely, to ice-boats.

A boat made of ordinary guttapercha was used as early as 1850, in Lady Franklin's expedition of the "Prince Albert" in search of Sir John Franklin. It was put under the charge of Mr. Parker Snow, who reported very favourably on its behaviour, and gave a short account of his experience with it in the *Illustrated London News* of Feb. 22, 1851, accompanied by a sketch showing the boat amongst the ice-floes. The diagram on the wall is a copy of this drawing. The boat was left in a cairn, and was again used in the second expedition in 1852 by Captain Kennedy, but it had to be abandoned on account of the heavy pack-ice. Guttapercha boats do not appear to have been used for subsequent Arctic expeditions, at least I have been unable to find any record of such having been the case. The boat sent out with the Prince Albert expedition was constructed by Messrs. Searle and Co., of South Lambeth, and covered with guttapercha at Wharf-road by the Gutta Percha Company. Its weight was only 18lb. A guttapercha boat built to carry two persons, but weighing 30lb., was exhibited by Charles Hubbard, of Dickleburgh, Norfolk, at the 1851 exhibition (Class 8, No. 180).

I had an opportunity of analysing some guttapercha used for boatbuilding at the Royal Dockyards, Woolwich, more than 30 years ago, and found it to contain 40 per cent. of resin, but this would be too much for Arctic temperatures, as I shall presently prove to you. Besides the greater resistance to concussion which hardened guttapercha would offer at low temperatures, it would also have the further advantage that a thinner covering could be used on account of its greater toughness, which would make the boat correspondingly lighter; its lower specific gravity also would tend in that direction.

I shall now show you by an experiment the superiority of hardened guttapercha over the natural material at low temperatures. On the table before me there is an Arctic Ocean *en miniature*, carrying three little boats made of different kinds of guttapercha. The boats are distinguished by flags of different colours.

(To be continued.)

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REVIEWS.

Quantitative Chemical Analysis by Electrolysis. By Dr. ALEXANDER CLASSEN and Dr. WALTER LOBB. Authorised translation by W. HALE HERRICK and BERTRAM B. BOLTWOOD. Published (in England) by Chapman and Hall. 12s. 6d.

This interesting book would serve, if for nothing else, to mark the progress recently made in Germany in subjects connected with electrolysis. The first half of the work is devoted to a short exposition of the dissociation theory of electrolysis, together with a description of apparatus and methods subsequently to be used. Reproductions of the splendidly-equipped electrolytic laboratory at Aachen are given, and altogether this part of the book tends to give an impression of a fertile field soon to be opened up for ordinary electrical engineers in the supply of plant for electrolytic operations, both scientific and commercial. In the second part methods for the quantitative electrolytic analysis of metals and alloys are given. A few years ago the determination of copper was almost the only electrolytic method used by chemists. Up to the present a vast extension of these methods has been effected, so that now something like a general method has been elaborated. This largely depends on the fact that more definite knowledge is now available as to the conditions necessary for electrolytic deposition. Many people have doubtless been troubled, when referring to the older English text-books on electro-metallurgy (by which electro-plating was generally meant), to find that "an E.M.F. equal to so and so was necessary" for a certain deposition. Now, as a matter of fact, the total E.M.F., E, necessary under any assigned conditions, is given by

$$E = E_1 + C R,$$

where E_1 is the back E.M.F. of polarisation, whilst C and R represent the depositing current and the resistance traversed by it in the cell. In the deposition of all metals, the current density to be employed is a matter of vital importance; further, in certain cases the polarisation E.M.F. plays an important part. Thus it is possible in certain cases to deposit a metal in a state of purity from an impure solution. Such points are fully dealt with. However, much remains to be learnt in this connection, as for instance, why is it that the addition of a small amount of lead acetate to a solution of platinic chloride will facilitate the deposition of platinum black? It may, indeed, generally be said that this latter is more easily deposited from impure than from pure solutions.

OUGHT MUNICIPAL ENTERPRISES TO YIELD A PROFIT IN AID OF RATES?*

BY EDWIN CANNAN, M.A.

Municipalities have been likened to joint-stock companies, the ratepayers being the shareholders. If the parallel were exact, there could scarcely be any question about the propriety of municipal enterprises yielding a profit, since to make a profit is the object of the existence of a joint-stock company. How far then does a municipality resemble a joint-stock company?

In form the two bodies are very much alike, the management of both being committed to an elected council, or directorate, and the ordinary members only interfering on rare occasions directly, though the citizens or burgesses exercise far more influence on the decisions of their representatives than the shareholders. But the basis of membership is very different. In the company it is ownership of a fraction of the homogeneous capital of the company, each fraction being exactly the same as every other fraction of the same magnitude. In the municipality it is connection with particular objects which have for the most part an individuality of their own, which are not in the possession of the municipality, but only subject to its claims for rates, and which are revalued from time to time so that they need not continue to bear the same proportion to the whole of the ratable property. The business of both the company and the municipality is economic work for the benefit of their members, but the company performs services for outsiders and distributes profits in money dividends to its shareholders, while in performing its ordinary functions the municipality provides commodities or services for its members directly, and consequently has no opportunity of making profits to be divided among them in money dividends.

As far as municipal enterprises are concerned, however, the position of the municipality resembles that of the company much more nearly. Municipal enterprise is distinguished from ordinary municipal work by the fact that the commodities or services which it provides are supposed not to accrue to the citizens approximately in proportion to the ratable value of the property with which they are connected, so that it is considered necessary to charge for them by methods and standards different from those which regulate the levying of rates. By hypothesis, then, the business is no longer a merely "mutual" one, in which each member receives direct benefit in proportion to his share, but a business like that of an ordinary company. The municipality ought to be allowed to make a profit for the same reasons as a company is allowed: (*a*) in order that it may have some inducement to undertake the enterprise, which it will not have if it must take all risk of loss and no chance of gain; (*b*) in order to secure efficient management; and (*c*) in order that the economic proportion in the production of different commodities may not be disturbed. The arguments against profit-making in municipal enterprise seem to be founded on an antiquated socialism or on a false analogy, either from co-operative institutions or from ordinary municipal work.

That there may be cases in which it is not economically desirable that the highest possible profit should be made is probable, but these cases are far less frequent than is supposed, and since when they occur the damage must be much greater to the locality than to the country in general, and also be tolerably obvious, there seems no need to restrict the freedom of the locality.

* Abstract of paper read before the British Association.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

100. Write a short essay (not more than 2,000 words) on the practical advantages of electricity for lighting purposes. (Note.—This being the hundredth question, the first essay will be awarded £1.—ED. *E. E.*)

101. Discuss the advantages and disadvantages of carrying the exhaust steam-pipe up the inside of chimney. If an advantage, how high should the steam-pipe be carried?—J. R. B.

ANSWERS.

Question No. 94.—Wanted, particulars of an easily-constructed form of potentiometer suitable for grading small ammeters and voltmeters.

Best answer to No. 94 (*awarded* 10*s.*).—The construction of a useful and easily-made potentiometer is shown in the following sketch, having a wood base, B, preferably of teak and well varnished. The copper strips shown at C C C are about 1in. wide and of 22 gauge.

These copper strips extend underneath the blocks, A, which are made of stronger metal, and are clamped down on the potentiometer wire, W, by four screws shown. This method of holding the wire is quite safe and is more convenient than the soldering, for the wire can be pulled through one end, while the clamp is screwed in its place; thus the wire is stretched tight over the scale, S, also there is no trouble in changing wires. The copper strips may be made out of straight metal doubled over at right angles, as shown at D, without any loss of conducting metal. The scale, S, is an ordinary meter measure without

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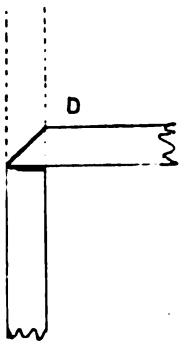
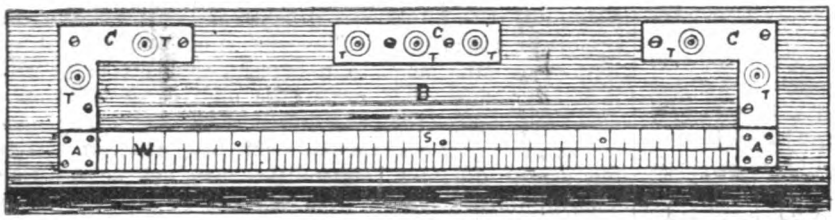
brass ends. If the terminals, shown at T are screwed on from the back of the wood base, the wood screws, shown in the figure, will not be necessary. The sliding contact is





made with the loose wire filed to a wedge shape, and fit in some non-conducting material, such as cork, so that the temperature of the hand will not interfere with the measurements taken.—BAGOT.

Question No. 95.—It is required to design a chimney shaft for a central station intended for an ultimate output of 2,000 h.p. How would you arrive at the dimensions required?

Best Answer to No. 95 (*awarded* 10*s.*).—The chief requirements of a chimney are to carry off the waste or superfluous gases and promote draught to aid combustion. This last requires that the chimney be of sufficient height to produce a draught of the required intensity to ensure that whatever kind of fuel used is consumed in the furnace. There must also be an opening sufficient to allow the useless gases to pass away. The intensity of draught varies nearly as the product of the height into the difference of temperature inside and outside the chimney, and is usually stated as equivalent to a column of water of, say, 2in. Height and area would therefore appear to be all that is necessary to consider in the design of an ordinary chimney. The height should not be less than 80ft.—reliable authorities say not less than 100ft.—as it has been found by experience that less, except under special circumstances, does not produce sufficient draught for a good result with inferior or low-priced coal. After a height has been reached sufficient to procure a draught of the required intensity, for the kind of fuel used, further addition to the elevation gives no adequate return for the expense incurred. On the kind of fuel most easily procurable, or intended to be used, much will therefore depend, and it is assumed that this will in every case have first consideration. If anthracite slack be decided upon, a draught equal to 1½in. of water will be necessary. It is well also to remember that a round chimney is more efficient than a square one, and a straight flue than a tapering one. It is, however, sometimes found convenient to have a chimney tapered somewhat a couple of feet from the top. The effective area of a chimney for a given power varies inversely as the square root of the height; due allowance should also be made for friction against the walls. Each pound of coal consumed yields on an average about 20lb. of gases, the volume of which varies as the temperature, and it may be assumed that a commercial horse-power requires an expenditure of about 5lb. of coal; far better (twice as good) results have no doubt been obtained with high-priced coal and a specially-selected fireman, but this is a safe basis to act upon. The subjoined figures issued under the authority of the Babcock and Wilcox Company, of New York, supplies the necessary information:

$$E \text{ (effective area)} = \frac{0{\cdot}3\ H}{\sqrt{h}}.$$

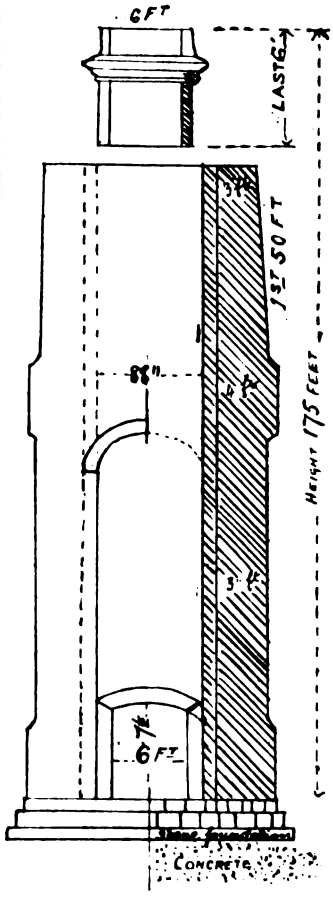
$$H \text{ (horse-power)} = 3{\cdot}33 \times E \times \sqrt{h} \text{ (square root of height)}.$$

$$h \text{ (height)} = \left(\frac{0{\cdot}3\ H}{E}\right)^2.$$

$$S \text{ (side of square)} = 12 \times \sqrt{E} + 4.$$

$$D \text{ (diameter of round chimney)} = 3{\cdot}54 \times \sqrt{E} + 4.$$

We have found by experience that a chimney 80ft. to 100ft. high gives fairly satisfactory results with a medium quality of coal. Let us add 75 per cent. to meet the case of a less costly fuel, making our chimney 175ft. The horse-power of our station is to be 2,000. Applying the above formula we find that the effective area works out at 46ft. nearly. Inverting this last result, we get the 2,000 h.p. to a fraction. The height by same formula comes out at 170ft. We have assumed a height of 175ft., a result sufficiently near for all practical purposes. Again applying our formula, a side of a square works out 88in. Should an octagon chimney be decided on, we have simply



to construct an octagon equal to this square. For a round chimney the result likewise agrees with the foregoing, bearing in mind the higher efficiency. To find the draught × height of chimney by ·007, and the result is 1½in. of water, nearly. We have to take an average here, as the temperature varies up along the flue. It now becomes necessary to find out if our chimney is dimensioned sufficient to carry off the waste products (gases) from 10,000lb. of coal with a draught equal to 1½in. of water. Assuming a temperature of 600deg. F., and same volume as atmospheric air of same temperature, and we find that it will take nearly twice as much, theoretically speaking.

The structural details next claim our attention. The external diameter of a brick chimney should be one-tenth of its height, which gives us a base of 18ft., or say 20ft. A substantial stone foundation should be provided, which should rest on bed rock or concrete. The extent of this latter depends upon the nature of the soil upon which the structure is to rest. Upon the stone foundation is placed the brickwork of the chimney proper. The taper of the chimney may be about $\frac{1}{16}$in. to each foot so far as tapering is necessary. The last length of 12ft. at top may consist of one brick and a half, extending by half a brick for each 25ft. downwards. Brickwork weighs about 120lb. per cubic foot, so that the necessary strength of materials may be gauged. A chimney constructed as before mentioned ought to be sufficiently strong to withstand wind pressure of these

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islands, and no special strengthening need be considered under this head. A thin partition of non-conducting material should be inserted between the inner lining and the outer brickwork of the chimney, which does not appear in attached drawing.

Should an iron chimney be preferred, the same formula holds good, but the efficiency is much higher, because there is no infiltration of air as there is in brickwork. These chimneys are lined throughout with brick, and secured by holding-down bolts; and if of sufficient weight to withstand the overturning power of the wind, need have no stays. The coefficient of wind pressure is about 26lb. per square foot, and a factor of safety must be allowed.—W. H. MURPHY.

Answer to No. 95 (*awarded* 5*s.*).—As the length of flue between the furnace and the chimney has a good deal to do with the decision of the cross-section of the throat-way, it will be necessary to first of all arrive at some idea of the total flue circuit for a station of 2,000 h.p. It will be assumed that Lancashire boilers are to supply steam to compound condensing engines, and that condensing plant is provided and arranged so that the possibility of its total stoppage is remote. The total horse-power is to be 2,000. A well-designed compound condensing should never take more than 20lb. of steam per horse-power per hour. Many engines of the above class consume a much less quantity than 20lb., but, in the absence of specific information, the above amount will be a useful and safe quantity to adopt. The total steam consumption will be $2{,}000 \times 20 = 40{,}000$lb. per hour. A standard 30ft. × 8ft. Lancashire boiler evaporates 8,000lb. of water per hour, and its two furnaces have each an area of 9ft. 6in. × 3ft. 3in. = 30 874 square feet. To evaporate 40,000lb. of water the number of boilers required would be $40{,}000 \div 8{,}000 = 5$. At least one extra boiler would be put down as a stand-by, making six in all. The length of flue between the furnace and the chimney for a single boiler is usually taken as being equal to about six times the length of the grate. In the case under consideration, if we assume that a 3ft. length of smoke-way is left free in each of the two side flues and in the bottom flue, and since the length of each furnace is 9ft. 6in., the following will be the flue circuit of each boiler installed:

Furnace flues (30ft. − 9½ft.) × 2	= 41ft.
Two side and one bottom flue, each 27ft.	= 81ft.
Proportion of main flue, say	= 8ft.
Total for each boiler.....	= 130ft.
Total length of flues for six boilers, 130 × 6.....	= 780ft.

As the chimney may not be able to be built close to the main boiler flue, if the total length of flue be taken at 800ft., a little latitude will be provided. The area of the throat-way is now required, and to arrive at this it is necessary to know the total coal consumption. A usual amount to allow is 20lb. of ordinary coal for steam raising per hour per square foot of grate area.

Each boiler has a grate area of $30{\cdot}875 \times 2 = 61{\cdot}75$ square feet.

The total coal consumption of six boilers will be $61\,75 \times 20 \times 6 = 7{,}410$lb.

The area of the throat-way also depends upon the height, and this latter will as a rule have to conform to the local by-laws. As, however, a minimum and not a maximum height is stipulated, as a rule, if the chimney be over 90ft. in height, no trouble is likely to arise under this head.

The height may be calculated from the following formula:

$$h = \left[\frac{C}{17\,(A - K\sqrt{A}}\right]^2$$

where h = height in feet;
C = weight in pounds of coal burnt per hour;
A = internal effective area in square feet;
K = constant depending upon size and shape (0·59 and 0·66 for round and square chimneys respective when over 9ft. in diameter).

The heights for various coal consumptions for a draught equal to 1in. of water have been worked out, and are tabulated in Table I. It will be seen that for a coal consumption of 7,410lb. per hour the height should be 200ft. Some tables also give the requisite area, but they are usually calculated for a flue length of 100ft. The area may be ascertained from the following formula:

$$A = \frac{1{\cdot}5 \times G}{H},$$

where A = area of chimney throat at smallest diameter;
G = area of firegrate;
H = height of chimney, in feet, above firebar level.

By formula:

$$A = \frac{1{\cdot}5 \times 61{\cdot}75 \times 6}{200} = 39{\cdot}72 \text{ square feet.}$$

The above area is for a flue circuit of 100ft., and as the flue circuit in this case is 800ft., it will be necessary to divide the above area by the constant given opposite 800 in Table II., the quantities in which have been calculated on the above basis.

$$\text{Hence, effective area} = \frac{39{\cdot}72}{0{\cdot}561} = 70{\cdot}8 \text{ square feet.}$$

For all chimneys over 70ft. in height a circular section should be adopted, as such a section is better able to withstand wind pressure. If, then, the chimney be circular, with an area of 70·8 square feet, the internal diameter will be—

$$\sqrt{\frac{70\,8}{0{\cdot}7854}} = 9\text{ft. } 6\text{in.}$$

This is the minimum effective internal diameter of the shaft. The lower half of the shaft will be lined with 4½in. firebrick, with a space of 1in. between it and the outer casing, to which it will be tied by means of six radial walls of firebrick. The upper half of the shaft will be built on the inside with fine hard bricks. The top must not be less than 9in. thick, and the walls must increase in thickness downwards at the rate of 5in. in every 20ft.

The thickness added to the walls will be $\frac{200 \times 5}{20}$ = 50in ..... =	4ft. 2in.
Add to this the thickness at the top	9in.
Also the air space between lining and outer casing	1in.
Making a total thickness at the base of shaft of...	5ft. 0in.

The total diameter of shaft measured at its base outside will be 5ft. × 2 + 9ft. 6in. = 19ft. 6in.

The chimney will be finished at its summit with a hollow cast-iron or fireclay cap. The foundation should be on the solid rock if possible, failing which the foundation should be taken down to such a depth as may be necessary to obtain a good bearing on hard clay or firm sand. Piling may be necessary in some instances. Whatever foundation may be used the surface must be levelled with a layer of concrete, which should not be less than 12in. thick in its thinnest part, and on this the brick base of the chimney is built in 6in. courses tapered to the exterior of the chimney shaft. The area of the foundation work depends upon the strength of the natural foundation. For some feet below the point at which the flue enters the shaft a cavity will be formed, so that the hot gases may not injuriously affect the rock or concrete or brick foundation. The total weight of the shaft above mentioned will be about 400 tons, which would give a weight of about 1·8 tons to the square foot. As the safe load for clay and sand varies from two to ten tons per square foot, according to dryness and thickness, the factor of safety allows ample margin. In Table III. the leading dimensions of the chimney are compared with the minimum dimensions required for a chimney of similar character by the rules of the London County Council.

TABLE I.

Weight of coal consumed per hour.	Height of shaft.	Weight of coal consumed per hour.	Height of shaft.
100lb. and under	60ft.	3,000lb. and under	160ft.
500lb. and under	100ft.	4,000lb. and under	180ft.
1,000lb. and under	120ft.	5,000lb. and upwards	200ft.
2,000lb. and under	140ft.		

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TABLE II.

Length of flues in feet.	Constant.	Length of flues in feet.	Constant.
50	1·076	800	0·561
100	1·	1,000	0·514
200	0·853	1,500	0·413
400	0·708	2,000	0·312
600	0·625	3,000	0·317

TABLE III.

Dimension.	2,000-h.p. stack.	L.C.C. minimum dimensions.
Height in feet above fire ...	200ft.	200ft.
Effective internal diameter	9ft. 6in.	—
External diameter at base.	19ft. 6in.	19ft. 3in.
Thickness of wall at top ...	9in.	8½in.
Increase in thickness	5in. every 20ft.	4½in. every 20ft.
Batter	1in. in 4ft.	1in. in 4ft.

F. STOTT.

Note.—In this answer the diameter arrived at is too large, as the total length of each boiler flue has been considered as if in series instead of being in parallel.—ED. *E. E.*

Answer to No. 95 (*awarded* 5*s.*).—The dimensions and design of a chimney for a certain output are regulated to a great extent by any local by-laws which may exist, such as the rules of the London County Council with reference to size of base, amount of batter, thickness of brickwork, etc.; some towns also impose a minimum height regulation, so that with the data given above it is somewhat difficult to arrive at an approximate idea of the size required. Presuming that the same conditions hold good as those which ordinarily exist in an electric light station, such as a battery of Lancashire boilers with economiser, and a set of engines taking on an average 20lb. of steam per indicated horse-power, then the total quantity of steam required will be $2,000 \times 20 = 40,000$.

Now, a good all-round average for a Lancashire boiler, with economiser and good steam coal, is 10lb. of water evaporated per pound of fuel. ∴ total quantity of coal consumed per hour = 4,000lb.

Taking a height of 175ft. for the chimney, there will be a draught of

$$7{\cdot}6 \times 175 \times \frac{t_c - t_a}{t_c \times t_a};$$

where t_c and t_a = temperature of gases and external air, + 460 in each case.

$$= 7{\cdot}6 \times 175 \times \frac{(460+400)-(460+60)}{(460+400)\,(460+60)}$$

$$= 7{\cdot}6 \times 175 \times \frac{340}{447{,}200}$$

$$= \frac{452{,}200}{447{,}200};$$

which equals a draught of slightly over 1in. of water.

Now, the effective area required to burn 4,000lb. of coal per hour $= \frac{c}{17\sqrt{h}}$, where c = coal burnt per hour in pounds and h = height of chimney in feet

$$= \frac{4{,}000}{17\sqrt{175}}$$

= 18 square feet effective area.

The actual diameter of the chimney is generally somewhat greater than the effective diameter, owing to the friction of the gases against the sides of the chimney. To obviate this effect the chimney is generally made 4in. greater in diameter, which brings out the actual diameter to

$$\sqrt{\frac{18 \text{ square feet}}{\cdot 7854}} + 4\text{in.} = 5\text{ft.}$$

Now, 5ft. is the minimum diameter of any part of the chimney. Taking this as the diameter at the top, then the external diameter will be 5ft. + 2ft. 3in. = 7ft. 3in.

With a batter of ¼in. per foot on each side, the external diameter at the bottom will be 7ft. 3in. + 7ft. 4in. = 14ft. 7in. The thickness of the shell starting with 1½ bricks, or 13½in., at the top will increase half a brick for every 25ft., so that thickness at the bottom will be 4½ bricks, or 3ft. 4½in.

The inside diameter at bottom = 14ft. 7in. − 2 (3ft. 4½in.) = 7ft. 10in., and the base, as a rule, is made one-tenth the height = 17ft. 6in.

If there is any likelihood of the temperature of the flue gases getting above 600deg., then an internal liner of firebrick would be put about halfway up the chimney, leaving a space of a few inches between it and the chimney proper, the air in this space efficiently acting as a non-conductor between the liner and the shell of the chimney. It will thus be seen that the principal dimensions are:

Height	175ft.	0in.
Minimum diameter at top.....	5ft.	0in.
External diameter at top	7ft.	3in.
External diameter at bottom	14ft.	7in.
Internal diameter of shell at bottom	7ft.	10in.
Diameter of base	17ft.	6in.

These dimensions give a good idea of what would be required under the ordinary course of affairs, but local conditions play such a very important part in chimney building that very big deviations from this size might possibly be found.—H. B.

MANCHESTER ELECTRIC SUPPLY REGULATIONS.

We have just received from Mr. C. H. Wordingham the new regulations issued in connection with the electricity department of the Manchester Corporation. These are of great interest, in that they are not duplications of other regulations, but contain several innovations, dictated by common sense, which tend to ensure that good and uniform work only is connected to the supply mains. We regret that we have not sufficient space at our disposal to permit us to publish the regulations in full, and hence can only give those parts which are essentially new or interesting. The general clauses, although not novel, are very valuable to consumers. They read as follows:

"Consumers are strongly recommended to make application for a supply of electrical energy before finally concluding the contract for wiring their premises, and before ordering motors, fittings, etc.; also to require their contractors to submit their proposals to the city electrical engineer for his approval. Unless this be done there may be delay in connection consequent on alterations being required.

"Most of the fire insurance companies issue regulations as to wiring of buildings, and consumers should give notice to their respective fire insurance companies that their buildings are being wired in order that the companies may send their inspector to watch the work while it is in progress in order to secure its being done to his satisfaction. In cases where fire insurance companies do not issue rules of their own, the recommendations issued by the Institution of Electrical Engineers should be strictly enforced.

"Contractors are hereby notified that the regulations which follow are only such as are absolutely necessary to secure a safe and satisfactory supply, and as such they will be strictly enforced. They are additional to, and are not in substitution of, the ordinary wiring rules. The recommendations issued by the Institution of Electrical Engineers should be closely followed.

"The inspection and tests made by the Corporation are made in the interests of consumers generally, and the passing of an installation for connection to the mains by no means implies that the work has been done in the best possible manner. The Corporation will take no responsibility whatever in respect of testing a consumer's installation on his own behalf. The Corporation will not supply or fix any internal fittings, except the meter and main fuse on the consumer's premises, and at the main fuse their responsibility ends. The responsibility for all wiring, fittings, and apparatus on the consumer's side of the Corporation main fuse rests solely with him. The work should be carefully inspected on the consumer's behalf by a person independent of the contractor.

"In accordance with the powers conferred by the Manchester Corporation Act, 1897, Section 34, the following regulations have been drawn up for securing the safety of consumers and the prevention of fire, and the Corporation hereby give notice that no installation which does not conform to these will be connected to the mains or supplied with electrical energy; and,

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further, that the supply will be discontinued in the event of any installation which may be connected ceasing to conform to them."

The regulations are numbered, and the first three are, as will be seen, chiefly concerned with the pressure and arrangements of supply:

"1. *Pressure of Supply.*—Continuous current will be supplied in all cases at a pressure of 200 volts or 400 volts, and in most of the streets in the central portion of the city at 100, 200, 300, or 400 volts.

"2. *Lamps, etc.*—For all purposes except motors a demand up to 2½ kw. will be supplied from one pair of terminals, above 2½ kw. the consuming devices must be divided into two approximately equal circuits. In those streets in which a 100-volt supply is available, the consuming devices must be divided into two approximately equal circuits when the demand exceeds 2½ kw. and is below 5 kw. If above 5 kw. they must be divided into four approximately equal circuits.

"The following shows the requirements for installations of various sizes. One 50-c.p. lamp may be taken as equivalent to two 25-c.p., to three 16-c.p., or to six 8-c.p., and one ordinary arc lamp (500 watts) to 15 8-c.p. lamps:

"Installations up to 80 lamps of 8 c.p. to be on one circuit not exceeding 25 amperes at 100 volts each, or one circuit not exceeding 12½ amperes at 200 volts each.

"Installations between 80 lamps of 8 c.p. and 160 lamps of 8 c.p. to be on two equal circuits not exceeding 25 amperes at 100 volts each, or two equal circuits not exceeding 12½ amperes at 200 volts each.

"Installations above 160 lamps of 8 c.p. to be on four equal circuits at 100 volts, or two equal circuits at 200 volts.

"3. *Motors.*—Current will be supplied at 200 volts for motors absorbing not more than 2½ kw.—*i.e.*, 3½ e.h.p.; above 2½ kw. at 400 volts. In those streets in which 100 volts is available the same rules apply, except that motors taking not more than ¾ kw., or 1 e.h.p., will be supplied at 100 volts if desired."

It will be seen from the above that the limit of supply for light or power from two terminals on the three-wire system is 2½ kw. All demands above this have to equally balance on the two sides of the three-wire system, except in the case of motors; these are connected to the outside wires at 400 volts. For lighting purposes this regulation entails the use of a three-wire system on the consumer's premises, but there is no objection to this now, as almost all the places are wired on the distributed-circuit system. This arrangement of wire is readily adapted for distributing two circuits of the three-wire system to practically every room. As a result, the difficulty central-station engineers have to fight against in balancing a three-wire system is largely done away with. The next rules to follow we pass over, but note that no meter rents are charged in Manchester. The next new departure has to do with the approval of wiring and fittings, as set forth in Nos. 17 and 18. These read as follows: "All wiring, electrical fittings, and appliances of every description situated on any premises intended to be used for the supply of electrical energy from the Corporation must be approved by the city electrical engineer before the installation is connected to the Corporation mains.

"Switches, fuses, fittings, and other apparatus may only be used after they have been certified by the city electrical engineer in writing as approved. Articles may either be submitted by consumers (directly or through their contractors) or by manufacturers. In the former case, the article to be actually used must be submitted, and, if approved, the certificate issued will apply only to the individual article. In the latter case, the article submitted must be identical with articles of a particular pattern made by the manufacturer, and, if approved, the article will be registered, and the certificate issued will apply to all articles identical with that tested. Such fittings will be known as approved fittings, and contractors will be entitled to use them without individual samples being tested during the period the certificate is in force. The certificate is in force for one year from the date of issue, but may be renewed from year to year at the discretion of the city electrical engineer without further tests of the article. Samples of all approved articles are kept at the electric light station, Dickinson-street, Manchester, for inspection. The following conditions must be fulfilled:

"(*a*) All articles submitted must be such as are actually to be used or are likely to be used in installations to be supplied with current by the Corporation.

"(*b*) Written application for testing must be made on the official form, to be obtained at the electric light station, Dickinson-street, Manchester, and must be signed by the person submitting the sample.

"(*c*) All articles must be delivered, carriage paid, at the electric light station, Dickinson-street, Manchester, and must be removed by the person submitting them within 48 hours of his receiving notice from the Corporation to do so.

"(*d*) The Corporation will not be responsible for any damage to any article, either in transport or while in their charge, nor for any loss sustained in consequence of the time which may elapse before the article is returned. All possible care and dispatch will be observed.

"(*e*) Each article must be clearly marked with a number and distinguishing mark.

"(*f*) Each article must be accompanied by a statement of the purpose for which it is intended, and for the maximum pressure and current it is intended to employ in connection with it.

"(*g*) No electrical measuring instrument can be received for calibration.

"Articles submitted by manufacturers are subject to the following additional regulations:

"(*h*) Samples must be submitted in duplicate, and both become the absolute property of the Corporation.

"(*j*) Each article must be marked with a trade mark or other means of permanent identification, and must be accompanied by a reference to the manufacturer's catalogue.

"(*k*) One of the samples will be tested, and the other preserved for inspection by contractors.

"(*l*) The certificate will be forfeited if any change is made in the design, size, workmanship, or material of the article, the sample of which has been approved, or if the certificate is published by the manufacturer as an advertisement."

This system of inspection and approval of fittings must entail an enormous amount of work on the electrical staff, but the outcome of it is to entirely abolish shoddy material. The supply of fittings and accessories will not be hampered by the regulations, as all leading manufacturers will be bound to get their apparatus certified once and for all. In fact, although at first the regulations may be considered stringent by some, they tend to ensure good, reliable fittings only being used. After this is once recognised, the rules will cause no delay in the execution of work. As regards the tests fuses and switches will be put to, these are foreshadowed in Rules 28 and 29. Thus we read:

"All conductors must be protected by fuses on both poles, which must be competent to cut off the current if this exceeds the normal current by 50 per cent. Such fuses must be provided wherever the conductor diminishes in size at the ends of the smaller conductors, where they are attached to the larger. Separate single-pole fuses are preferable in all cases, and they alone must be employed on circuits where the pressure of supply exceeds 100 volts. Wherever possible, fuses should be grouped together on distribution boards. When this is done, fuses of the same polarity must be fixed on a board distinct from that supporting those of opposite polarity. It is preferable that distribution boards should be used in all cases, and that lamps should be grouped in circuits not exceeding 2½ amperes at 200 volts, or five amperes at 100 volts. When this is done, it is not requisite to provide fuses for the individual lamps."

Again: "Switches must be so constructed that they do not heat when the full current is left on continuously, so that it is impossible for them to remain in a position between full on and full off, and that they will break the circuit when a current 50 per cent. in excess of that for which they are rated is broken at a pressure 50 per cent. in excess of that for which they are intended to be used."

Further rules as to the use of motors, radiators, etc., are given, and we note that in the case of motors supplied at a pressure of 400 volts the conductors must be enclosed in strong metal casing efficiently connected with earth. The conductors used must have an insulation resistance of not less than 2,500 megohms per mile.

The rules as a whole are the best we have yet seen, and show that Mr. Wordingham means to have as good work carried out on the consumer's premises as he has been careful to get inside the supply station.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, Esq., M.I.C.E., chairman; Sir Gilbert A. Clayton-East, Bart., deputy-chairman; Captain H. Riall Sankey, R.E. (ret.), M.I.C.E.; Lieut.-General Sir Richard H. Sankey, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

Ninth half-yearly report of the directors, to be submitted at the ordinary general meeting of the Company, to be held at the Victoria Works, Rugby, at 2.45 p.m. on Wednesday, Oct. 5, 1898:

After writing off as depreciation from plant, patents, etc., the sum of £5,591. 3s., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £2,012. 18s. 3d. brought forward) is £19,534. 1s. 6d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 8 per cent. per annum upon the ordinary shares, together amounting to £9,476. 3s. 8d. The amount payable to the original directors in accordance with the articles of association is £2,616. 10s. 11d., leaving a balance of £7,441. 6s. 11d. From this the directors propose to carry £2,000 to the debenture redemption fund and £3,000 to the reserve fund (against £1,500 last half-year), leaving a balance of £2,441. 6s. 11d. to be carried forward.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bridgwater.—The Trustees invite tenders for wiring, supply of fittings, lamps, etc. Further particulars appear in our advertising columns. Tenders by Sept. 27.

Leigh.—The Electricity Committee of the Urban District Council invite tenders for the supply and erection of various plant. Further particulars appear in our advertising columns. Tenders by Oct. 14.

Thrybergh (Rotherham).—Tenders are required for lighting Thrybergh Colliery by electricity. For particulars and permission to inspect apply to Mr. W. Hargreaves, agent, Rothwell Haigh, Leeds. Tenders to be addressed to Messrs. J. and J. Charlesworth, Limited, colliery proprietors, Milnes House, Wakefield. by Sept. 26.

Ashton-under-Lyne.—The Market Committee of the Corporation are prepared to receive tenders for the installation of the necessary wires, fittings, etc., for the electric lighting of the public market. The current will be supplied from the town mains. Specification, etc., can be obtained on application to Mr. John Neal, borough comptroller, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender and specification. Tenders by Oct. 3.

Plymouth.—Tenders are invited for the supply of an enclosed (iron-clad) continuous-current motor, shunt-wound, for 10 b.h.p. at 850-950 revolutions, for 520-volt circuit, complete with spare armature, starting switches, and resistances. Specification and form of tender may be obtained by actual manufacterers on application to Mr. John H. Rider, borough electrical engineer, East-street, Plymouth, to whom sealed tenders must be delivered by Oct. 6.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1 000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Hull.—The Electric Lighting Committee invite tenders for the supply of the following cars, etc.—viz , 45 electric motorcars, 20 trail cars, 2 sprinkler cars, 2 traversing platforms. Specifications and forms of tender may be obtained of Mr. A. E White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Rolling Stock," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 30.

Bexhill.—The Bexhill Urban District Council invite tenders for the following work in connection with their electric lighting station: (Section A) water-tube boilers; (B) steam dynamos and balancer; (C) switchboards; (D) storage battery; (E) underground cables and pipes, arc lamps and posts. Copies of the specifications, with form of tender and general conditions, can be obtained at the office of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster, S.W. Applications for any or all of above must be accompanied by a cheque for £5. 5s., which will be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting, Tender for Section —," must be delivered at the offices of Mr. Fred. A. Langham, clerk, Council Office, Bexhill, by 10 a.m. on Sept. 28.

Hull.—The Corporation are prepared to receive tenders for the steel roofs, etc., for the extension of the electric light station, Sculcoates-lane. The work includes seven plain trusses about 50ft. span, and seven about 40ft. span, and the total weight of steel and iron work is about 26 tons. Specifications and forms of tender may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. A limited number of blue prints of the contract plan will be furnished on payment of 5s., not returnable, but the Corporation do not undertake to supply all applicants. Remittances to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Roof Extension," are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 29.

Rathmines.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pumps, ejector, economiser, electric motor; (B) engine-house plant—high speed steam dynamos and accessories; (C) condensing plant and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) underground work—trenching, cables, etc.; (H) posts for incandescent street-lighting; (I) lanterns and incandescent lamps for same; (J) meters. Tenderers are at liberty to tender for any section, but not part of a section, and applicants must state for which section they wish to tender, in order that the requisite drawings may be forwarded. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, 64, Victoria-street, London, S.W., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders, sealed and marked "Tender for Electricity Works," must be addressed to Mr. F. P. Fawcett, secretary to the Township Commissioners, at the Town Hall, Rathmines, co. Dublin, and be delivered on or before Oct. 5.

RESULTS OF TENDERS.

Buckley.—Tenders have been received from the Sandycroft Engineering Company and Messrs. Mather and Platt, Manchester, for electric lighting.

Kingston.—Twenty-five tenders have been received for wiring the Victoria Hospital varying from £56. 10s. to £125. 9s. 6d. The current is to be taken from the Corporation mains.

London.—The City and South London Railway Company have accepted the tender of Messrs. L. Whitehead and Co., Limited, at £10,749, for the erection of engine and boiler houses.

London.—The tender of Brockie-Pell Arc Lamp, Limited, has been accepted for the supply of over 300 of their patent arc lamps required for the lighting of the new Great Central Railway.

Fulham.—Tenders have been received by the Vestry from the Horsfall Company, Messrs. Beaman and Deas, and Messrs. Manlove, Alliott, and Co., for a combined dust destructor and steam-raising plant.

London, N.W.—The tender of Messrs. Sharp O'Brien, and Co., Minories, at £403, has been accepted for wiring for electrical installation, together with electric bells, at Abbey Court-mansions, N.W.

Newington.—The following tenders have been accepted by the Electric Light Committee: British Insulated Wire Company, mains, etc., £9,082; General Electric Company, switchboard, £1,475; Pritchetts and Gold, accumulators, £900.

Bootle.—The Town Council have accepted the tender of the Reason Manufacturing Company, Limited, Brighton, for the supply of Wright's patent maximum demand indicators, in accordance with the specification prepared by Mr. T. L. Miller, for a period of 12 months, including maintenance.

Glasgow.—The Clyde Lighthouses Trustees have accepted the following tenders for work, etc., in connection with the alteration of the light at Cumbrae Lighthouse from a fixed oil light to a flashing electric light: P. M'Bride and Co., Port Glasgow, alterations on buildings, £695. 5s. 9d.; J. Milne and Son, Limited, Edinburgh, revolving carriage, etc., £525; W. Dixon and Co., Glasgow, electric plant, £920; M. Henry Lepeaute, Paris, optical apparatus, £568; Campbell Gas-Engine Company, Limited, Halifax, additional engine and compressor, £380.

BUSINESS NOTES.

Exeter.—The Local Government Board have sanctioned the borrowing of £7,000 for purposes of electric lighting.

Chichester.—A scheme to connect Chichester and Bognor by means of a direct light railway is now being promoted.

Appointments Vacant.—As reference to our advertising columns will show, there is a number of vacancies for engineers, etc.

Personal.—We are informed that the directors of the Hotel Cecil have appointed Mr. W. Poynton as their chief engineer.

Removal.—The offices of the Reflector Syndicate are removed from 39, Victoria-street to Grosvenor-mansions, Victoria-street.

Dundee.—The erection of electric lamps in connection with the electric lighting area in the city has been commenced this week.

New Offices.—We are informed that Mr. Walter L. Le Maitre, C.E., has taken offices at Carlton-chambers, Baldwin-street, Bristol.

New York.—It is rumoured that the Walker Electric Company, of Cleveland, has been absorbed by the Westinghouse Electric Company.

Cardiff.—The Local Government Board have sanctioned loans of £28,125 for electric lighting purposes and of £500 for the Newport-road extensions.

Willans and Robinson, Limited.—The registers of transfers and members of this Company will be closed, prior to the ordinary general meeting, to Oct. 5 inclusive.

Leamington.—The Town Council have decided that application be made to the Board of Trade for the grant of a provisional order under the Electric Lighting Acts, 1882 to 1888.

Swansea.—It appears that owing to the delays in the present relaying works, the tramway company have abandoned the intention of seeking powers to make further extensions of their line in Swansea.

Chislehurst.—The building which is being erected at the rear of the Royal Parade by Mr. J. Otway, at a cost of about £1,300, for the electric lighting company, for storage purposes, is nearly completed.

Yarmouth.—The statement of the Electric Light Committee shows a profit for the year of £200 after paying all liabilities. A system of electric tramways for Yarmouth is being advocated in the local Press.

Burton.—The Town Council have joined the association of municipal corporations, local authorities, and companies formed to resist Mr. Rucker's claims, and decided to contribute to the transformer patent defence fund.

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Glasgow.—The Corporation have adopted the recommendation of the Tramways Committee on the proposed extension of the tramways to Paisley, and decided upon the acquisition of the tramways in the burgh for £18,000.

Lynn.—The Local Government Board have directed an enquiry to be held into the proposed electric lighting loan of £30,000. In the meantime tenders for the works have been received, as well as a report thereon by Prof. Robinson.

Royal Electrical Company of Montreal.—The directors have declared a dividend on the share capital for the quarter ended Aug. 31 last of 2 per cent., being at the rate of 8 per cent. per annum, payable on and after 1st prox.

Rawtenstall.—The Town Council have decided that no consent shall be given for any private company to obtain electrical powers in connection with the borough, but, on the contrary, the Corporation will obtain such powers for themselves in the ensuing session of Parliament.

Vauxhall Bridge.—The temporary bridge lately opened to the traffic at Vauxhall is lighted by a number of incandescent electric lights, giving the bridge a fairyland appearance reminiscent of the exhibition grounds at Earl's Court. Other Thames bridges would not be the worse off for a similar illumination.

Society of Engineers.—The next ordinary meeting of this society will be held at the Royal United Service Institution, Whitehall, on Monday, Oct. 3, when a paper will be read on "Protective Metallic Coatings for Iron and Steel," by Mr. Sherard Cowper-Coles, A.M.I.C.E., M.I.M.E., M.I.E.E.

Direct Spanish Telegraph Company.—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the ordinary shares, both for the half-year ended June 30 last, payable on 1st prox.

Belfast.—The Electric Committee will propose to the Corporation that the latter promote a Bill in Parliament for the laying of electric lines of tramway on the principal roads and streets in the city of Belfast not provided with a tram service. The electric lighting station will be formally opened by the Lord-Lieutenant of Ireland on the 18th prox.

Dover.—Plans for a new light railway to run from Dover along the eastward cliffs to Martin Mill, near St. Margaret's Bay, have been submitted to the District Council. The railway is to cross three public roads on the level, one of which affects the Kent County Council, and the matter has therefore to be deferred for the consideration of their surveyor.

Falmouth.—The junction line from Truro to Falmouth having been completed by the National Telephone Company, communication between the two places was established on the 20th inst. A number of gentlemen assembled at Falmouth Municipal Buildings in the morning, when the Mayor declared the line open, and the usual set of speeches was delivered.

Svea Lamps.—From Messrs. J. C. Lyell and Co., electrical engineers and manufacturers, we have received a new catalogue of their ordinary, opaline, and coloured lamps. We understand that the firm guarantee a life of 1,000 hours, and an average of three watts per candle-power at first and not more than four watts per candle-power at end of 1 000 hours.

Sunderland.—The Town Council adopted on Wednesday last the tramways scheme recommended by their special committee. It was decided to take steps to purchase the local tramway system on the expiration of the lease next year, and to work it under the Corporation. It was agreed to adopt the overhead electrical trolley wire system. The scheme will cost about £250,000.

Tees-Side Tramways.—The Imperial Tramways Company have issued a well-illustrated pamphlet dealing not only with the history of the localities, but with the construction, equipment, and operation of the system, inaugurated July, 1898. A plan is added showing the proposed extension to Grangetown in the east, Yarm in the south-west, and Aclam in the south of the present system.

Kensington.—Notices and plans relative to extensions of their mains in the parish have been received by the Vestry from the Notting Hill Electric Lighting Company for Dawson-place, Chepstow-place, and Palace-gardens-terrace; and from the House-to-House Electric Light Supply Company for Tregunter-road, Nevern-road, Earl's Court-square, Pembroke-gardens, Drayton-gardens, and Earl's Court-road.

Gorleston.—The proprietors of the tramways are contemplating running them by electricity, and have offered under certain conditions to supply the current to Gorleston and Southtown for lighting purposes. Mr. Preece has been consulted in the matter, and according to his opinion Gorleston should have the electric light, and thinks it should be supplied by the Corporation and not by the tramway company.

Cupar.—Edmundsons' Electricity Corporation have supplemented their offer to instal the electric light in the town by guaranteeing to light the streets of Cupar and the town hall and clock at a cost not exceeding that at present paid by the Corporation for gaslighting. The Town Council have adopted a kind of non-committal report of a committee, and the matter will probably be discussed again very shortly.

Leeds.—A deputation of members of the Burnley Corporation visited Leeds on the 13th inst. to view the electric tramways. An inspection was made of the permanent way now in course of construction on the Beeston-road, the power station was visited, and a journey made on an electric car to Roundhay. The deputation was afterwards entertained to luncheon by the chairman of the Leeds Highways Committee at the Queen's Hotel.

Technical Classes.—We refer readers to our advertising columns for particulars of arrangements for the winter term. At the City and Guilds Technical College the new session begins on Oct. 3, at 6 p.m.—At the Northern Polytechnic Institute, Holloway-road, N., the session began on Sept. 19.—At the Northampton Institute, Clerkenwell, E.C., classes in electrical engineering, dynamo making, etc., are announced.

Walker.—With reference to a notice from the Walker and Wallsend Union Gas Company, applying for the consent of the Council towards the company obtaining a provisional order for electric lighting in the Walker district, the District Council have resolved that, as the Council intended to apply to the Board of Trade for an electric lighting order in the ensuing session, the Council, therefore, could not consent to the company's application.

Hackney.—At the last meeting of the Vestry the Electric Lighting Committee submitted the names of three firms of engineers for the selection of one by the Vestry—viz., Messrs. Burstall and Monkhouse, Mr. Robert Hammond, and Messrs. Kincaid, Waller, and Manville. The engineers have been asked to advise on a combined scheme of electric lighting and dust destruction, for electric lighting only, and also as to the area of the installation.

Newcastle.—The *Newcastle Daily Chronicle* says that the modified scale of charges which the National Telephone Company will apply to Newcastle and district from Oct. 1 next will not only tend to simplify and popularise the telephone system, but will abolish one or two anomalies which have hitherto irritated subscribers and caused a good deal of confusion. The great feature of the change is that it will be a substantial reduction in the prices charged for the divisional area of each subscriber.

Copper.—Messrs. Lewis Lazarus and Sons, in their last metal report, state that copper opened strong at last prices, but gave way 2s. 6d. per ton during the afternoon. On first 'change 300 tons were sold at £52. 2s. 6d. cash, £52. 5s. Nov. 10, £52. 6s. 3d. three months. On second 'change 250 tons more were placed at £52 cash, £52. 2s. 6d. and 1s. 3d. November and December prompts, £52. 2s. 6d. three months, and closing values are £52 cash, £52. 2s. 6d. three months. Settlement price, £52. 2s 6d.

Buckley.—At the last meeting of the District Council it was reported that the Council's offer to purchase the local gasworks for £3.500 had not been accepted, the gas company offering to sell for £4,750. The Lighting Committee recommended that as the gas company were unable to accept the Council's offer, the clerk should be instructed to prepare an application for a provisional order to light the village by electric light, and that an electrical engineer be engaged forthwith to report upon the best method of lighting.

Montrose.—At the last meeting of the Town Council the Provost reported that good progress was being made with the arrangements for acquiring the introduction of the electric light in the burgh. The provisional order had received the Royal assent, and the whole matter was in order. The first step would probably be a visit of the directors of the company to Montrose and Brechin in the course of the autumn, after the holiday season, and then practical steps would be taken without loss of time to introduce the electric light.

"Light versus Illumination."—The new issue contains several articles on the scientific distribution of light, interspersed with diagrams and illustrations. The pamphlet is issued by Holophane, Limited, and is prepared for distribution among those who are interested in the scientific aspect of the "Holophane" system. We understand the above-named firm is prepared to supply the same, free of charge, to any electrical engineer who will send them a post-card with his address. Its contents well warrant that small trouble.

Partnership.—We are informed by Mr. R. W. Blackwell that he has, as from the 30th inst., taken into partnership Mr. Philip Dawson, who has been an associate with him for some years past in his business of electrical engineer, merchant, and contractor. The style of the firm will be Robert W Blackwell and Co., and the head offices of the business, which will be carried on as heretofore, will be at 39, Victoria-street, London, S.W. The new firm will take over all the liabilities of the present business and assume all the responsibilities of the same as from the 30th inst.

City and South London Railway.—Messrs. Cole, Marchent, and Morley, of Bradford, have received the order for the large engines required in the City and South London Railway Company's new generating station. These engines are horizontal slow-speed Corliss engines, each of 1,000 h.p., and running at 85 revolutions per minute. The generator, which is being made by the Electric Construction Company, Wolverhampton, will be mounted directly on the crankshaft. Each engine has two cylinders, 24in. and 48in. diameter respectively by 48in. stroke.

Kirkcaldy.—At a meeting of the Town Council on the 18th inst. it was agreed to give notice at once of their intention of applying for a provisional order for the electric lighting, and parliamentary powers to lay down an electric tramway. The preliminary notices will be issued immediately, and Prof. Kennedy is to be asked to supply the plans and all professional advice. The area that will be sought to be lighted with electricity will be the High-street, power being secured to extend the same. The tramway route will be the original plan from West Bridge to Dysart, with circular tour *vid* the Den and Victoria roads.

Chelsea.—The annual report of Mr. T. W. E. Higgens, surveyor to the Vestry, states that the number of houses in Chelsea

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lighted by the Chelsea Electricity Supply Corporation for the last three years was 777, 1,032, and 1,243 respectively. The pressure records of the company have been examined from time to time, and their high standard of efficiency has been fairly well maintained. The question of lighting Kensal Town by electricity was under consideration during the year, but the Vestry seemed to consider that the initial expense was too great. The advisability of obtaining motor dust-vans is still under consideration.

New South Wales.—The report of the Minister of Public Works, just issued, shows that works in connection with the following electric tramways are in progress: Willoughby electric tramway, 2 miles 45 chains of single track; George-street and Harris-street electric tramway, 3 miles 20 chains of double track; and Rose Bay electric tramway, 1 mile 23 chains of single track. Trial surveys, with report and estimate, have been made of the following proposals: Tighe's Hill to Waratah, 1 mile 5 chains of single track; extension to St. Leonards railway station, 50 chains of single track; and Newcastle to Cockle Creek and Lake Macquarie, 6 miles 40 chains of single track.

New Company.—The Drake and Gorham Electric Power and Traction (Pioneer) Syndicate, Limited, has been registered with the object of applying for powers to construct light railways all over the United Kingdom, and has already purchased the Northfleet Tramway Company and the Exeter Tramway Company. We understand that when the necessary preliminaries have been completed a company will be floated with a capital of £250,000. Mr. E J. Poston, the owner of the Gorleston Tramways, is chairman of the syndicate, among other directors being Messrs. Lucas and Aird. The new company will be managed by Mr. Bernard Drake, in conjunction with Mr. Albright.

Bristol.—Provided it is found that the revenue from the electricity undertakings of the bodies represented by the association of municipal corporations' defence fund *re* the Zipernowski-Deri patent is not less than £500,000 per annum, the Town Council will join in the scheme and agree to contribute to the defence fund ratably with the other bodies in proportion to the gross revenue derived from the electric light undertaking for the year ended March 25 last. The results of the working of the electric undertaking have been so satisfactory that the committee intend to reduce the price of electricity supplied to private consumers from 6d. to 5d. per unit from Oct. 1, 1898.

Huddersfield.—At the monthly meeting of the Town Council on the 21st inst. it was decided to apply to the Local Government Board for sanction to borrow £50,000 for machinery, mains, and other apparatus required for the supply of electricity. It was stated it had not been absolutely decided to apply electric traction on the Lindley, Edgerton, and Outlane section of the tramways, that the proposal to ask for power to borrow £50,000 was contingent upon it being decided to run the cars on that section by electricity, and that the difference between the £31,500 required for the tramways and the loan of £50,000 would be required for other extensions of the present electric lightign works

Accident.—An accident occurred in Stockton early on Saturday morning in connection with the Tees-Side system of electric tramways. Two cars collided near the Stockton racecourse, on the road between Thornaby and Middlesbrough. At the time there was a very heavy mist, which prevented the drivers from seeing more than a few yards in front. Both cars were going at the rate of about 12 miles an hour in the same direction on a single line. They were very much damaged, one being almost totally wrecked. Though there were about 30 passengers on each car none were seriously injured, though one or two were cut and bruised. One of the drivers sustained a nasty cut on the skull, and one of the conductors had his collar-bone broken.

Perth.—At a special meeting of the Police Commissioners on the 21st inst., it was decided that the Commissioners should entertain favourably the proposal to lease the provisional order for the electric lighting to a company, provided it could be done on satisfactory terms, and, with the view of ascertaining the best terms that could be obtained, to remit the application already made and any offers that might come in to the Electric Committee, with powers to examine the same and to negotiate with each of the companies as they should think right, an instruction to the committee being that it should be a distinct condition that the company to be preferred must adopt the Commissioners' schemes and specifications, and that the work must be carried out to the satisfaction of the Commissioners' engineer.

Greenock.—At the meeting of the Greenock Police Board on the 20th inst., it was reported that 29 applications had been received for the position of resident electrical engineer in the burgh. Of these a selection of seven had been made, consisting of the following gentlemen: Mr. Albert T. Bartlett, London; Mr. Stephen E. Bastow, Hull; Mr. S. Edgar Fedden, Edinburgh; Mr. J. M. Smyth, Blackburn; Mr. Charles T. Taylor, Leeds; Mr. William R. Wright, Burnley; and Mr. Henry M'Ewen, Glasgow. It was agreed that the candidates should be reduced to three, who would be asked to meet the Finance Committee. It was stated that in making the appointment not only would the fitness of the applicants to superintend the erection of electrical plant be taken into account, but that knowledge of the application of electricity to tramway traction would be considered.

India Rubber (Mexico), Limited.—The Shareholders' Committee which has been making an investigation into the circumstances connected with the promotion of India Rubber (Mexico), Limited, has sent out a report to the general body of shareholders. The committee bring serious charges against the promoters and vendors, and propose to call an extraordinary general meeting for the purpose of passing resolutions requesting the directors, in the name of the Company, to commence an action against the Mexican Finance Corporation, Limited, the promoters of the India Rubber (Mexico), Limited, and various other persons; also that a committee of *bond fide* public shareholders of the Company (unconnected in any way with the promotion thereof) be appointed to give effect, if necessary, to the foregoing resolution, and generally to watch over and investigate the affairs of the Company, etc.

Liverpool.—The Lighting Committee have decided to extend the electric mains in Newington and Tarleton-street. The electrical engineer's report for the month of August shows that the total supply to private consumers was 119,600 units of electric energy, as compared with 83,260 units supplied during the corresponding period of last year. For Corporation purposes the supply amounted to 142,981 units, as against 104,616 units supplied in August, 1897. A local paper states that it seems that the cost of the experimental electric tramline in the city is to be considerably more than was at first thought. To the Special Tramways Construction Committee the controller and auditor of accounts has submitted an estimate of the probable cost of this experimental line, and the committee have adopted a resolution that the Council should be recommended to approve of the supplementary estimate of £35,000 for the construction of the experimental line of tramways from St. George's Church to the Dingle.

Bootle.—The Corporation have resolved to undertake (through registered contractors) the wiring of consumers' premises upon the following terms: When the cost of wiring does not exceed £10 the sum of £1 will be added thereto for drawing up the specification, examining work, and office expenses, and for each additional £10 or fraction thereof a further charge of 10s. will be made. The cost is to be liquidated as follows: 10 per cent. on completion of work, the balance by 20 equal quarterly payments of principal, with interest at the rate of 3 per cent on the amount remaining unpaid. The committee will guarantee the installation for the first 12 months. Each applicant is to enter into a contract stipulating to pay all instalments, with interest, owing, and in case of applicant being the tenant the landlord is to be party to the contract, the tenant to find security. An advertisement will be issued giving notice of the regulations for installation work, and the intention of the Corporation to register wiring contractors.

Paisley.—An official enquiry was held on the 21st inst. by the Light Railway Commissioners for the purpose of considering the application made to them by the British Electric Traction Company for an order to authorise them to construct light railways in Paisley and district. At the close of the enquiry the Earl of Jersey (chairman) said that the Commissioners had to adhere to the view which was expressed a short time ago—that they were not prepared to go against the strong wishes of the Paisley Corporation, and allow the tramways to be put down within the burgh as proposed by the British Electric Traction Company in the order applied for. They had therefore to refuse the application before them. Mr. Morse asked for expenses in respect of the treatment given the company, but the Court refused to grant expenses. Mr. Balfour Browne then said he thought it right to state that no discourtesy had been meant to the British Traction Company by the Paisley Corporation or by any of the parties in the enquiry, in so far as the company had not been notified sooner of certain negotiations which had been proceeding. These negotiations had only been completed on Monday, and until that day the Paisley Council were not in a position to know what to do.

Bradford.—The total income of the electricity department for the half-year ended June 30 last is stated in the report just presented to the Corporation as £9,565. 14s. 7d. In the corresponding period of the previous year it was £8,726. 12s. 3d., which shows an increase of £839. 2s. 4d. The total expenditure for the half-year, including interest and sinking fund, was £7,907. 4s. 5d., as against £7,061. 2s. 1d. for the corresponding period. The profit for the half-year was £1,658. 10s. 2d., against £1,665. 10s. 2d. The consumers number 720, against 521. The total units consumed was 480,294, against 443,288, or an increase of 8¼ per cent., exclusive of current supplied for public arc lamps, for which no return has been made. The total profits since the opening of the electricity works until June last amounted to £18,391. 10s. 8d., after paying interest and sinking fund. The total amount written off for depreciation had been £7,307. 15s. 6d., leaving the sum of £11,083. 15s. 2d. The gross profit was £3. 4s. 9½d. per cent. for the half-year on the capital outlay of £168,506. The net profit showed 18s. 7d. per cent. for the half-year. Taking the June and December half-years together, the trade profit was £11,784. 2s. 3d., representing £7. 16s. 7d. per cent. per annum on capital outlay.

Langdon Davies Motor Company.—This Company is making a bold bid for success in the supply of alternate-current motors to work on the public supply mains. The well-arranged list of motors we have received shows by the prices attached that the Company means to supply motors at most reasonable rates. We are specially glad to note that the extraordinary claims for high efficiency and large starting torques made on behalf of these motors some two years ago have been dropped, and that in the present case good all-round figures have been substituted, such as may be obtained by careful design. The advantages claimed for the motors are as follows: They are self-starting without taking a current larger than that taken when running at full load; they are very simple in construction and are not liable to get out of order; they have no brushes, commutators, or collecting rings, the presence of which in other motors necessitates constant attention and frequent repairs; the whole of the circuits in the motor through which the currents pass being permanently closed, there is no sparking, which latter is a source of danger in mines, etc., and the absence of which lessens insurance risks everywhere; they require no skilled attention whatever; the cost is low; and,

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finally, the power factor is high, which, though comparatively unimportant to the user, is of importance to the supply company.

Hanley.—Colonel W. R. Slacke, R.E., Local Government Board inspector, held an enquiry last week into the application of the Town Council for sanction to borrow £4,000 for purposes of electric lighting. It was stated that there were 363 private customers at present, and their number was rapidly increasing. The application was made with a view of providing additional feeders to the central area of the town, known as the compulsory area. It was to relieve the present pressure on the mains caused by the increased consumption. Mr. Cowell, one of the electrical engineers, produced diagrams, showing the number of private lamps and the increase monthly during the past year. The private lamps were equal to 25,750 lamps of 8 c.p. They wanted a new high-tension feeder.—At the Council meeting Mr. Cowell reported that on the evening of Saturday, Aug. 27, a Ferranti steam alternator broke down, and that for about eight minutes the light had to be shut off from the town. He explained the cause of the delay in restoring the light, one reason being the want of reserve power to meet such a case. The new engine, which should have been supplied earlier, was now rapidly being pushed forward by Messrs. Ferranti, and it was hoped that it would be ready for use before the end of the month.

Ashton.—The report of the Electricity Committee adopted at the last meeting of the Town Council contained a resolution to the effect that the boilers and economisers for the works should be placed with the Vulcan Boiler and General Insurance Company, Limited, for inspection and guarantee as per their tender. The Comptroller reported the receipt of 33 applications for the position of electrical engineer, which were referred to a sub-committee for the purpose of selecting a number to appear before them. Tenders for free wiring were referred to the same committee. The Town Clerk reported that he had written to the surrounding local authorities asking whether, in the event of the Corporation deciding to promote a Bill in the ensuing session of Parliament authorising them to supply electricity outside the borough, they would at the same time apply for the usual provisional order under the Electric Lighting Acts, and, on the necessary powers being obtained, be willing to enter into an arrangement for the Corporation to supply electrical energy within the respective districts upon terms to be hereafter agreed upon. Two of the authorities had replied to the town clerk declining to enter into the proposed arrangement—the others had not decided the matter. It was resolved that such of the authorities as had not come to any decision should be invited to attend a joint meeting to consider the question, and that the town clerk should be instructed in the meantime to ascertain the probable cost of an unopposed Bill.

Fulham.—The forthcoming electricity works have begun to throw their shadows of troubles ahead. From the agenda of the Vestry for Wednesday's meeting we gather that Mr. Delissa Joseph has asked that body for permission to make arrangements to be supplied with electric current from Hammersmith until the Fulham installation was completed, at the same time pointing out that in the event of the Vestry not giving the necessary permission, he would have no alternative but to construct his own plant to provide the current required; also that it was intended, in addition to lighting his flats with electricity, to have an electric lift in each block of flats, and that in the course of time he would become a good client to the Vestry. The Vestry's consulting engineer has suggested that perhaps a way out of the difficulty could be arranged by the Hammersmith Vestry selling the current to the Fulham Vestry, and the latter reselling same to the consumer. This matter has referred to the solicitor and engineer to report whether the request of Mr. D. Joseph could be complied with without prejudice to the Vestry's interest.—The directors of the Granville Theatre have arranged for a temporary supply of electricity for the lighting of their theatre, and for this purpose they are placing storage batteries on the premises of Mr. Davies, in the Broadway, Walham Green, this gentleman having consented to charge their batteries during the daytime. They propose to avail themselves of the supply so obtained by means of an overhead conductor.

Newington.—At the last meeting of the Vestry the Electric Lighting Committee reported that under the powers vested in them they had during the recess accepted the tender of the British Insulated Wire Company for the insulated electric mains, conduits, junction boxes, etc., at £9,081. 19*s.* 6*d.*; the tender of the General Electric Company, Limited, at £1,457, for the main switchboard and instruments; and the tender of Messrs. Pritchette and Gold, for £900, for the battery of accumulators and accessories, which now covered the whole of the work to be let under contract. The following summary of the contracts was presented—namely, the station, £12,928; supply and fixing engines, generators, and public lighting plant, £8,975; supply and erection of boilers, £9,348; electric mains, conduits, etc., £9,082; main switchboard and instruments, £1,457; accumulators and accessories, £900. To this had to be added 7½ per cent.—£3,002—for engineers' commission, clerk of works salary, and contingencies, which brought the total up to £45,692. In view, therefore, of the necessity of further extension of mains down Westmoreland-road and East-street, the committee advised that the loan should be increased to £50,000, and the money raised under the instalment system, repayable within 42 years, the London County Council being asked to accept the deferred system of payment of capital for five years. The committee therefore recommended that the resolution of Feb. 16 should be rescinded, and the following substituted in its place: "That application be made to the London County Council for a loan of £50,000 to enable the Vestry to carry out the provisions of the Newington Electric Lighting Confirmation Act of 1897, such loan to be taken up in instalments of £10,000 as the work proceeds, and repaid within a period of 42 years, and that the Council be asked to defer the repayment of the principal for a period of five years under Clause 11 of Section 13 of their Money Act of 1898." The recommendations were agreed to.

Electric Traction in the Midlands.—A *Birmingham Daily Post* representative has gleaned some particulars as to the intentions of the British Electric Traction Company, who have recently opened a line of electric tramways from Kidderminster to Stourport, and which has already given promise of being of great public utility. Our contemporary states: "The company consists of a body of financiers who have also acquired the Dudley and Stourbridge steam tramway undertaking, and which they are now converting to an electric system—that is, so far as it runs through the urban districts of Brierley Hill, Amblecote, and Stourbridge. Nothing has as yet been done to connect the length of line—nearly two miles—within the boundary of Dudley municipal borough. Arrangements have been entered into, however, with the Dudley Corporation whereby the Corporation will become owners of all the electric tracks within the borough, and which will be leased for a period of 21 years to the traction company. An official of the company informs our correspondent that the work of reconstructing the Dudley tracks will be put in hand at an early date, so that it will be safe to assume that within the next three months electric cars will be running from Dudley to Stourbridge. The company have also obtained orders empowering them to lay a tramway from Stourbridge to Kinver, and also a similar line from Holly Hall, on the southern side of Dudley, into Kingswinford, and *vid* Wordsley into Stourbridge, thus opening up a large and in some parts densely-populated district. Again, they have a scheme for constructing a new line from Dudley, through Netherton, into Cradley Heath, the last-named town being the centre of a population bordering on 50,000 within a small radius. This manufacturing district has been as yet almost entirely neglected, so far as means of transit are concerned. Our correspondent is also informed, on authority which can be relied upon, that the company have schemes in hand throughout the South Staffordshire district, including West Bromwich, Wolverhampton, Wednesbury, Walsall, and intermediate places, and which it is the intention of the company to join into one immense system of road railways. Incidentally it may be mentioned that the British Electric Traction Company is already working the electric tramways at Walsall, Wednesbury, and Darlaston. The company have schemes already in progress towards completion or in contemplation in numerous parts of the country, and are not only laying down electric tramways, but are negotiating for the supply of electric light. The Kidderminster Town Council has consented to transfer its electric lighting powers upon terms to the British Electric Traction Company. The company, owning as it does the electric tramway to Stourport, is well adapted for generating electric energy."

PROVISIONAL PATENTS, 1898.

SEPTEMBER 12.

19337. Electric apparatus for regulating clocks. Robert James Rudd, 78, Sydenham-road, North Croydon.

19348. Improvements in the trolleys or contact devices of certain electrically-driven vehicles. Alfred Horswill Gibbings and James Kay, 2, Market-street, Bradford.

19360. Improvements in the means or method of signalling on tramways. James Kay and Alfred Horswill Gibbings, 2, Market-street, Bradford.

19381. Improvements in electric traction. Miles Walker, Morland, Chislett-road, West Hampstead, London.

19396. Improvements in electrical indicating apparatus. Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

19399. Improvements in arc lamps. Paul Mersch, 1, Queen Victoria-street, London. (Complete specification.)

SEPTEMBER 13.

19418. Improvements in telephone installations. Franz Oprendek, Friedrich Kolischer, and Alfred Landmann, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19445. Improvements in electric batteries. Henry Blumenberg, jun., 78, Fleet-street, London.

19480. Improvements in apparatus for controlling and regulating electric currents. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, Fulham, London.

19491. An improved device for equalising the travel and the current supply in type-printing telegraphs. Johann Kustermann, 6, Lord-street, Liverpool. (Complete specification.)

SEPTEMBER 14.

19500. An improvement in connections for electrical fuses Thomas McEwan, 8, Elder-street, Edinburgh.

19524. Improvements in or connected with electric clocks, time switches, or the like. George Francis Bristow, jun., and William Jones, 8, Quality-court, Chancery-lane, London.

19535. Improvements in and connected with electric motors partly applicable to dynamos. Samuel William Maquay and Paul Edward Vanderpump, 55, Chancery-lane, London.

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19536. Improvements in and connected with primary batteries. Samuel William Maquay and Paul Edward Vanderpump, 55, Chancery-lane, London.

19537. Improvements in dynamo-electric machines. James Burke, 46, Lincoln's-inn-fields, London. (Complete specification.)

19555. Improvements in the bulbs of electric incandescent lamps. Curt Bartenstein, 45, Southampton-buildings, Chancery-lane, London.

19564. Improvements in or relating to the generation and utilisation of electricity from thermopiles. Charles M. Johnson, 111, Hatton-garden, London.

SEPTEMBER 15.

19612. Improvements in switches for controlling electric motors. Frank William Reed, 70, Deansgate, Manchester.

19614. Improvements in electric telegraphs. Charles Adams-Randall, 63, Chancery-lane, London.

19621. Improvements in coin-freed electric meters. Charles William Scott Crawley, 16, Red Lion-street, Clerkenwell, London.

19632. Improvements in and relating to secondary batteries. Walter Ambrose Crowdus, 45, Southampton-buildings, Chancery-lane, London.

19636. Improvements in or connected with the distribution of electricity on the three-wire direct-current system. Alexander Bewicke Blackburn and Wilfred L. Spence, 47, Lincoln's-inn-fields, London.

19644. Electric dynamic system of propulsion. William Humphrey Wheatley, 40, Chancery-lane, London. (Leon Rosenfeld, Constantin Zelenay, and Julian Dulait, Belgium.)

SEPTEMBER 16.

19688. Improvements in connection with the mechanism of electrically illuminated devices for automatically making and breaking electric circuits used in such electrically illuminated devices. John Sibley Richardson, Samuel Jevons, and William Alfred Gent, 77, Colmore-row, Birmingham. (Complete specification.)

SEPTEMBER 17.

19722 Improvements in a "built in system" of insulated electric conductors. William Richard Macdonald and Archibald Frank Stevenson, 4, St. Ann's-square, Manchester.

19779. An improvement in incandescent lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Julius Moeller, Austria.)

19785. Improvements in incandescent bodies for incandescent electric lamps, and in the process of manufacturing the same. Carl Kellner, 46, Lincoln's-inn-fields, London.

19788. Improvements in motor-driven vehicles and in electric motors therefor. Walter Ambrose Crowdus, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

19445. Distribution of electrical energy by means of polyphase currents and induction coils or transformers therefor. Lake. (Grassi and Civita.)

19567. Converter chambers and their connections, and fuse and switch apparatus for use therewith. Partridge.

19719. Methods of, and means for, electrical conversion and distribution. Lamme. (Date applied for under International Convention, Jan. 28, 1897.)

21437. Method of raising and lowering electric light pendants. Braham.

21974. Electric telephones. Sloper.

23979 Switches for controlling electrical currents. Booth and Hobday.

23988. Apparatus especially suitable for grinding and polishing the commutators of electrical apparatus. Perry.

24405. Field telephone and other cables. Nichols and W. T. Henley's Telegraph Works Company, Limited.

24519. Construction of overhead lines of electric railways or tramways. Dawson.

24521. Frog for overhead conductors or trolleys of electric railways or tramways. Dawson.

24522. Overhead lines of electric tramways or railways. Dawson.

1898.

2604. Electric time switch. Thompson. (The Self-Winding Clock Company.)

9070. Contact shoes for electric railways. Brown.

10383. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

12366. Electrical circuit controllers. Lake. (Tesla.)

16282. Bonds or connections for the rails of electric railways. Weber.

16602. Drums for holding electric cables and covers to be used with such drums. Oxley.

17360 Drums for holding electric cables. Oxley.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receip's for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Sept. 17	4,055	3,730	+ 325	—	—
Blackpool and Fleetwood Tramroad	,, 17	996	—	—	9,915	—
Bristol Tramways and Carriage Co.	,, 17	3,384	2,725	+ 659	—	—
City and South London Railway	,, 18	900	896	- 4	11,388	10,803
Dover Tramways	,, 17	241	136	+ 105	5,805	—
Dublin S.D. Electric Tramways	,, 16	1,025	748	+ 276	12,533	9,091
Halifax Corporation Tramways	Sept. 7	323	—	—	2,832	—
Liverpool Overhead Railway	Sept. 18	1,495	1,401	+ 94	—	—
South Staffordshire Tramways	,, 16	642	667	- 25	23,300*	23,466*
* Receipts since	Jan. 1.					

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	13½-14½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9½-10½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2 xd
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝ xd
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	104-106
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	10-10½
——	6	6 6½
—— Pref. Half-Shares	1	1½-1¾
—— ,, ,,	5	4½-5
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6 6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24½-25½
—— 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	8	2¾-3¼
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	13-14
—— ,, ,, ,,	6	8½-9½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	1¾ 2¼
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	126-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ordinary Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22½-23½
—— 4 per cent. Debentures	100	105-107
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	9-9½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	17-18 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5¾-6⅛
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5¾-6¼
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Company	10	15½-16½
Oriental, Limited, £1 shares	1	1½-1¾
—— £5 Shares	5	7½-8
—— £4½ shares	4	6½-7
Oriental Telephone and Electric Company	1	⅛-¼
Royal Electrical Company of Montreal	⅛	162-166
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	2¾-3¼
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	102-103
Telegraph Construction and Maintenance	12	30-33
—— 5 per cent. Bonds	100	100-105
Waterloo and City Railway, Ordinary	100	126-132
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

Optical Exhibition.—This exhibition at the Mansion House, under the auspices of the Spectacle Makers' Company, will be opened on Monday next, Oct. 3.

The Electro-Harmonic Society.—We would again remind our readers of the smoking concert of this society to be held at the St. James's Hall Restaurant to-night at 8 p.m. The programme appeared in our last issue.

The Coolgardie Exhibition.—It is proposed to hold an international mining and industrial exhibition at Coolgardie next year. All being well the exhibition will be opened in March, and will remain open for at least three months. Full details may be obtained from Mr. E. T. Scammel, of 18, Queen Victoria-street, E.C.

Technical Education. — The *London Technical Education Gazette* gives in its September issue a most complete list of classes to be held in the metropolitan area during the coming winter. The arrangement of the list into subjects under which the places and times at which classes are held in that subject are classified into postal areas, is most useful.

Huxley Lecture.—This lecture will be delivered this year by Prof. Virchow at St. Martin's Town Hall at 4 p.m. on Monday next, Oct. 3. Prof. Virchow's lecture will be delivered in English, and should prove of exceptional interest considering the author's reputation for original thought and work. We also note that Prof. Virchow's visit is to be celebrated by a complimentary dinner at the Hôtel Métropole on Wednesday, Oct. 5.

The Bradford Accident.—The Board of Trade enquiry into the circumstances of the mishap to an electric tramcar at Bradford is adjourned, but several witnesses have already been heard. Thus, the city surveyor, Mr. Cox, stated his opinion that the accident was caused by the driver relying upon the hand brake and putting such pressure upon it that it blocked the wheels, thus rendering the electric brake useless. Mr. R. W. Blackwell said the only rational way of explaining the occurrence was on the ground that the driver lost his head. The enquiry was adjourned so that the driver may attend when he has recovered from his injuries.

Electrical Stage Appliances.—The first theatre in London to adopt electrical power for changing scenes, as advocated in Mr. Edwin O. Sachs's work on "Stage Construction," is the Theatre Royal, Drury-lane. Mr. Sachs is making arrangements by which large sections of the stage floor, measuring together 40ft. by 7ft., can be raised to any level above or below the stage, individually or together, by simply working an ordinary switchboard, and the installation will be ready for the coming pantomime. The Thames Ironworks hold the contract, and the heavy constructional work has already been carried out by them under Mr. Sachs's directions in an unprecedentedly short time, whilst so elaborate a play as the "Great Ruby" was in rehearsal.

Magnetic Observations in the Azores.—Prince Albert of Monaco read a paper before the conference of the British Association on terrestrial magnetism at Bristol on the above subject. He pointed out that magnetic observations taken at the Azores would be valuable, because (1) they would be obtained in a situation near latitude 40deg. N.; (2) the permanent causes of perturbation of actual magnetic observation, such as electric lighting, tramways, and other applications of electricity, would not be present; (3) the geographical position intermediate between Europe and America would be capable of furnishing most useful indications for the comparison of the magnetic curves obtained in these two parts of the world. Prince Albert went on to explain that he had arranged for Captain Chaves to carry out the work, and to determine at what point on the islands the observatory should be built.

Electric Lighting Procedure.—In many ways the Electric Lighting Acts have helped the industry, and the difference in cost between a parliamentary Bill and an unopposed electric lighting provisional order is well known. An opposed provisional order, on the other hand, costs more, and is subject, in common with other Bills, to several absurd regulations. The Bermondsey order is a case in point. The London Electric Supply Corporation most strenuously opposed the granting of the order to the local vestry, but in spite of this the order reached the House of Lords and nearly passed. The limited time at the end of the session, we believe, only prevented this order becoming law. Yet next year all the preliminaries have to be gone through again, all the witnesses have to go before the various committees, and last, but not least, all the fees and costs have again to be borne. Still, the Bermondsey Vestry perseveres, and we wish them success.

The Boston Exhibition.—At the exhibition arranged for the benefit of the recent tramway congress, the General Electric Company made rather a new departure in its exhibit. The company showed very little apparatus of interest, but made a spectacular display in the shape of a globe laid out to represent the world, with a miniature electric railway running around the equator. The globe itself was 26ft. in diameter, covered with papier maché, accurately mapped out and studded with miniature incandescent lamps at all points where General Electric plants are located. The various countries and colonies were distinguished by the national flags, and the stars and stripes appeared prominently over the Philippines, the Ladrones, Hawaii, and Porto Rico. The miniature lamps were naturally most dense in the United States of America, but wherever land appeared above the ocean there was almost certain to be a lamp. A miniature car electrically lighted ran rapidly on a narrow platform built horizontally around the equator. The interior of the globe was, says the *Electrical World*, handsomely furnished and used as a reception-room.

Finsbury Technical College.—The special lectures at the above college will this year be commenced by a course of six lectures on the relations between light and electricity, by Prof. Silvanus P. Thompson, D.Sc., F.R.S. The lectures will given on Thursday evenings at 8 o'clock, beginning on Thursday, Oct. 6. The following is the syllabus:—Lecture I.: Electric discharges and their optical properties: glow, brush, spark, arc—The nature of the luminosities in rarefied air. Lecture II.: Electrical discharges in vacuo-kathode rays and their congeners—Researches of Crookes, Hittorf, Lenard, Swinton—Röntgen's rays — Luminescence lamps. Lecture III.: Electric oscillations—Researches of Kelvin, von Helmholtz, Lodge, Hertz, Tesla. Lecture IV.: Electric waves: their optical properties—Researches of Maxwell, Hertz, Lodge, Branly, Righi, Bose — The electromagnetic theory of light. Lecture V.: Photo-electric phenomena—Effect of light on selenium — Photo-electric cells — Diselectrification of metals by light. Lecture VI.: Magneto-optics—Researches of Faraday, Kerr, Kundt, Zeeman, Righi. The fee for the whole course is only 6s.

Electric Traction in Australia. — One of the requisites for the economical working of a large electric tramway is some method of utilising the plant during working hours as uniformly as possible up to its full capacity. One way in which this ideal may be to some extent realised is to dispose of the surplus power to other

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users during the times when it is not all required for the tramways. The Railway Commissioners of New South Wales will have a large amount of surplus electric power to dispose of from the Ultimo power-house, and for a long time past negotiations have been proceeding off and on for the Sydney City Council to take part of the surplus power for electric lighting purposes. So far, however, no definite arrangement has been reached. The suggestion has been made that the new Queen Victoria Markets might be conveniently lighted from the tramway power-house, but nothing has yet been done in this direction. In any case, the machinery at the power-house will not be ready for some months. The Railway Commissioners some time ago informed the City Council that they would have sufficient surplus power available for electric lighting purposes of this kind.

Society of Engineers.—This institution is the first of the engineering societies to commence its winter's programme by an ordinary meeting, to be held at the Royal United Service Institution, Whitehall, on Monday, Oct. 3, at 7.30 p.m. On this occasion a paper will be read on "Protective Metallic Coatings for Iron and Steel," by Mr. Sherard Cowper-Coles, of which the following is a synopsis: Corrodibility of iron and steel—Consequent importance of an effective protecting coating—Zinc the best coating at present in use—Electro-chemical action of zinc and iron—History of the galvanising industry—Lead galvanising—Hot galvanising—Cost and output of plants—Comparison of surfaces obtained by hot and cold galvanising—Impurities in zinc applied by the hot process—Effects of these impurities—Painting galvanised iron—Preece's test—Zinc flashing—Preparation of receiving surface—Pickling—Sand blasting—Description of electro-zincing plant—Cost and output of plants—Galvanising steel wires—Description of electro-zincing plant for wires and tubes—Electrolytes—Best working conditions—Comparison of actual and theoretical deposits—Tables of weights and thicknesses of zinc coatings—Table of cost for various thicknesses of zinc and cadmium coatings—Cadmium galvanising—Coating iron and steel with copper.

Economising Electrical Power. — Mr. E. G. Connette read a paper on the economy of power where tramways are concerned before the recent Boston convention. The author spoke from experience gained with the Nashville Street Railway. The company owning this line made a contract with a power company a few years ago to furnish the power for its use on a car mileage basis. This road operates from 45 to 60 16ft. to 22ft. single-truck cars daily, making from 5,000 to 7,000 miles per day. Upon the mileage basis there was no incentive to economise in the use of power, and little attention was given to the economical application of the current. On Feb. 1 this year a new contract was made on a meter basis, and since that time a thorough system has been inaugurated for the attainment of the greatest economy in the use of power. A large wattmeter was installed in the power-house, and the record of this meter is taken as a basis of settlement each month; the feeder lines were inspected carefully and tested, the earth returns were examined, and all weak places strengthened. A wattmeter was placed on each car over the door opposite the register ends of the car. The meters are read both when a car comes into the shed and when motormen change at relief time, and a daily report is made, showing the number of car, the name of motorman, the kilowatt-hours, the name of road and number of trips, the kilowatt-hours per car mile, and the number of miles. Under the system of paying for power on a mileage basis, the consumption of current was from 1·75 to 1·90 kilowatt-hours per car mile, while now, after a lapse of six months under the meter system, the power has been reduced to from 1·10 to 1·15 kilowatt-hours per car mile, or from 35 to 40 per cent. saving in consumption of power and a relative saving of expense in its production.

Wireless Telegraphy.—The Rev. Lawson Forster, D.D., LL.B., presided at a meeting held last Monday evening in the Queen's Park Institute, Harrow-road, when Mr. W. Lynd delivered a lecture on the recent experiments in wireless telegraphy. The lecturer at first dwelt at some length on the discovery and gradual perfecting of telegraphy with wires. He stated that the birth of telegraphy was in 1837, when Cook and Wheatstone first made their experiments. The first use made of it was by the Great Western Railway, who had a five-needle instrument on their line between Paddington and Slough. What first convinced the public of its utility was the capture by its aid of a murderer named Towel. As for the Morse invention, this was a very great step in making telegraphy practicable, but though the Americans claimed Morse as the inventor of telegraphy, the real inventors were Cook and Wheatstone. The discovery made by Mr. Marconi met with immediate recognition by the British Government. Various experiments were carried out at different places with comparatively short distances, and then came the memorable trial from Penarth to Weston-super-Mare, where the ordinary Morse telegraph worked through nine miles of space by Marconi's system. The second important experiment took place in Italy through 12 miles of space, and telegraphic communication has been established between Swanage and the Needles (17½ miles), and there had been daily communications since January between Bournemouth and the Isle of Wight. The lecturer pointed out the great use of wireless telegraphy in communicating with light ships, lighthouses, etc.

Electric Traction in Japan.—We gather from *Electricity* that Mr. T. Y. Dzushi, Chief of Finance and Manager of Stores of the Imperial Government Railways of Japan, and Mr. K. Sugahara, chief engineer of the Kobu and of some street railroads soon to be built in Japan, were at the recent Boston convention. To use an American expression, the privileges of the floor were extended to these gentlemen and they were invited to address the convention. Mr. Sugahara then made an interesting speech, of which the following are abstracts: "Japan is achieving a great deal in her material progress and is striving to accomplish in rapid succession what she learns from abroad. The progress of the Japanese street railway system is very slow and it is in a primitive stage as yet. For instance, the street railways altogether are only about 60 miles in length and most of them depend on horse power, except the Kyoto and Nagoyo electric lines. Several electric railways, however, have been projected in different cities and towns throughout the country. Still, the speaker firmly believed that in the near future Japan will be found a network of electric street railways. There were about 40,000 jinrikishas and 90,000 wagons drawn by men as means of transportation in Tokio, which greatly interferes with the progress of street railways. Notwithstanding these difficulties, Tokio horse car railway companies pay on the capital invested 30 per cent. dividends annually, and the steam road 13 per cent. It was his great desire that Japan shall progress to such a degree that when any of those present went to Tokio they might go to any place in the city by street cars, not by jinrikisha, and that the country may be seen as one of the industrial countries of the world, and not alone a country of beauty and curiosity," The speech *in extenso* accurately represents the forward policy of Japan as a nation.

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Chelsea Polytechnic.—A noticeable point about this institution is the systematic attempt made to provide a really sound groundwork for future scientific work. In the technical day classes students are prepared for the more advanced courses in the City and Guilds Institution, and the syllabus of the courses shows how conscientious this preparation is. Illustrated prospectuses for the day and evening classes respectively are issued, and from these a good general idea of the work may be obtained. We notice with satisfaction that an elementary knowledge of the calculus is imparted to day students at a comparatively early stage. This undoubtedly marks an advance on the old system of previously plodding laboriously through a weary course on "conic sections," which, though valuable as in the education of a mathematician, may be well dispensed with by students purposing to follow careers as engineers. In the evening classes, the electrical engineering section (under Mr. A. Schwartz) furnishes exceptional opportunities to students. The lectures, which are fully illustrated with experiments and photographs of the principal English and foreign installations, comprise such subjects as the following: generating stations, distribution, switchboards and instruments testing and calibrating, engine testing, dynamos and motors, and accumulators. The practical work comprises electrical testing (including measurements of current, E.M.F. and resistance, permeability and hysteresis tests, photometric tests, platinum thermometry, etc.), engine trials (in which tests are performed on both gas and steam engines), dynamo and motor trials. A course on alternating and polyphase currents is also provided for more advanced students. Finally, it may be remarked that both the physical and mechanical departments have been equipped with great judgment and at considerable expense. It may be hoped that the success which this institution has already achieved may be continued into the future. Illustrated syllabuses may be obtained at a price of 1d. each, or by post, 2½d. each.

The New London University.—In accordance with the Act passed in the last session of Parliament, the drawing up of statutes and regulations for the new London University has been entrusted to the following commissioners: Lord Davey (chairman), the Bishop of London, Sir William Roberts, Sir Owen Roberts, Prof. R. C. Jebb, Dr. Michael Foster, and Mr. E. H. Busk. The following instructions given to the commissioners under the new Act differ in some important respects from the recommendations of the Royal Commission which issued its report in 1894, although that report has been taken as forming in the main the basis of the future scheme for the university: (1) The principal elements in the new university are to be the senate and convocation, the academic council having now assumed the position of an advisory committee of the senate parallel to the council for external students and the Board for University Extension. (2) The number of the senate (exclusive of the chancellor) has been reduced from 65 to 55, and the proportion of members of convocation upon the senate has been raised from 13·8 per cent. to 30·9 per cent. The members of convocation who sit upon the senate will, with a few additions, compose the committee called the council for external students, which will deal with matters relating to external students. (3) The area covered by the University of London has been extended from the county area to a radius of 30 miles round London, and the Agricultural College at Wye has been specially included. (4) The commissioners have power to recognise as teachers of the university not only those attached to the few institutions named in the original report, but any teachers attached to institutions within the above radius whom they consider to merit recognition. The teachers recognised by the commissioners will be formed by them into the faculties of the new university. The faculties will elect 16 members to the senate, and these members, with one or two additions, will form the committee of the senate termed the academic council, which will deal with matters relating to internal students.

Testing-Tanks for Steamship Models.—We have referred before to the fact that in the United States the first of these testing tanks is about to be constructed, and that electricity is to be used very largely in it. In England every prominent shipbuilding yard has such an experimental tank, and in these electricity is chiefly used for recording purposes. We learn the following details of the American equipment, where electricity is to be the motive power, from our contemporary, *Electricity*, of New York: "The building to be devoted to this purpose has been erected in the navy yard at Washington, along the east river front. Its dimensions are 500ft. long by 50ft. wide, and has two small extensions at either end. The interior construction shows a basin of concrete 370ft. long by 43ft. wide, with a depth of 14ft. in the centre. In one of the extensions will be the heating, ventilating, and filtering apparatus, and in the other the necessary electrical equipment. The electrical installation will supply the necessary power for driving the model-towing carriage. The approximate weight of this towing carriage is 45,000lb., and it is to be driven by four electric motors arranged in pairs. These motors will be wound for 250 volts, and at the voltage named all four motors, acting through suitable gearing, will develop the necessary power for attaining the highest rate of speed—*i.e.*, 2,000ft. per minute. The controlling gear, which will be located on the towing carriage, will be so arranged that not less than 45 different speeds will be available. The towing carriage will be braked by electricity, the braking arrangement being able to bring the carriage to rest from a speed of 1,000ft. per minute, and that in a distance not exceeding 100 yards." Our contemporary adds that this tank will prove of great value, and that many times its cost will unquestionably be saved to the Government by a judicious use of the electric towing carriage. We cannot see the advantages of the towing carriage from some points of view, and its heavy weight, 20 tons, seems wholly out of place. The acceleration of this weight is a most serious matter, as can be gathered from the power of the electric brakes. Even at half maximum speed 100 yards is spoken of as the distance required for stopping. The tank itself is only 123 yards long, and hence it can only be inferred that the speeds spoken of cannot be safely attained. Perhaps the weights as quoted are wrong.

Justice in the States.—The legal decisions of the law courts in the United States have often surprised us, but the following is one of the most surprising rulings when viewed in the light of English law. It is the judgment in the Appeal Courts in the case of Gilmartin *v.* the Lackawanna Valley Rapid Transit Company, and decides that, "While city passenger railway companies have not an exclusive right to the use of the parts of the streets occupied by their tracks, the Supreme Court of Pennsylvania says that they have a right-of-way and a right to an unobstructed track for the passage of their cars. In the use of their tracks their rights are superior to those of the public. The convenience of the individual in the use of the part of the street to which the cars are confined must give way to the convenience of the public who use the cars. The use of electricity as a motive power by street railway companies has greatly increased the danger to those who drive or walk on city roads. Many uses of streets which were formerly comparatively safe are now

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extremely dangerous. Of the increased danger all persons who use the streets must take notice, and a high degree of watchfulness and care is required of them. With these principles in mind the Court reverses a judgment for personal injuries rendered against a street railway company in a case that was tried for the claimant on the theory that she had a right to walk on the track longitudinally, and that if she was vigilant in watching for the approach of a car she had done her whole duty, a view adopted by the trial judge. The track was a single one, with turn-outs, in a city street. She lived on the street, and was returning home at night, choosing to walk on the track because the surface there was hard and smooth, while the carriageway was dusty and the sidewalks uneven in places. The motorman did not see her until she was struck, from behind, and he stopped the car within its length. It also appeared that the headlight was not burning, and that the gong was defective, and did not always ring. But the Supreme Court says that a reasonably prudent person would not have been on the track under the circumstances, especially knowing that a car was coming behind, and it could not be heard on account of other noises in the neighbourhood, and that she was guilty of negligence of being there. Her right to use the track was subordinate to that of the company." It appears to us that in any English court damages would have been granted, even had the headlights and bell been in order. We are indebted to the *Street Railway Review* for the above report.

Inventions in China.—The following important Imperial decree, which is really the promise of the enactment of copyright and patent laws, was issued at Pekin on July 5, 1898. We take it from *Indian Engineering*, and give it as an example of what the Chinese Emperor wanted to do before he was confined: "From ancient times until now the first duty of Government has been to bring order out of chaos, and shape the rough materials at hand. With the increasing facilities of international commerce of late our country has been filled with an influx of scientific, mechanical, and artistic things which are an education to the masses, whose eyes are daily being opened to their usefulness. China is a great country, and our resources are multitudinous. We do not lack either men of intellect and brilliant talents capable of learning and doing anything they please, but whose movements have hitherto been hampered by old prejudices which have formed a bar to these brilliant minds in thinking out and introducing to practical use new inventions. Now that we have entered upon the high road towards the education and enlightenment of the masses for the purpose of making our empire strong and wealthy like other nations, our first duty should be the encouragement and employment of men of genius and talents. We therefore hereby command that from henceforth if there be any subject of ours who should hereafter write a useful book on new subjects, or who should have invented any new design in machinery or any useful work of art and science which will be of benefit to the country at large, such persons shall be honoured and rewarded by us in order to serve as an encouragement and exhortation to others of similar genius and talents. Or, perhaps, if it be found that such geniuses have also real ability to become officials, we shall appoint them to substantive posts as a reward or grant them decorations or fine raiment in order to show the masses the persons who have gained honour by their talents and genius; while they shall also be allowed to enjoy the fruits of their labours by being presented with papers empowering them to be the sole manufacturers and sellers within a certain limit of time. Again, to such as have administrative talents and the necessary funds either to build schools, or begin irrigation works for the benefit of agriculture, or build rifle factories or cannon foundries, all of which will be of great benefit to the population of the empire at large, these men shall be rewarded on the same scale as men who have gained distinction in the army or navy in order to give such persons special encouragement to work for the good of themselves and their country. We hereby further command the Tsungli Yamên to draw up the regulations which shall govern the various matters noted within this edict, and report at once to us."

Tramway Tips from America. — The *Street Railway Journal* publishes an exceedingly full and heavy number in connection with the Boston convention of street railway engineers. In it there is an article, evidently an editorial, entitled "Some Suggestions to European Electric Railway Builders." The *raison d'être* of the above article is apparent from the following quotation: "America has wasted—if we can call it wasted—so many millions of dollars in experiments that it observes with something like a shudder the danger that the same old weary course of trial and failure may be gone over again abroad." The first suggestion deals with the necessity of a substantial road-bed. The author is afraid that European engineers do not appreciate the tremendous pounding which electric railway tracks have to stand, and which apparently has been too severe for many American tracks. The article goes on to say: "It may be urged that the concrete foundations for track usual in Europe will cure this trouble, but this has not been American experience where tried, though there is undoubtedly some advantage in concrete foundations. The true remedy, as near as we can now judge, is first to use 60ft. rails, and so to reduce the number of the joints; second, to butt the joints together in paved streets; third, to increase the carbon in the rail, thereby giving it a hardness which will prevent the battering of the head; and, finally, to use a "square-shouldered" section, so as to permit of accurate fitting of the joint plates and a strong vertical support—this, whether the support be of iron cast around the joint or of wrought-iron girder fishplates. Track special work—such as frogs, crossings, etc.—should be made of the best material and with the greatest care. Transition curves, of course, should be made in all cases, and the greatest care taken to obtain easy movement of the car at all points of the road. Great Britain is undoubtedly ahead of America in the care taken with track return circuits, and, in fact, has gone to an extreme in demanding low-voltage drop in the earth. While a seven-volt drop generally means less electrolytic effect with pipes and wires, it does not always do so, since it is current which produces these troubles, and current can be obtained from low voltage in quite as great a quantity as from high, providing only that the earth resistance be sufficiently low. In overhead construction Europe has paid more attention to the ornamental than has America. With attractive poles, and a simple and unobtrusive wire structure, there can be no reasonable complaint from municipalities at the overhead electric system. Power station equipment should be in the fewest possible units consistent with reliability of service. The early American practice of having stations with 20 and 30 small units has been replaced by having stations with fewer and larger ones. The ideal station is one made up of five units, of which four are of the same size and one but half that size, the smaller one being useful for the night service. No fixed rules can be laid down for rolling-stock, except that all cars should be made as strong and durable as possible. Local conditions must to a great extent govern the forms of cars used. All the above tips are valuable except the one

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where it is assumed that Ohm's law does not apply to track returns. Surely the editor does not mean what he says in this case.

Rotary Converters for Tramway Work.—Dr. Louis Bell contributes an interesting article on the above to the current number of the *Street Railway Journal*. The conclusions are somewhat as follows: For every kilowatt delivered from the terminal of the rotary converters, at least 1¼ kw. must be generated at the central station, and usually more than this. In other words, one cannot reasonably expect to get from the transmission system, line transformers, and rotary converter, an all-day efficiency higher than about 80 per cent. If one were working under conditions of maximum economy, 80 per cent. would certainly be surpassed, but railway work does not furnish these conditions. Again, the author says, when the total output required must be divided into scattered units of only a few kilowatts each, the advantages of transmission become very important. If, for example, one is operating a considerable interurban line requiring, say, a total capacity of 1,000 kw., and the question arises between two 500-kw. stations and a 1,000-kw. station with a 500-kw. sub-station, considerable discrimation is required. At 70 per cent. load factor in a 1,000-kw. station the cost will be about 1·4 cents per kilowatt-hour. In a 500-kw. plant at the same load factor the cost would be about 1·8 cents. This in itself is too small a margin to justify rotary converters. If, however, the 500-kw. plant cannot be assured of a load factor higher than 50 per cent., the cost will be, say, 2·15 cents, while the larger plant remains at 70 per cent., thus shifting the balance to the other side of the ledger. The question of economy, therefore, hinges under such conditions on the relative load factor of the whole system and of its parts. Few data are available on this particular item, since nearly all plants aggregating 1,000 kw., or even several times as much, are operated from a single station. In the few systems operated from several power stations, the load factor does not vary greatly between station and station, but the stations are mostly so large that a little variation would be expected. With an aggregate power as low as 1,000 kw., the use of sub-stations is evidently on debatable ground. On the other hand, with an aggregate power of 500 kw., such as might exist on an interurban line, the curves make it very evident that transmission to a sub-station would pay. In general, one may safely say that unless a line requires independent stations in the neighbourhood of 500 kw. each, there is a strong probability that transmission from a single station will pay. With outputs above that point, sub-station work will very often be found to be uneconomical. The dividing line between the two cases appears to lie under ordinary conditions somewhere between 250 kw. and 500 kw. for each station where only two stations are concerned. It must not be supposed, however, that one can settle the case once for all by installing a number of small sub-stations, for with extreme sub-division one comes at once into competition with boosting and other modifications of ordinary feeding systems. Under present conditions the rotary converter finds its most important use in the utilisation of water power for railway purposes, and in this field its importance must not be too lightly estimated. In some interurban work it is likely to find a legitimate and important use even when operated from a central steam plant. In heavy city and suburban work its value is, to say the least, very problematical so far as general distribution is concerned, although it is not unlikely to prove a useful adjunct. Its chief weakness is the fact that, like other moving machinery, it requires attention, and, furthermore, it cannot be applied without a very material loss of energy. Skilfully used, however, it is a most valuable addition to the resources of modern engineering.

The Boston Convention.—The seventeenth annual convention of the American Street Railway Association was held in Boston at the beginning of the month. The meeting for the reading and discussion of papers was rendered more valuable by an exhibition of street railway plant and accessories. Our contemporary the *Electrical World*, which has always a critical eye for novelties, makes the following notes on the exhibits as a whole: "Particular interest was displayed in the running gear of double-truck cars, and the most advanced examples of this part of a railway equipment showed close resemblance to the standards of steam railroad construction, in the use of swing bolsters, series springs, and in the general arrangement of the brake rigging and details, combined with the feature peculiar to electric car service—namely, maximum traction construction, the use of which is becoming almost universal in double-truck electric railway work. The term 'maximum traction' is applied to trucks in which but one motor per truck is used and in which the weight upon the motor-driven pair of wheels is greater than that upon the idle pair. As a rule, the driving wheels are larger than the others, although this is not always the case. The unequal distribution of the weight is obtained either by overhanging the motor from the driving wheel end of the truck or by placing the bolster nearer that end, or by a combination of these two methods. The purpose of this arrangement is to obtain increased tractive effort, 50 per cent. of the weight of the car apparently being generally considered insufficient for the needs of street railway work, although such cars are ordinarily run without trailers, and this percentage is much higher than that considered necessary in steam railway work. A disadvantage of the maximum traction truck is the fact that its use largely does away with one of the chief advantages of double trucks over single trucks—namely, the reduction of the weight per wheel and the consequent reduction of rail pounding, wear and tear, and the increase of comfort to passengers. The chief advantage of maximum traction double-truck cars, therefore, over single-truck cars is the greatly shortened wheel base and consequent ability of the truck to take sharp curves without grinding. A general comparison of the advantages and disadvantages of single and double truck cars was well brought out at the convention in the paper of Mr. Richard McCulloch. The conclusion of this paper is that double-truck cars are advantageous where the runs are long, the speed is high, and stops are comparatively infrequent, while the single-truck car is more suitable for short runs, dense traffic, many stations, and low speed. Two disadvantages of the double-truck car often felt in city service and not noticed in this paper are the inability of the conductor to keep track of the large number of passengers carried, and, therefore, to collect his fares, and the more frequent stops of the larger car, owing to the larger number of passengers carried, and the consequently reduced speed. In the electrical part of car equipments a most remarkable uniformity has come about in line with the general uniformity and standardisation of electric railway systems, which is, although this industry is of more recent growth, much more marked than that of electric lighting systems. Four-pole motor construction, with windings on all poles, cylindrical steel shells, laminated polar projections bolted in, two-path armatures, barrel windings, high density in the armature core under the slots, are features that are now almost universal.

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ELECTRIC LIGHT AND POWER AT THE HOFORS IRONWORKS, SWEDEN.

Amongst the various works visited by the Iron and Steel Institute in Sweden last month, those of the Hofors Ironworks were, perhaps, the most interesting. These works are the oldest in the province of Gestrikland, and were founded in the beginning of the seventeenth century. Hofors and many other small ironworks in the neighbourhood got their ores from the Torsaker Mines, which were quite sufficient to meet the small requirements in old times. However, as the output from blast furnaces and forges grew, also ores from Norberg, and later on from Bispberg and Wester Bergslagen, began to be used. The works have grown most rapidly, as all new improvements in iron manufacture have been adopted. The power for the works at Hofors was at first obtained from a 92ft. fall near by, but with extensions the water available proved insufficient. More power was therefore secured by an electrical transmission scheme, from a waterfall of 100ft., at a distance of about 1½ miles from Hofors. There six turbines furnish a total of 1,400 h.p., which is used for the rolling-mills, auxiliary machinery, and machine shops. These were, we believe, the first rolling-mills driven exclusively by electricity.

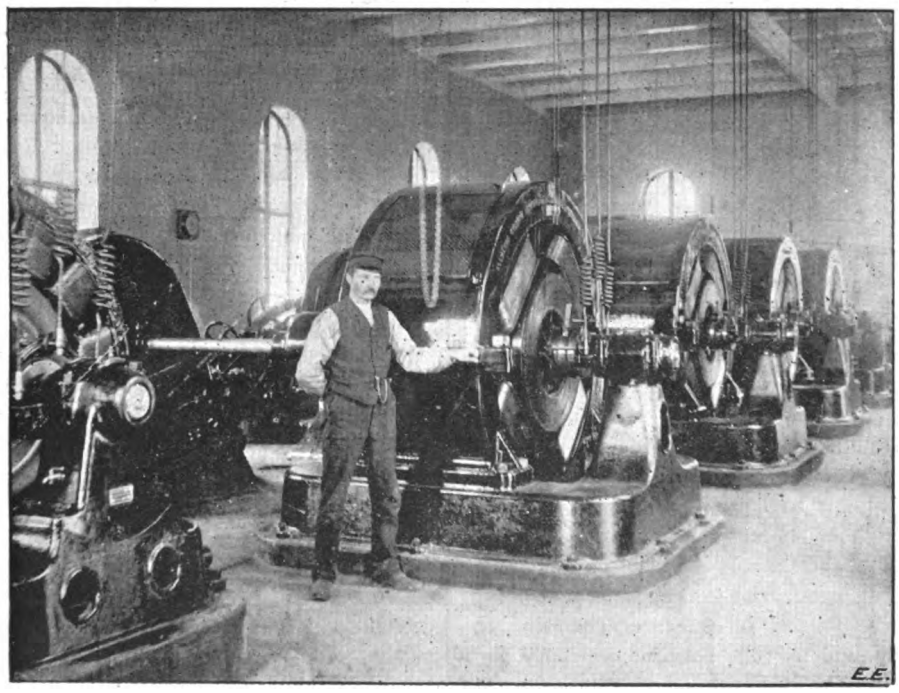

FIG. 1.—Three-Phase Power Station at Hofors.

The present yearly output of the works is about 11,000 tons of pig iron, 18,000 tons of Bessemer and open-hearth ingots, and 15,000 tons of rolled, hammered, or pressed material, as finished product. Besides those who work in the woods and the mines the company employs in the works about 500 men.

Description of the Electric Plant.—Electricity is used at Hofors for both lighting and transmission of power. The lighting plant is very simple in character. It consists of a continuous-current three-wire system, which is fed by two generators of 30 h.p. capacity each. The generators are both belted to the shaft of a 100-h.p. turbine. The voltage is 110 volts on each side. Arc lamps as well as incandescent lamps are used. In the daytime a number of small motors (some 40 h.p. together) are also fed from these circuits. While the electric light plant just mentioned has nothing peculiarly interesting about it, the transmission of power system, on the contrary, is of a character which justly has attracted the great interest of electricians as well as of technical people in general. Not only is it a fact that this plant was the first one built for furnishing power for rolling-mills exclusively by electricity, but also these motors were, at the time when the installation was erected, the largest of their type in any part of the world. The generating plant at the primary station is situated at the 100ft. waterfall, which has previously been referred to. The turbines at the waterfall, six in number, were designed and supplied by Messrs. Qvist and Gjers, of Arboga. Two of the turbines are of quite a special design, each being composed of two wheels, thus making it possible to obtain on the same shaft either 300 h.p. at 480 revolutions per minute, or 200 h.p. at 320 revolutions per minute. The four remaining turbines have only one wheel each, and are of the following sizes: two giving 300 h.p. at 480 revolutions per minute, one for 150 h.p. at 515 revolutions per minute, and, finally, one for 40 h.p. at 720 revolutions per minute. The electrical apparatus was altogether designed and manufactured by the Allmänna Svenska Elektriska Aktiebolaget, of Westeras. The well-known three-phase system was used—the above-named company having acquired the rights to this system from the late Jonas Wenström, to whom in the year 1890 was granted very complete patents concerning three-phase apparatus.

The generators (Fig. 1) are directly connected each to its own turbine. Each of the 300-h.p. turbines runs a 300-h.p. four-pole three-phase dynamo, working at a voltage of 900 volts (measured from the neutral point to each of the terminals). The field magnets, which are made of cast iron, are stationary, while the armature with laminated core revolves. The armatures have a diameter of 37½in. and a laminated length of 28½in. The normal frequency is unusually low, being only 16 complete cycles per seconds. The energy required for the excitation of the field of each generator is 2,700 watts. The weight of one of these generators is about 19 tons. The 150-h.p. turbine is also coupled to a three-phase generator of corresponding capacity, giving 900 volts at a frequency of 60 cycles per second. This generator has 14 poles; otherwise it resembles the larger machines in design, as well as to materials used for its construction. The diameter of the armature is 33½in. and the length of lamination 21in. The excitation at full load is 1,500 watts. Two continuous machines, both coupled to the shaft of the 40-h.p. turbine, are provided to excite the alternators. These machines also provide the current for lighting the power-house and some private houses. One switchboard made of white marble serves for the whole, and is arranged as shown in Fig. 2. Each three-phase generator is equipped with three fuses, one three-pole switch, ammeter, and field rheostat. Three of the large generators are connected each to its own system of overhead conductors supported on wooden poles from the power-house to the works, whereas the fourth serves as a stand-by in case anything should happen to any one of the others. The 150-h.p. generator also operates on a line of its own. Each of the exciters can furnish current for the excitation of all the three-phase machines

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simultaneously. The line consists of nine copper wires of 9mm. diameter each and three wires of 5·5mm., all mounted on the same poles. The length of the line is about 1½ miles. The overhead construction is shown in Fig. 3. Four motors, each of 200 h.p. capacity, are installed for driving the rolling-mills—one for the medium train, two for the wire mill, and one for the "fine" train.

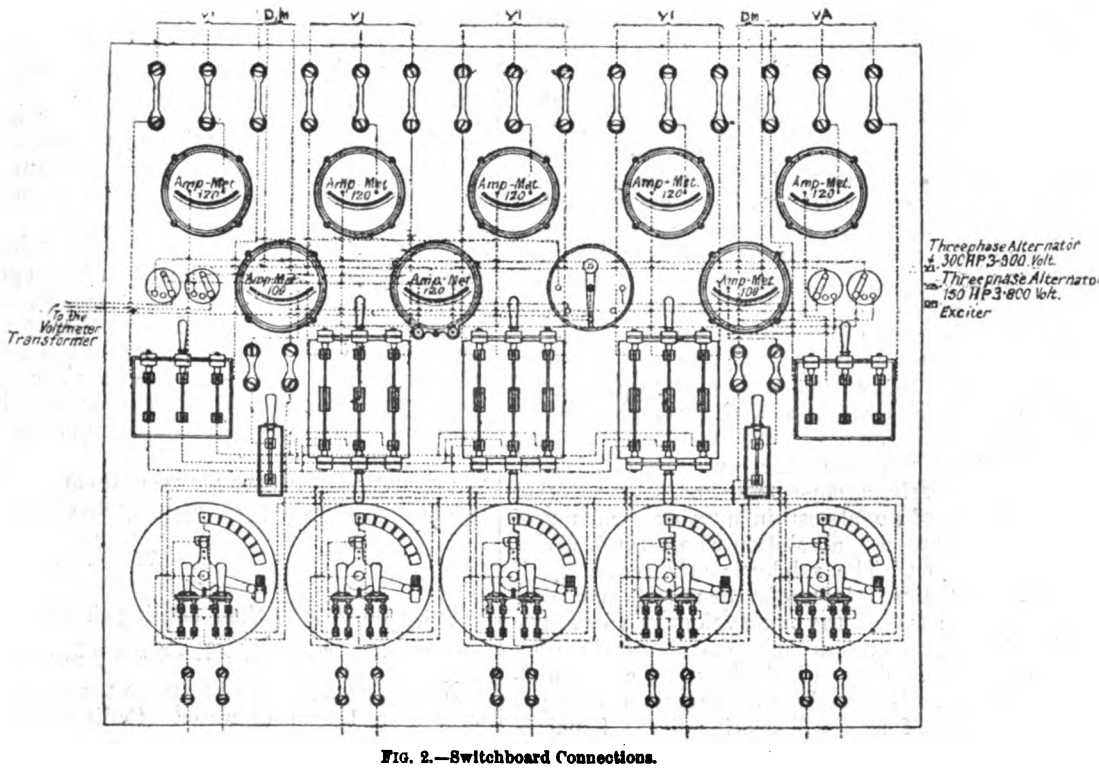

FIG. 2.—Switchboard Connections.

Each motor is fed from its own generator independently of the others, so that more than three motors cannot run at the same time if loaded to their full capacity. These motors are inductive three-phase motors with short-circuited armatures. They have four poles, and run about 460 revolutions per minute. The diameter of the

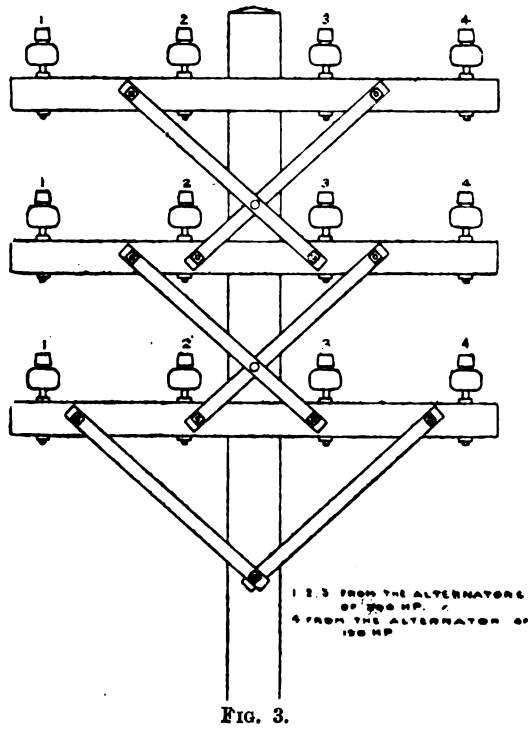

FIG. 3.

rotors is 35in., and the length of the lamination 29in. The starting of the motors is entirely done in the power station. The generator and its motor are, when standing, left connected to the corresponding line. Then the excitation is put on the generator fields, and the gates of the turbine are opened. In this way the generator and motor start about the same time. When started in this way the motors develop their full-load torque when starting without the use of any resistance boxes. Telephones are used between the works and the power station. In addition to these large motors which drive the mills there are also 13 smaller motors of an aggregate capacity of 210 h.p. These motors get their current from the 150-h.p. generator, the larger motor being fed directly from the line voltage, and the smaller ones by means of transformers. Some of the motors are fitted with short-circuited rotors, and others are arranged with complete secondary windings for securing good starting torques. This plant has now been running for about two years, and has given perfect satisfaction.

Messrs. Karl Wallin and Andersson and Ernst Danielson made a report as experts on this plant in July last on behalf of the company to see if the plant fulfilled the conditions in Section 2 of the contract. They report briefly as follows: "The power of one of the turbines of the power plant was measured by means of a brake. When carrying out this measurement the armature belonging to the corresponding generator was removed, all the gates of the turbine were fully open, and all the other turbines in the power-house were shut down. A series of observations were made in order to find the power of the turbine at different speeds. Afterwards the brake was removed from the turbine shaft and applied on one of the motors in the works, and at the same time the armature of the generator was put in place and connected to the turbine shaft. On account of these observations it was accordingly only necessary to take readings of the number of the revolutions of the turbine in order to determine its corresponding horse-power. The motor in the works was then run on the brake, and its corresponding power was obtained. As a result of these measurements, and after allowing for the energy which was absorbed in the field magnets of the generator, its rheostat, and exciter, we have obtained at normal speed (480 revolutions per minute of the generator corresponding to a speed of about 456 revolutions per minute of the motor) an efficiency of 75 per cent., and at 520 revolutions per minute of the generator, corresponding to 494 revolutions per minute of the motor, an efficiency of 72 per cent. The corresponding horse-power of the motor was 244 h.p. at 456 revolutions per minute, and 216 h.p. at 494 revolutions per minute." In conclusion, the experts say that the entire plant is very well laid out, and that, as far as they have been able to ascertain, everything belonging to it is manufactured of the best materials and with the greatest care. They especially praise the ample and solid construction which is a characteristic feature of the whole of the machinery.

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ELECTROLYTIC THEORIES AND THEIR RELATION TO COMMERCIAL ELECTRO-CHEMISTRY.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

(*Continued from page 296.*)

As we have seen, the theory of Grotthus assumes an electrolyte to consist of molecules, each comprising in the simplest case two atoms, situated at a definite distance apart, and possessing respectively equal charges of opposite signs. As a consequence, such a molecule would behave in an electrical field very much as a small magnet does when placed in a magnetic field. Further, it is assumed that, as a preliminary to electrolysis, these molecules are twisted round so that the vector line joining the negative to the positive atom in each molecule will be directed along the line of fall of potential at the place in the liquid where it is situated. Thus chains are formed, very much as iron nails will hang, one below another, from the pole of a magnet.

If an attempt is made to picture this process in its connection with the subsequent splitting up and *immediate* recombination, it will be seen that it necessitates that most, if not all, of the molecules are forcibly redirected, as described above.

Now, it is known that the purest water which can be obtained is very nearly a non-conductor. On the other hand, the addition of an almost infinitesimal amount of sulphuric acid will produce a solution whose conductivity is enormously greater. The sulphuric acid molecules, if uniformly distributed, will be too far apart to form chains, as supposed above; and if the application of an electric force splits these molecules up, immediate recombination can hardly take place, unless with the ions of the surrounding water molecules. If immediate recombination does not take place, a number of ions will continually be found *in the free state* during the progress of the electrolysis.

The question may fairly be asked whether any evidence as to the preliminary formation of molecular chains during electrolysis can be obtained. This part of the subject has received comparatively little attention up to the present. If the theory of Grotthus has any claim on our attention, it is as a mechanical model of the mechanism of current conduction in a liquid. As we have seen, difficulties are not absent when only the actions which take place in an ordinary laboratory voltameter are under consideration. On the other hand, is it possible to conceive of anything like the process which this theory would require in the case, say, when a difference of potential is established between the earthed terminals at the ends of the Atlantic cable?

The supposition that the atoms comprised in a molecule do actually possess charges as assumed by Grotthus is not at all an unlikely one. I have recently worked out the results of such a supposition in relation with the specific inductive capacity and optical refractive index of substances.* As some indirect evidence in regard to the probability of the formation of molecular chains, as assumed by Grotthus, may thus be obtained, a brief *résumé* of part of the reasoning employed may not be out of place here.

If two plane plates arranged parallel to each other be charged, *in vacuo*, with quantities of electricity respectively equal to + Q and − Q units (electrostatic), per unit area, the electromotive intensity at any point between the plates will be equal to $4\pi Q$, and the difference of potential between them will be equal to $4\pi Q d$, where d is the perpendicular distance from one plate to the other. Now, suppose that a liquid dielectric is introduced between the plates. This may be supposed to consist of polarised molecules as previously imagined. In a state of equilibrium—*i.e.*, when there is no impressed electric force—the molecules may be pictured as grouping themselves somewhat after the manner of the small magnets in Prof. Ewing's model of a magnetisable substance. In the present case, owing to the electric field between the condenser plates, each positive atom will tend to move toward the negative plate, whilst each negative atom will be strained in the opposite direction. In the paper referred to I have shown that these strained molecules will produce an electric field parallel to, but directed oppositely from, the impressed field, the number of lines of force per square centimetre being given by $4\pi n q \delta$,

where n = number of charged ions per cubic centimetre;
$\pm q$ = the ionic charge;
$\pm \delta$ = the average displacement of an ion along the lines of fall of potential due to the charged plates.

Here it will be noticed that when q is positive δ will positive, whilst we must take $-\delta$ corresponding to $-q$.

Consequently nq will be equal to the sum of the charges contained in unit volume of the medium, taken without regard to sign.

Let us now supposes that water is the liquid introduced between the condenser plates. Although the specific inductive capacity of water cannot be obtained by a statical method, like that used for instance by Faraday, yet Cohn and Arons* have determined its value with sufficient accuracy by a dynamical method. The value found by these experiments is 76. The meaning of this result is that if $4\pi Q = E$ = the electromotive intensity between the plates when charged *in vacuo*, whilst E′ represents the electromotive intensity between them when the water is introduced, the charges remaining unaltered. Then

$$\frac{E}{E'} = 76. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

But, according to the reasoning sketched out above,

$$E' = E - 4\pi n q \delta.$$

Now, nq will be equal to twice the charge carried by the oxygen in 1 grm. of water. Calling this quantity N (in electromagnetic units of quantity), we may rewrite (1)

$$\frac{E}{E - 4\pi N \delta v^2} = 76. \quad . \quad . \quad . \quad . \quad (2)$$

where E is now given in electromagnetic units, and $v^2 = 9 \times 10^{20}$, and is equal to the square of the velocity of light, or the ratio:

Capacity of a condenser, measured in electromagnetic units: capacity of same condenser, measured in electrostatic units.

Further, $$N = \frac{2}{\cdot 000824}.$$

If E = 100 volts = 100×10^8 C.G.S. units, then

$$\delta = \frac{75}{76} \cdot \frac{10^{10}}{4 \times 3{\cdot}14 \times \frac{2 \times 10^4}{8{\cdot}24} \times 9 \times 10^{20}} = 3{\cdot}5 \times 10^{-16} \text{ cm.} \quad (3)$$

Hence an average displacement of the charged atoms along the lines of fall of potential of $3{\cdot}5 \times 10^{-16}$ cm. is all that is required to account for the specific inductive capacity of water, the substance possessing the highest known value for that quantity. In other words, a greater displacement than this would lead to a higher value for the specific inductive capacity than that determined experimentally. Now, the probable size of atoms and molecules is known, at least as far as its order of magnitude is concerned. According to Lord Kelvin, this magnitude is somewhere between 2×10^{-7} and 1×10^{-9} cm.

Hence the average atomic displacement produced in water when subjected to an E.M.F. of 100 volts per centimetre is excessively small even when compared with the size of a molecule. This result tells distinctly against the probable formation of molecular change by the majority of molecules in an electrolyte. We have proved this in the case of nearly pure water. Further, Cohn and Arons found that the specific inductive capacity of an aqueous solution differed only slightly from that of pure water. The method employed by these experimenters depended for its success on the use of alternating currents, and thus any effects due to the presence of free ions could be distinguished from molecular rotations resisted by elastic

* "An Extension of Maxwell's Theory of Light to include Dispersion, Metallic Reflection, and Allied Phenomena," by E. Edser; *Proceedings* Royal Society, vol. 63, pp. 374-389. See also Helmholtz, *Wied. Ann.*, 1893, pp. 389-405, 723-725; and Larmor, *Phil. Trans.*, 1897, pp. 206 300.

* Cohn and Arons, *Wied. Ann.*, 33, p. 13, 1888.

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forces tending to restore the molecules to their original positions.

The above reasoning has been given not alone to point out an inconsistency in the theory of Grotthus, but because it leads us naturally to the consideration of certain facts which may indicate a theory more in accordance with our experimental knowledge.

Most experiments on electrolysis have been performed in aqueous or alcoholic solutions. Now, water, though it occurs so generally, must yet be considered as a very abnormal substance. Thus, its specific heat is extremely high—its specific inductive capacity is the highest known—whilst some experiments of Prof. Ramsay and Dr. Shields indicate that at ordinary temperatures it really consists of complicated units, each comprising several distinct molecules, held together in a state of loose aggregation. This last result agrees with the assumption made above that the molecules are arranged in equilibrium figures similar to those assumed by the magnetic molecules of iron.

Turning to alcohol, we find its properties approximating much more closely to those of water than do those of the majority of other liquids, such, for instance, as carbon, bisulphide, or ether. Thus, whilst the specific inductive capacities of the last two liquids are respectively equal to 2·67 and 4·75, that of ethyl alcohol is equal to 26·5. It becomes probable, therefore, that the conditions which render possible the flow of an electric current through an aqueous or alcoholic solution are intimately connected with the abnormal behaviour of pure water and alcohol in other respects.

(To be continued.)

ELECTRIC CANAL HAULAGE.*

BY A. H. ALLEN, A.I.E.E.

In the days before the advent of the locomotive engine, by far the greater part of the goods traffic in the interior of this country was carried on by means of canals, of which about 4,000 miles are in existence, representing an immense amount of capital. In the year 1825, when the prosperity of the canal traffic was at its highest, the Birmingham Canal yielded a revenue of cent. per cent., and one of the Manchester canals paid in dividends every second year a sum equal to the total original outlay.

With the development of railways, however, our once splendid canals—the heritage of the eighteenth century—rapidly fell into comparative disuse, and at the present day the traffic upon them forms but a small proportion of the whole inland trade of this country; a woeful contrast with the prosperous canal systems of Germany, France, and Belgium, and far from creditable to ourselves.

It would be interesting, if time allowed, to enquire into the causes which have brought about this decay of a vast system of communication, and reduced it to its present state; but to be brief, the fundamental factors are the slow speed of transmission as compared with that of railways and coasting steamers, and the heavy charges for tolls and for towing. The very fact that the traffic has decreased has reacted upon the tolls, for it is found that the cost of maintenance of canals is practically constant, irrespective of the amount of traffic, so that as the traffic diminishes the tolls must be increased. Hence, if, by increasing the speed and reducing the cost of towing, a larger traffic can be attracted, the tolls will be reduced also.

The method of haulage in general use remains the same as it was a century ago—by horses. Steam tug-boats have, it is true, been adopted here and there, but their use is limited by many considerations, such as the cost of the boats, the damage done to the banks of the canal by the scouring action of the propellers, and the very low efficiency on account of the small cross-section of the canal, while the cost of haulage is but little less than that of horse traction.

The subject of this paper is an adaptation of electrical traction to canal haulage with a view to accelerating the speed and at the same time reducing the cost—the two most important considerations in connection with goods traffic. The system to be described is the outcome of years of study on the part of Messrs. Thwaite and Cawley, civil engineers, of Westminster; the aim of the inventors has been to provide an economical and efficient method of haulage, which can be applied to any canal without in the least interfering with the use of horses, thus enabling the latter to be displaced by degrees, if desired. The system is about to be tested on one of the great northern canals. It has been submitted to the critical examination of our most eminent canal experts, and it is admitted that it shows promise of satisfying the numerous and difficult conditions of canal traction.

Previous attempts towards applying electric traction have generally been in the direction of supplying electrical energy, by means of overhead wires along the banks, to electromotors carried on board the barges. The motors were usually geared to screw propellers (as, for instance, on the Erie Canal)—in one case to an aerial propeller. None of these methods have attained any degree of success, chiefly on account of the same difficulties as lie in the way of steam propulsion. A length of three miles on the Burgundy Canal is operated electrically by means of a chain laid along the bed of the canal. A tug-boat fitted with an electromotor and chain barrel works to and fro on the chain, hauling a train of barges. The current is received from an overhead wire, and returns *vid* the chain and earth. The system is well adapted for the case in question, as two out of the three miles are through tunnels; but the great loss of time incurred when one train passes another is a fatal bar to its general adoption.

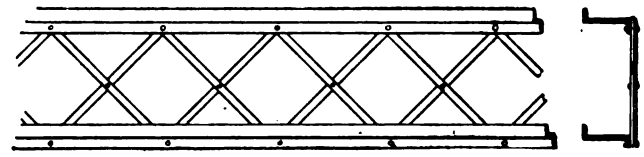

FIG 1.—Section and Elevation of the Track.

In the present system all these difficulties are avoided by making the motors entirely independent of the barges and hauling the latter by means of ropes, exactly as with horses; in this way the waste of energy incurred with a screw propeller is almost entirely obviated. An aerial railway is provided, consisting of two steel rails of channel or Z section braced together at one side so as to form a rigid girder (Fig. 1), and supported at a height of 9ft. or 10ft.* above the towing-path by means of cast-iron brackets or wooden posts (Fig. 2) at intervals of about 30ft. Each of these rails constitutes a running track for a number of electric locomotives, each consisting simply of an electromotor mounted on a four-wheeled carriage; two of the wheels run upon the upper surface of the rail, supporting the weight of the locomotive, and two run beneath the rail, bearing against the lower surface in such a way as to ensure the stability of the locomotive (Fig. 3). Two horizontal rollers are pressed by springs against the edge of the rail, in order to guide the carriage in the correct running position. The locomotive is thus locked to the rail, and is securely held in position by its own weight; moreover, by giving suitable proportions to the relative lengths of the axles of the wheels, the total pressure between the wheels and the rail can be made as great as may be desired—far greater than the weight of the locomotive itself—so that there is no limit to the adhesion which can be obtained between the wheels and rail. As the maximum drawbar pull of a railway locomotive under ordinary conditions is only about one-seventh of its weight, this is an important feature of the system.

The motor shaft carries at each end a worm, gearing with a worm-wheel on each of the four axles, so that all the wheels are drivers (Fig. 4). The gearing runs in an oil bath, and can be so designed as to give an efficiency of 90 per cent. Automatic lubrication is provided for all the working parts, so that frequent inspection is not necessary.

The motor itself is of the ordinary direct-current series-wound traction type, and need not be described in detail. The tractive force required to tow a barge carrying

* Paper read before the British Association at Bristol.

* Where horses are not used, the rails may with advantage be fixed at a height not exceeding 6ft from the ground, so that the locomotives may be more readily accessible.

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100 tons on a canal of ordinary cross-section, at the rate of 2½ miles per hour, is from 250lb. to 300lb.; the maximum brake horse-power at full speed is therefore $= \frac{2{\cdot}5 \times 5{,}280 \times 300}{60 \times 33{,}000} = 2$ b.h.p. But in order to get up speed quickly at starting, the motor must be designed to give a tractive force of about 600lb. for a short time. Such a motor would weigh about 300lb. and the weight of the motor and carriage would not exceed 900lb. For a speed of four miles per hour, under the same conditions, the motor should give a tractive force of 750lb. at full speed, and, say, 1,200lb. at starting; the weight of the motor would in this case be about 600lb., and of the motor and carriage about 1,400lb.

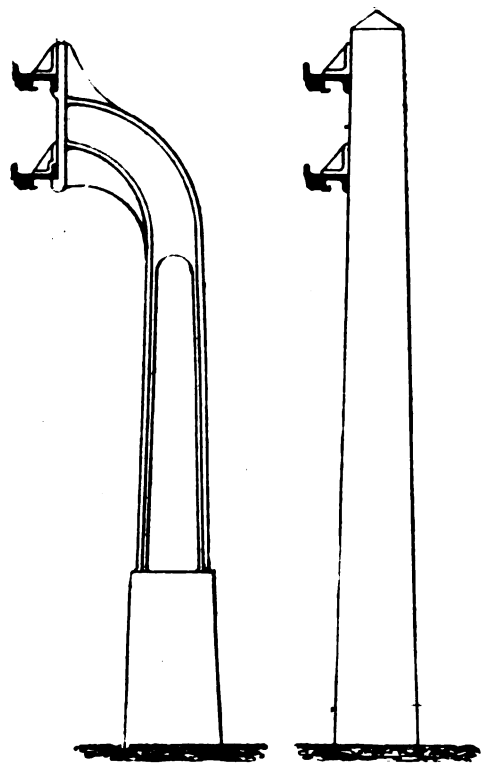

FIG. 2.—Elevation of the Poles to Support the Track.

are electrically bonded together so as to provide a return path of low resistance.

It will be seen that the two rails form an "up" line and a "down" line, so that the locomotives run on the upper rail in one direction and on the lower rail in the opposite direction. Each locomotive is provided with a link, to which the tow-rope is attached, the other end of the tow-rope being secured to the mast of the barge exactly as in the case of horse haulage. When two barges meet, that one which is being towed by the lower locomotive steers close to the towing-path, while the other barge steers wide, so that the tow-rope of the second barge passes clear over the first; thus there is no possibility of entanglement or crossing of the ropes, and the locomotives and barges pass freely without necessitating a stoppage. The importance of this point will be realised if it is borne in mind that on the average three minutes are lost every time two barges pass when drawn by horses, or about one-fifth of the whole time occupied in making a journey on a busy canal.

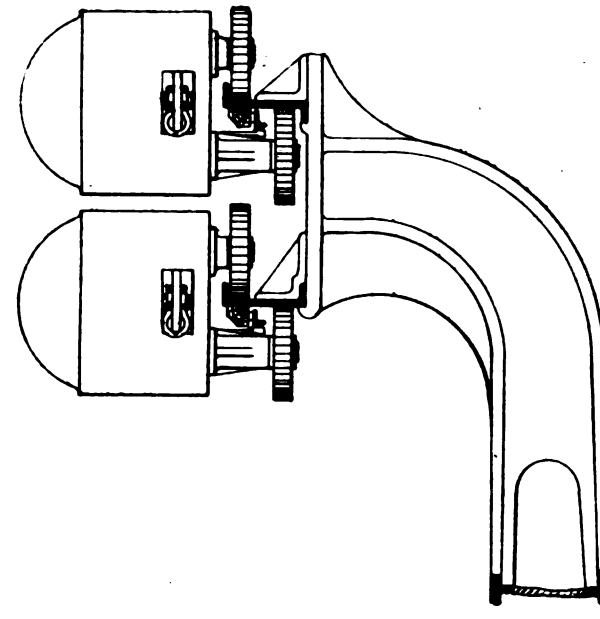

FIG. 3.—View of Two Motor Carriages Passing.

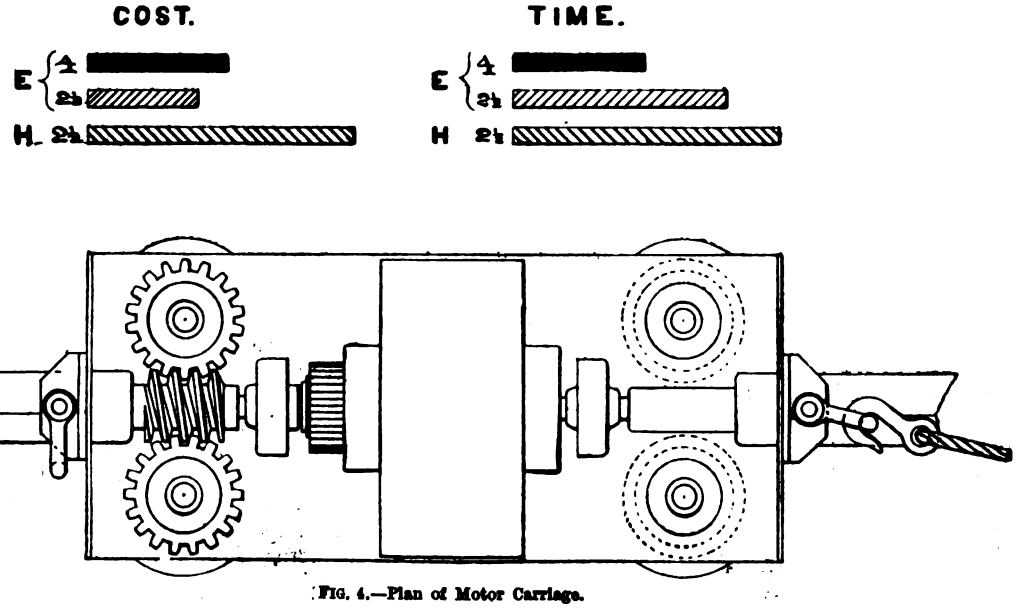

FIG. 4.—Plan of Motor Carriage.

To the lower side of each rail is bolted a continuous creosoted wood batten, which supports the electrical conductor—a flat copper or steel angle bar—insulated from the wood by means of porcelain insulators. The position of the conductor is such that it is shielded from the weather, and, to a great extent, from mechanical injury. The current is collected from the conductor by means of an insulated brush attached to the locomotive, and after passing through the motor is conducted by the wheels to the rails, which

The locomotive is controlled entirely from the barge, no driver being required. Various methods of control are available. Two light cords may be used, leading from the barge to a switch mounted on the motor carriage, or a single cord may be employed, together with a switch so constructed that on pulling the cord the switch is closed; the next pull opens the switch, and so on alternately. Another method of control is by the use of a concentric or twin wire cable for the tow-rope; in this case the starting

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switch may be placed in the barge itself, in the charge of the bargemaster, or the switch may be carried in the locomotive and controlled by electrical means from the barge. It should be remembered that, even when starting up to a speed of four miles an hour, the current at 500 volts would not exceed 14 or 15 amperes, so that elaborate switching apparatus is not necessary.

Since the whole apparatus is entirely separate from the barges, and complete in itself, it is evident that any barge or boat whatever may be towed without requiring the slightest alteration. On arrival at the end of a journey the locomotive may be at once coupled to another barge, leaving the first to be unloaded or otherwise at leisure; hence the plant can be kept continuously at work at its maximum earning capacity, and the ratio of the expenditure to the receipts can be kept down, both on this account and because a given number of locomotives can serve the needs of a much greater number of barges.

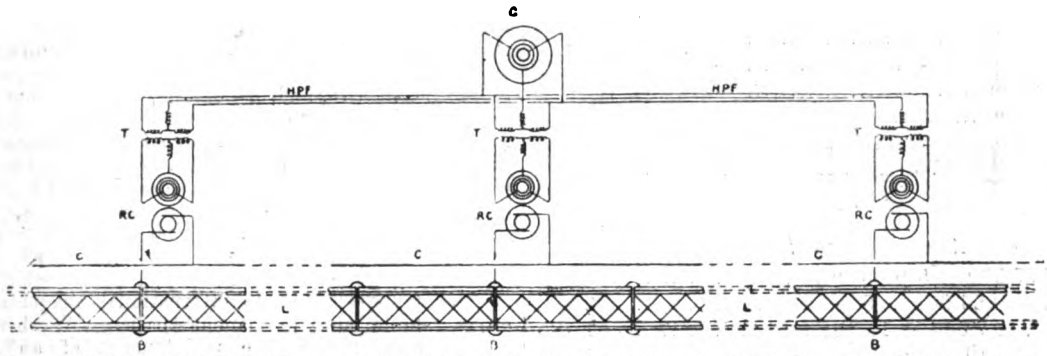

FIG 5.—Diagram of Electrical Distribution System. Index to parts—B, bonds; C, working conductor; G, three-phase alternate-current generator H.P F, high-pressure feeders; L, aerial railway line; R C, rotary converters; T, stationary transformers.

Electrical power is supplied from one or more generating stations situated at suitable points on or near the canal; it is important to notice that water power may be used if such be available, or the generating plant may with great advantage be erected at a colliery if the canal passes through a coalfield, so as to obtain coal at the lowest possible rates. The canal itself supplies water for condensing purposes if steam power is used, but it is preferable to employ gas-engines, by means of which, in conjunction with the Thwaite system of gas producers, it has been proved to be possible to generate one indicated horse-power hour with an expenditure of less than 1lb. of coal.

In the case of long canals the power would be transmitted on the three-phase alternating-current system at high pressure, and transformed down to direct current at low pressure at convenient points on the line, as shown in Fig. 5. For short canals the current will be supplied direct to the line.

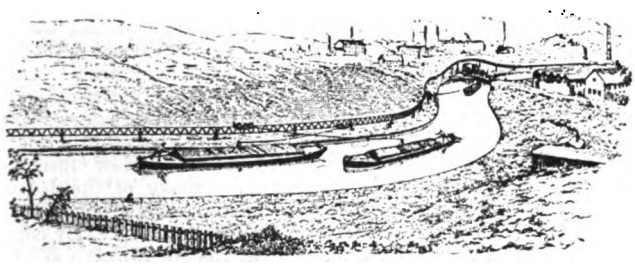

FIG. 6.—General View of the Thwaite-Cawley System.

A very important feature of the system is the fact that not only will power be available for hauling barges, but it may also be used for working cranes, factory machinery, lock-gates, etc., and for lighting warehouses and the canal itself if desired; a useful application of power is to capstans at the locks, by means of which the barges can be handled with rapidity and ease when entering the locks or leaving them. As canal traffic with electrical haulage can be carried on both by night and by day, the conditions of working are specially favourable to a low cost of power, the generating and distributing plant being constantly in use with no idle period.

In order to illustrate the economic possibilities of the system, estimates have been prepared showing the cost of haulage (1) by horses, (2) by electric locomotives, at the same running speed as with horses, and (3) by electric locomotives at a higher speed (four miles per hour). For the purpose of this comparison, the case of a level canal 30 miles in length has been taken, with an annual traffic of 100,000 tons per mile. The details of the estimates are given in an appendix to this paper; the results, in brief, are as follows:

	Cost per ton-mile. d.	Time occupied in transit. (hours).
Haulage with horses at 2½ miles per hour.	0·077	... 15
Electric haulage at 2½ miles per hour	0·032	... 12
Electric haulage at four miles per hour ...	0·041	... 7½

It will be seen that, without taking advantage of the higher speed possible with electric haulage, the cost is 58·4 per cent. and the time 20 per cent. less than with horses, while when the speed is increased to four miles per hour the cost is 47 per cent. and the time 50 per cent. less than with horses.* Further, in the latter case no allowance has been made for the reduction in the capital cost of barges (of which a smaller number would suffice), in the interest and depreciation on capital, and in the wages paid to bargemen, nor for the increase in the traffic and reduction of tolls which are sure to follow the increase in speed, the sale of electrical energy, the great reduction in cost of maintenance during prolonged frosts, etc., all of which are items of the first importance in this connection.

To sum up, then, the electrical system of haulage possesses the following advantages, amongst others: The boats require no alteration whatever; the delays in passing incurred with horse haulage are obviated; bridges and tunnels cause neither difficulty nor delay; no time is lost in waiting for a train of barges to be loaded, as is the case with steam; power can be supplied to private consumers, etc., at a low rate; the cost of haulage is reduced by 50 or 60 per cent., and the time occupied in transit by 20 to 50 per cent. as compared with horse haulage; in case of frost, the standing expenses are enormously less than with horses.

APPENDIX.

Basis of calculations: canal, 30 miles in length; daily traffic, 10,000 tons; 100 barges, each carrying 100 tons, and completing one journey per diem on 300 days per annum; 80 per cent. through traffic, 20 per cent. distributed; therefore average lead, 27 miles.

CASE I.—Cost of haulage by horses: each barge is towed by one horse in 10-mile stages, one stage being a day's work for a horse.

Capital Cost.

300 horses at £40	£12,000
300 sets harness at £10	3,000
300 stalls at various points on the line of route at £30	9,000
	24,000

* On some of our most important systems the dimensions of the canal and of the locks will only permit the passage of barges carrying 50 tons of cargo; in this case the saving in cost is increased to nearly 65 per cent. at 2½ miles per hour and to 60 per cent. at four miles per hour, the same traffic being taken; but the cost of horse haulage is doubled, and that of electric haulage is also increased, though to a less extent.

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Annual Expenditure.

Interest on £24,000 at 5 per cent.	£1,200
Depreciation on £12,000 at 20 per cent.	2,400
„ „ £3,000 at 15 per cent.	450
„ „ £9,000 at 5 per cent.	450
Maintenance of horses at 18s. per horse per week..	14,040
Wages of 150 drivers at £50 per annum	7,500
	£26,040

$$\text{Cost per ton-mile} = \frac{26{,}040 \times 240}{300 \times 10{,}000 \times 27} = 0{\cdot}077\text{d.}$$

$$\text{Time occupied in transit} = \frac{30}{2\frac{1}{2}} + 3 = 15 \text{ hours.}$$

CASE II.—Cost of electric haulage at 2½ miles per hour; each barge is towed by one locomotive making one journey per day.

Capital Cost.

Aerial railway, 30 miles at £1,800 per mile		£54,000
Electrical plant	£4,500	
Gas-engines and producers	4,000	14,000
Distributing mains	5,000	
Switchboards, etc.	500	
Generating station and sub-stations		2,000
Locomotives, 100 at £75		7,500
		£77,500

Annual Expenditure.

Interest on £77,500 at 5 per cent.	3,875
Depreciation on £54,000 at 5 per cent.	2,700
„ „ £7,500 at 15 per cent.	1,125
„ „ £14,000 at 8 per cent.	1,120
„ „ £2,000 at 4 per cent.	80
Coal, 2,000 tons at 10s. per ton	1,000
Wages of eight men at £75 (average)	600
Management	200
Oil, waste, stores	200
	10,700

$$\text{Cost per ton-mile} = \frac{10{,}700 \times 240}{300 \times 10{,}000 \times 27} = 0{\cdot}032\text{d.}$$

$$\text{Time occupied in transit} = \frac{30}{2\frac{1}{2}} = 12 \text{ hours.}$$

CASE III.—Cost of electric haulage at four miles per hour; each barge is towed by one locomotive, which makes two journeys per day.

Capital Cost.

Aerial railway, 30 miles at £2,400 per mile		£72,000
Electrical plant	£6,000	
Gas engines and producers	5,500	19,100
Distributing mains	7,000	
Switchboards, etc.	600	
Generating station and sub-stations		2,500
Locomotives, 50 at £120		6,000
		£99,600

Annual Expenditure.

Interest on £99,600 at 5 per cent.	4,980
Depreciation on £72,000 at 5 per cent.	3,600
„ „ £6,000 at 15 per cent.	900
„ „ £19,100 at 8 per cent.	1,530
„ „ £2,500 at 4 per cent.	100
Coal, 2,800 tons at 10s. per ton	1,400
Wages, 10 men at £75 (average)	750
Management	250
Oil, waste, stores	300
	£13,810

$$\text{Cost per ton-mile} = \frac{13{,}810 \times 240}{300 \times 10{,}000 \times 27} = 0{\cdot}041\text{d.}$$

$$\text{Time occupied in transit} = \frac{30}{4} = 7\frac{1}{2} \text{ hours.}$$

Backward Progress.—The *Financial News* had yesterday a clever leader on electric traction. In it the Progressive party in the London County Council was taunted with being more conservative than the present Government with its opposition to electric traction.

INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY.

PRESIDENTIAL ADDRESS.

BY PROF. A. W. RÜCKER.

(Concluded from page 404.)

With regard to the future, I do not propose to lay before you any detailed scheme, but on discussing the matter among ourselves, the following principles should, in my opinion, be adhered to: The International Meteorological Conference has held a number of successful meetings. I believe that I am right in saying that the right to attend that conference was at first confined to those who were officially connected with meteorological and magnetic observatories, but that of late invitations have been more widely distributed. If the authorities of that conference see their way to inviting in future most or all of those who are known to be specially interested in terrestrial magnetism, I do not see why the Magnetic Conference, which would then be constituted once in five years, should not meet all our requirements. If, however, additional meetings are necessary, I would urge that they should be held in turn in different countries, and, if possible, in connection with existing societies which play elsewhere the part taken by the British Association in this country. That a permanent committee should be established is essential, and the mode of appointing this body must no doubt be considered, but I hope that in the course of the next few days the committee may be able to discuss the whole question, and that when the next meeting of the Meteorological Conference takes place we may be able to lay before the committee suggestions which may lead to the foundation of an international magnetic association on a stable and permanent basis. Another matter of great importance is the maintenance of an international journal devoted to terrestrial magnetism. This we now possess, thanks to the energy of Dr. Bauer, and I feel sure that all present will agree that such a means of intercommunication is invaluable. I believe, however, that the enterprise is threatened with financial dangers, and I desire to take this opportunity of urging all those who are interested in its success to do what they can to support it by increasing the circulation. There is every reason for making more use of a common journal. The records of the observatories are necessarily so bulky that anyone who desires to obtain the facts as to the magnetic state of the earth at any given time must collect or consult a large library of quarto volumes, in some of which the magnetic facts are mingled with data interesting chiefly to the meteorologist or astronomer. It is no doubt essential that an account of all the work done at each observatory should be published in a collected form, and that full details of the magnetic observations should be given, but for many, nay, for most purposes, those who use the records will require only final results. The means of the various elements for the year, for each month, or for any other period which may hereafter be adopted, and the diurnal variation, are in general wanted rather than the hourly values. If these means could be published together once a year an enormous boon would be conferred upon magneticians. For special purposes the theorist will have to test his views by reference to the results published in their fullest detail, but it would be no slight gain if the more salient facts could be compared by being placed side by side in the same journal. One advantage such a system would unquestionably possess. It would impress upon the authorities of the observatories the necessity for adhering to a common form of publication. Some small beginnings have already been made. The Kew Observatory Committee now publish in the *Proceedings* of the Royal Society the annual means of the elements recorded by all the observatories which send their publications to Kew. By comparing two of these tables, the secular change can at once be determined. But the system is capable of extension, not merely to the normal values of the elements, but to disturbances. By common agreement, Greenwich and Parc St. Maur publish in each year the records of the same magnetic storms. If this agreement could be extended, and if the facts thus selected were brought into juxtaposition, we might hope for a fuller and more instructive analysis than is at present usual.

Turning from questions of organisation, the primary business of our conference will be to discuss four questions submitted to our committee by the International Meteorological Conference. The first two of these refer to the methods for calculating and publishing the monthly means of the magnetic elements which should, in our opinion, be adopted. I will not anticipate the discussion which will take place on these points, except to say that it will be necessary to bear in mind not only what is desirable, but also what is practicable in view of the resources at the disposal of the directors of the various magnetic observatories. Another question deals with the relative merits of long and short magnets, and on this point we shall have the advantage of hearing a report on the subject by M. Mascart. Lastly,

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there is a very important proposal for the establishment of temporary magnetic observatories at certain specified places. General Rykatcheff and Prof. von Bezold present an important report on this subject, and I will only remind you that, whereas the accuracy and mathematical expression of the magnetic state of the earth's surface depend entirely on the number and position of the spots at which the magnetic elements are accurately known, the establishment of temporary observatories will be a costly undertaking, for the carrying out of which all the resources at the disposal of international science will have to be employed.

Another point of considerable practical importance will also be brought before us. The rapid extension of electrical railways and tramways is a serious menace to magnetic observatories. From all parts of the world we hear of observatories ruined or threatened by the invasion of the electrical engineer. Toronto and Washington have already succumbed; Potsdam, Parc St. Maur, Greenwich, and Kew are besieged; and the issue largely depends upon whether these great national observatories can or cannot make good their defence. It seems to be a law of nature, ruling alike the human race and the humblest microbe, that the products of an organism are fatal to itself. The pessimist might infer that we are in presence of another instance of the universality of the application of this law, and that pure science is threatened by the very success of its practical applications. The smoke of our cities blots the stars from the vision of the astronomer, who, like the anchorites of old, flies from the world to mountains and desert places. It is only in the small hours of the morning when

> "Save pale recluse, for knowledge seeking,
> All mortal things to sleep are given,"

that the physicist can escape from the tremors of the traffic of a great town. Civilisation as it spreads by aid of the means that science has placed at its disposal is destroying records, and obliterating boundaries by the study of which the anthropologist and biologist might have read far back into the history of our race. And now, in turn, the science of terrestrial magnetism, which, on the one hand, is forging another link to connect the sun and earth, and, on the other, is penetrating within the surface of the globe to depths beyond the ken of the geologist, is threatened by the artificial earth currents of the electric railway. That the crisis is serious there can be no doubt, but I will only anticipate the fuller discussion which will take place by stating that magneticians, in common with the rest of the world, recognise the great benefit which electric traction confers upon the community at large. We are not so foolish as to desire to embark on a crusade against a great industrial improvement of which science may well be proud; on the other hand, we must hold fast to the position that provision for the conveniences which are immediately appreciated by the public should be made with as little damage as possible to those studies which are not less for the ultimate benefit of the race. Had science when the use of coal was introduced been sufficiently advanced to devise means for smokeless combustion, an evil which now in more senses than one darkens the lives of the inhabitants of our great towns might have been prevented from attaining its present gigantic proportions. We are now at the beginning of another industrial epoch, which may, indeed, if power is transmitted from a distance on a large scale, brighten our skies, but which threatens to saturate the earth beneath us with electric currents. That these may interfere with the general comfort is evident from the injury which has been done to underground pipes at Washington and elsewhere. The construction of a powerful electrical railway in the immediate neighbourhood of the laboratories of a college would interfere with its efficiency, and make it impossible to perform experiments of certain types. In such a case, however, something could be done by arranging the experiments to suit the conditions under which they would have to be performed. But in the case of a magnetic observatory no such protective measures are possible. The very object of the observatory is to measure the earth's field, and if that field is artificially altered, no modifications of the methods of measurement, however ingenious, can overcome this fundamental defect. I am glad to take this opportunity of acknowledging that both the danger to pure science and the necessity for obviating it have been acknowledged by those who are chiefly interested in the technical applications of science; and in particular that one of the principal technical journals has supported the view that industry can and ought to respect the necessities of research.

If, however, there be any who are inclined to ask whether the careful study of terrestrial magnetism has led or is leading to any definite results, or whether we are not merely adding to the lumber of the world by piling up observations from which no deductions are drawn, we may answer that, though the fundamental secret of terrestrial magnetism is still undiscovered, the science is progressing. In the presence of several of the most active workers I will not enter into a detailed discussion of the tasks to which they are devoting themselves; I will only ask that the doubter should compare a good summary of the state of the science of terrestrial magnetism written 15 or 20 years ago, such as that contained in the article by Balfour Stewart in the "Encyclopædia Britannica," with what would be written on the same subject to-day. Additions would have to be made to the descriptions of the instruments employed, to the discussion of the theory of the diurnal and secular change, while such questions as the reality of earth-air currents and the tracing of loci of local disturbance have only been dealt with effectively in very recent times. When, too, we compare the older models of the magnetic state of the earth with that devised by Mr. Henry Wilde, we cannot but admit not only that a great advance has been made in forming a simple diagram of the magnetic state of the earth, but that it is possible that the model contains a very pregnant hint as to the physical construction of the earth as a magnetic body. The fact that Mr. Wilde has imitated the declination and dip with remarkable accuracy all over the surface of the earth by means of a simple arrangement of electrical currents, and by coating the oceans with thin sheet iron, has not attracted the attention it deserves. Whether the physical cause thus suggested be due to the greater depth to which the underground isothermals penetrate below oceans, the bottoms of which are always cold, or whether the geological nature of the rocks is different below the great depressions and elevations of the earth's surface respectively, may be open to question, but I am persuaded that the matter should be more fully investigated.

In conclusion, let me once more revert to the points on which I dwelt at the beginning of this brief address. We meet with the confidence of men who know that their science is progressing, but with the mingled hopes and fears of those who still have to deal with the great unsolved problem of the causes of terrestrial magnetism and of its manifold fluctuations. This solution will be most easily attained if we are not merely content to collect facts, but if we so arrange that they shall be easily dealt with. To observe is our first duty, to organise our second, and if these be fulfilled we may hope that a theory of terrestrial magnetism will in the future crown the efforts not merely of him on whom the first glimpse of the truth may flash, but of the international co-operation which has, by way of preparation, made "the crooked straight and the rough places plain.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE III.

(Concluded from page 406.)

The "red" flag marks the one made of best Pahang, the "black" that made of common guttapercha, and the "white" flag that made of the same material as the last, after extraction of the resin. I take one boat after the other out of the ice, and, laying it on an anvil, I give it a blow with a wooden mallet. First, the "red," which you observe withstands the blows without breaking; next, the "black," which is shattered into fragments, and would therefore not have withstood the action of the pack-ice; lastly, I take the boat with the "white" flag and give it a good blow, but strike it as hard as I will it resists the blows of the mallet perfectly. The little boats have been in the tank amongst the ice for several hours, but as they are only partially immersed in the water and the air is rather warm in this room, the conditions are naturally not so severe as they would be in the Arctic regions. I have therefore prepared another little experiment to show you what would happen there. This double-walled copper vessel contains a mixture of powdered ice and salt, having a temperature of about 10deg. or 15deg. C. below zero. In this mixture strips of different kinds of guttapercha have been kept for a sufficiently long time to acquire that low temperature. I take one of these strips out quickly and give it a blow with an iron hammer on a cold anvil. You observe it shows a crack. This is the Pahang. I take another strip and strike it in the same way. It actually breaks across. This is a material containing more resin than the former. I take a third strip. This withstands the blows perfectly, and from the mark on it I see it is the hardened guttapercha. This clearly shows you the superiority of that material over the others at exceptionally low temperatures. In order to obtain an idea how greatly the physical and mechanical properties of guttapercha are affected by the extraction of the resin, a large number of raw materials of medium quality were cut up into small pieces, which were intimately mixed and divided into two portions. One portion was simply washed in the ordinary way with water, the tests of the cleaned material being shown at A; the other was treated with petroleum spirit until nearly all the resin had been extracted, and was then washed like the first; the results of the tests are shown at B. In a

* Cantor Lectures delivered before the Society of Arts.

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similar way, other mixed raw materials were treated with petroleum spirit and then cleaned in the ordinary way; the tests of these are shown at C, D, and E. The comparison between A and B is most interesting and instructive. Take, for instance, the softening temperature, which was 37·7deg. C. before the treatment, and 57·2deg. C. after; or the time of hardening, which was reduced from 17 minutes to less than a minute. The breaking strength per square inch rose from 1,592lb. to 5,662lb. but the elongation diminished. The electrical properties, on the other hand, are but little affected, the insulation being practically the same as before, and the decrease of specific inductive capacity is probably due to the smaller percentage of water in the hardened material. The extraction of the resin in this case is far from complete, as the results of the analyses show. The sample marked C is, in that respect, decidedly better, the raw material used in this case being of superior quality, and the results obtained with the hardened material correspondingly more favourable, particularly as regards the tensile strength, which is extremely high—viz., 6,757lb. per square inch. The comparatively low insulation and exceptionally low specific induction of sample C are to be attributed to the particular description of the raw material and not to the extraction of the resin. The remaining two samples, D and E, were obtained from raw materials similar to that used for B. The percentage of resin left in E is a remarkably low one, and the softening temperature of 61·6deg. C. is one of the highest hitherto observed in hardened materials, and certainly higher than that of any natural kind of guttapercha.

Absorption of Oxygen.

It has long been known that atmospheric oxygen, in the presence of light, deteriorates guttapercha, and many experiments have been made in this direction, but I believe none so comprehensive and exhaustive as those which I am now going

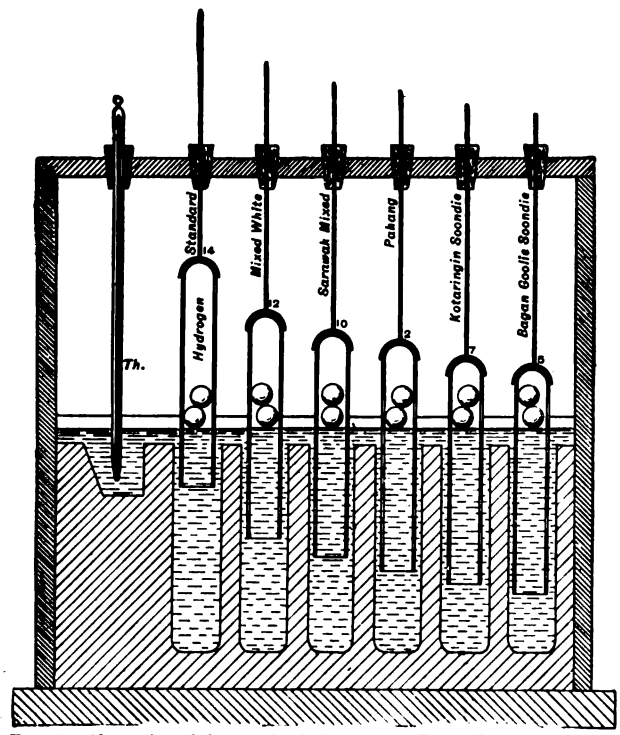

Fig. 56.—Absorption of Oxygen by Guttapercha. Exposed to daylight for 40 days during the Spring of 1897. (Total sunshine, 185 hours; mean temperature, 15deg. C.

to describe. The object of these experiments was to compare the avidity of the different "brands" of guttapercha in absorbing oxygen under otherwise similar conditions. For this purpose small spheres of clean guttapercha of eight square centimetres superficial area and two cubic centimetres contents were enclosed in glass tubes filled with oxygen gas and inverted over mercury troughs, as shown in Fig. 56. Each trough was provided with six such tubes, and was so arranged that every tube could be brought over a kind of well and there filled with oxygen from one of the bottles of compressed gas supplied by Brin's Oxygen Company. According to our tests this oxygen contained 7 per cent. of nitrogen, but was otherwise sufficiently pure for the purpose. Each tube had a capacity of about 30 cubic centimetres, and contained two spheres to accelerate the absorption. The tubes were refilled, when the composition of the residual gas approached that of the atmospheric air. The mercury troughs were placed outside a window on the south front of the laboratory, fully exposed to the sunshine, the latter being recorded by a Jordan's instrument. The experiment extended over 24 weeks, from the latter part of April to the beginning of October last, the total amount of bright sunshine during that period being about 680 hours, and the mean temperature during daytime 19·8deg. C. The results of the experiments were graphically represented.

According to some experiments with spheres made from guttapercha obtained by Sérullas's and my own process respectively, there is practically no difference between the two as regards absorption of oxygen.

Behaviour Towards Ozone.

The ready absorption of oxygen by guttapercha would lead one to expect that it would also be particularly susceptible to ozone, which, as is well known, attacks caoutchouc very energetically. Contrary to what has repeatedly been asserted, such, however, is not the case. On this board are mounted a number of strips of guttapercha, representing the different brands of this material, and also strips of guttapercha from leaves and of balata. Each of these strips has been subjected to a continuous stream of ozonised oxygen gas for three consecutive hours, and the places where the gas has played on the strips are marked by white lines; but, even if you examine them closely, you can only detect a slight shiny patch on some of them, for instance, on the strip made of Bagan goolie soondie and on that of balata, and a little roughness on others, for instance, the three best kinds, Pahang, Banjer, and Bulongan. But even when in the form of thin tissue, guttapercha is hardly affected, as I will show you by an experiment. Through this Siemens ozoniser I shall pass a current of oxygen from that steel cylinder, and I will then start the induction coil. The oxygen issuing from the apparatus through this glass nozzle is strongly ozonised, as you will, I think, presently notice from the peculiar smell it imparts to the air. In the stream of ozonised gas I hold the thin tissue stretched over a frame, and although I expose it for over a minute, you cannot observe any action on it. I repeat the experiment with a membrane of pure para-caoutchouc similarly stretched over a frame, and you observe that a few seconds suffice to pierce it, as if it were mechanically injured. But I can show you the marked difference in the behaviour of these two materials towards ozone in yet another way. Here is a glass tube, enclosing a piece of guttapercha tubing, and I pass ozonised air for a considerable time into the tube, but, as you observe, no visible effect results. Another glass tube, containing a piece of grey vulcanised rubber tubing, will now be connected to the ozone apparatus, and a few minutes will suffice to produce numerous cracks on the surface, and when I take it out you will observe that the rubber has been very much affected.

Deterioration and Preservation.

The principal cause of the destruction of guttapercha is the absorption of atmospheric oxygen, which alters the gutta and produces a brittle resin of quite a different nature to that originally present in the material. This destructive oxidation is greatly assisted by light, as we have seen, and also by other causes; for instance, by any action tending to make the material porous, such as alternate wetness and dryness, the presence of substances which exercise a solvent action on guttapercha as a whole, or any of its components, etc. Certain alkaline substances and decaying organic matters also appear to act injuriously, but it is not infrequently quite impossible to assign a definite cause for the local decay observed. I have here a collection of short lengths of guttapercha-covered wires, which had been used for street work, and now show numerous places where the guttapercha covering has become defective. These wires have been kindly sent me by Mr. Preece, of the Postal Telegraph Department.

It is, however, not merely manufactured guttapercha which undergoes these destructive changes; for raw material of the very best kind succumbs in course of time to the combined action of air and light, as you will see from these pieces, which have been in our showroom for a great number of years fully exposed to air and light, and are now completely resinified. They were originally of excellent quality, none of them containing more than 20 per cent. of natural resin.

The observation made during the experiments on the absorption of oxygen—viz., that the Soondie varieties of guttapercha, when exposed to light, are particularly prone to oxidation, is borne out by another experience. Here are some pieces of "Getah Sundek" from Payena Leerii, presented to Kew Gardens by Sir Hugh Low in 1883, and which were in perfect condition when I saw them there in 1885. They are now quite resinified and yellow on the surface, owing to the exposure to diffused light in the museum. I have here another piece of exactly the same material given to us by the director of Kew Gardens in 1885, which has since been kept wrapped up in tinfoil, and you observe it has retained its original colour and freshness, showing no signs of oxidation.

Another and still better example showing the beneficial effect of protection from light is Lobb's specimen of guttapercha, to which I referred in my first lecture. In spite of its great age (over 50 years) it is still in an excellent state of preservation, because it was sheltered from light in the cupboard of the Kew Herbarium. Again, Oxley's "guttapercha cover," which I also

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showed you a fortnight ago, exhibits a well-preserved patch where it was formerly covered by a label.

Besides protecting guttapercha from light, it should, if possible, be also protected from air. This is the case when it is completely immersed in water, and in that respect submarine cores are more safely placed than subterranean wires.

Another way of excluding the air to some extent is to varnish the guttapercha articles, and this method is resorted to by the War Office, for instance, in connection with the gun impressions, which have to be kept for reference.

For specimens of value, particularly those kept in museums, which may be required for analysis after a number of years, I venture to propose the use of a 4 per cent. solution of formaldehyde, which does not appear to affect the material, and is otherwise an excellent preservative, but my experience with that material is perhaps too limited to fully justify my doing so, and this must therefore be considered as a suggestion merely.

When guttapercha is oxidised it becomes porous and full of cracks. If it is used for insulating wires the insulation fails at such places, since the moisture penetrates the pores and fissures, and establishes an electric contact with the conducting wire.

A sound piece of core can be bent backwards and forwards at will without sustaining any injury, but if an oxidised piece, like this I have here, be taken, it breaks immediately when bent. But I can show you a still more typical example of the decay of the material by oxidation. On this board there is an old gun impression, given to me at the Royal Arsenal. From a distance it looks the same as the others standing by its side; but when I give it a blow with my fist it is shattered to pieces like a sheet of glass. I could hit the sound impressions as hard as I liked without in the least injuring them.

Artificial Substitutes.

In my last lecture I explained what I meant by natural substitutes, and I told you that I only knew of one material which deserved that name—viz., balata.

With artificial substitutes the case is different, at least if we are to include under that name all materials now used in place of guttapercha in any of its former applications. Of such there is quite a number in existence under various names—*e.g.*, celluloid, xylonite, ebonite, stabilit, ambroïn, etc.—of which I cannot do more than mention the names to-night. I think, however, that a material which would really deserve the name of a substitute for guttapercha should be able to replace it to some extent in its principal application—*i.e.*, the insulation of electrical conductors.

A material professing to fulfil this stipulation is the gutta Française proposed by Mons. E. Mourlot, of Paris, in 1878, and of which at the time very favourable reports were given by the Press. It is prepared from the bark of the birch tree by distillation, and its price was given as 2·50fr. per kilogramme. The material was said to improve guttapercha when mixed with it, making it more durable in air, and also securing it against the attacks of rats in underground conduits. In this connection I may perhaps call your attention to an interesting object which Mr. Hookey kindly lent me—viz., the skeleton of a rat found entangled in some guttapercha-covered wires belonging to the Postal Telegraph Department.

I have a large sample of gutta Française here, and also some mixtures of this material with guttapercha, and I will now show you that they, like guttapercha, become soft and plastic in hot water. Our experience with the French substitute has not been very favourable, as we have found that if any appreciable quantity of it is added to guttapercha it makes the latter coarse and brittle, and also unfavourably affects its electrical properties.

The latest substitute for guttapercha, of which samples, sent me only a day or two ago, are mounted on that board, is called Velvril, a compound of collodion cotton and nitrated castor or linseed oil. This material is said to be quite durable when exposed to the inclemencies of weather, and to be waterproof. In the process of manufacture, the velvril paste is moulded like guttapercha, but it afterwards hardens and cannot then be softened by heat alone. Cord can be made by squirting the paste through a die, and it has been proposed to use this substance as an insulating covering for wires in place of guttapercha. Mr. Walter Reid has promised to send me a sample of insulated wire for testing, and it remains to be seen whether the results of the electrical tests are satisfactory.

Some compounds containing guttapercha are very useful for different purposes, and a specially useful one, consisting of a mixture of guttapercha, colophony, and Stockholm tar, is known under the name of Chatterton's compound. It is largely used in connection with the manufacture of guttapercha-covered wires, as a binding material between the copper conductor and the guttapercha covering, or between the different layers of guttapercha on the core.

A compound consisting of equal parts of guttapercha, resin, and coal-tar was proposed in 1847 by Surgeon Little to Dr. Oxley, as a useful cement for various purposes.

Concluding Remarks.

I have now reached the end of my long programme, and must, I am afraid, plead guilty to having considerably exceeded the limits of the time allotted to these lectures; for this I now offer you my apologies. When it was first arranged that I should deliver this course of lectures on guttapercha, and I was asked to decide about their number, I had some misgivings whether I should find sufficient material for three. Whilst preparing them, however, the subjects which appeared to merit attention multiplied to such an alarming extent that I had ultimately to contend with the reverse difficulty—viz., that of *l'embarras de richesse*. I have endeavoured as far as I could to do justice to other inventors and investigators, and any omissions in that respect I beg you not to attribute to want of appreciation, but solely to lack of time.

Some of the tables, to which I have only briefly referred, will be given in the appendix, and you can then refer to them at your leisure; but there will be a limit even in that respect, and I shall have to postpone any further remarks to a future occasion. I would have liked particularly to refer more fully to the various analyses and other researches, which were here described for the first time.

I have mentioned the various application of guttapercha in the arts and manufactures in the course of this lecture, and I thought that a production demonstrating the suitability of this substance to works of art would form an appropriate conclusion to our subject.

I have here a panel made to my design by my old friend, Mr. Theodore Scheerer, chief of the modelling department at the Royal Iron Foundry at Wasseralfingen, in Wurtemburg. On the panel are the portraits of Sir William Hooker and Dr. Werner von Siemens *en bas relief*, modelled in red-coloured guttapercha and enclosed in appropriate frame. Guttapercha, made plastic by heat, was laid on zinc plates bit by bit and worked over with heated modelling tools. Of course my friend, who had never used this material before, had first to accustom himself to it, but the results show how thoroughly he finally mastered all difficulties.

On the top of the frame in the centre you observe a full-size representation of the flowering branch of the Isonandra gutta, described by Hooker in 1847, and in the corners are enlarged reproductions of the flower and fruit. At the side there are leaves of the Isonandra partially overlapping each other, and there are other designs in leaves and flowers on the bottom part of the frame. All these are modelled from guttapercha of its natural brown colour. Between the two portraits is an actual piece of the first submarine core laid across the English Channel in 1850, and manufactured by the Gutta Percha Company. In the left-hand bottom corner there is a section of the first Atlantic cable, manufactured by Messrs. Glass, Elliott, and Co. in 1857, and in the right-hand corner one of the last cables laid across the Atlantic Ocean—viz., the third one manufactured in 1894 for the Commercial Cable Company by Messrs. Siemens Bros. and Co.

Note.—In conclusion, the lecturer expressed his indebtedness to Mr. Carl von Siemens, the chairman, and Mr. Alexander Siemens, the managing director of Messrs. Siemens Bros. and Co., for kindly allowing him to bring the subject before the society, and enabling him to make the lecture attractive by numerous objects and specimens from their works at Woolwich. Dr. Obach also expressed his sincere thanks to the following gentlemen and firms for their valuable assistance, the loan of interesting exhibits, etc.—viz.: the director of the Royal Gardens, Kew, Dr. W. T. Thistleton-Dyer; the keeper and assistant keeper of museums at Kew, Messrs. J. R. Jackson and J. M. Hillier; the assistant keeper of the Herbarium at Kew, Mr. W. B. Hemsley; the director and assistant director of the Colonial Museum at Haarlem, Mr. F. W. van Eeden and Dr. M. Greshoff; the directors of the Botanic Gardens at Singapore and Buitenzorg, Mr. H. N. Ridley and Dr. M. Treub, and the director of the Pharmaceutical Institute at Berne, Prof. A. Tschirch; the curator of the Botanical Museum at Berlin, Prof. K. Schumann, and also Prof. E. Sérullas, of Paris; the director-general of ordnance factories and his first military assistant, Sir William Anderson, and Comm. B. H. Chevallier, R.N.; the engineer-in-chief of the Postal Telegraph Department and the assistant engineer, Messrs. W. H. Preece and J. Hookey; the council of the Institution of Electrical Engineers and the late secretary, Mr. F. H. Webb; the director of the Gutta Percha Company, Mr. Willoughby Smith; and Messrs. R. and J. Dick, of Glasgow, and H. Rost and Co., of Hamburg; Messrs. Behn, Meyer, and Co., of Singapore, particularly their Mr. H. Dittmar and Mr. L. Hüls, also Mr. C. P. Robertson Glasgow, of Singapore; Mr. C. Sachs, of the British Museum; Messrs. G. P. Simpson, G. Hume, and A. R. Brooks, of London, and Mr. Th. Scheerer, of Wasseralfingen; his colleagues, Messrs. W. Dieselhorst, P. Estler, and C. Hager; his assistants, Messrs. W. Eichenauer, A. Smith, and P. A. Gysi, C. F. Smith, K. Weathers, T. Crockford, and F. Martin.

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ELECTRICAL FIRE RULES.

When making regulations for diminishing fire risks the insurance companies have a mass of information at their disposal which is more or less in an undigested state. Experts after a disastrous fire cannot as a rule determine what actually started the conflagration, and hence the opinions expressed are only conjectures. Other cases in which the fire is checked in its earlier stages afford much valuable information as to the causes, and in such cases careful classification by experts would be of great value. In the United States this classification is carried out by a joint board of underwriters, and the results, as we have noted before, show most clearly that fires caused by electricity are entirely preventable. A similar issue of joint reports on fires would be of great service to our English fire insurance companies. At present each company has its own experts with their own opinions, and the result is that uniformity in regulations is not obtained. The Liverpool and London and Globe Insurance Company has of late years devoted great attention to its electrical rules, and has now issued a series of supplementary rules about what are called special risks. Under this heading are included warehouses for the storage of produce, corn, textile, and oil mills, theatres and music halls, and, lastly, electricity works. These works would, we believe, not have been included had it not been for the fires which have occurred in the older stations, in the design of which fire risks were not duly considered. Even now the company only suggests details which tend to diminish these risks, and does not firmly say that the details must be adopted. Nearly all these suggestions deal with the switchboards, and the first advises that: "It should be locally possible to entirely disconnect all current at the main switchboard in the event of a fire starting at the board. Current from generators within the station can, of course, be disconnected by stopping the generators; current from accumulators or from distant stations should first be brought to switches at a separate simple sub-board, and thence to the main board." The above idea is good, but the method of carrying it out cumbersome. The fire would have time to get a firm hold before the machinery could be stopped, whereas the disconnection of all exciting circuits would give the same effect in much less time. The other suggestions, such as the spacing of contacts beyond arcing distance and the reduction of conductors behind the switchboard, are good, but the company's experts must remember that the term "arcing distance" is a most indefinite one. The factor of length is often of much less importance in the question of maintaining an arc than the arrangement of cooling surfaces round the path of the arc. One of the suggestions we do not agree with. This is to the effect that if gas is used for "emergency" lighting, then no metal gas-pipe should be at the back of any switchboard, nor within twelve inches of any conductor. By all means do not have gas-pipes in amongst switchboard conductors; but is this more dangerous than having an iron-framed switchboard, or iron rods

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to support the conductors, as advised? Again, is it not equivalent to saying that no conductor in the station shall be placed within twelve inches of the iron frames of the dynamos, or at least equivalent as regards risk. Another point we should like to see raised is the use of wood or other moisture-absorbing insulation around conductors in places of special risk. Thus we find the company advising the use of asbestos sheeting as an insulation for theatrical purposes in spite of the fact that asbestos, when wet, does not insulate, and almost falls to pieces. Still, on the whole, the regulations are such as are dictated by common sense, and they will be of great service in special cases.

THE TELEPHONE QUESTION.

The policy of the Government on the telephone question will not be decided till Parliament meets again, but in the meanwhile there are signs that then a quick decision must be come to. Thus Mr. P. G. Burrell, on behalf of the Postmaster-General, has written to the town clerk of Glasgow the following letter: "With reference to the Department's letter of the 16th inst., and to previous correspondence, I am directed by the Postmaster-General to acquaint you, for the information of the Corporation of Glasgow, that his Grace will be prepared to give the Corporation a license for a telephone exchange on their securing from Parliament the requisite powers for working an exchange system. I am to add that it will be a condition of the license that it will expire on Dec. 31, 1911." The Telephone Committee will accordingly apply for the necessary powers, and after the Select Committee's report there is no doubt but that Parliament will either grant the request, or, better still, order the Post Office to carry out the work of establishing a competitive exchange without delay.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

MAGNETIC DISTURBANCES.

SIR,—Will you permit me to correct one sentence of your report of my remarks at the British Association at Bristol on the "Magnetic Disturbances Caused by Electric Tramways and Railways"?

Your reporter makes me say "he considered that the polyphase system, such as was now being used in Switzerland, at Lugano, and up the Jungfrau, was a much better one than the direct-current system, as far as magnetic disturbances were concerned, if earth returns were not employed." Three corrections are needed to make this represent my contention: (1) the words "for heavy electric railroads" should be inserted, seeing that it was for them that I advocated the use of three-phase currents; (2) the "not" in the last sentence should be deleted, for I recommended three-phase systems only in those cases where an earth return *is* employed, as is, indeed, the case at Lugano, on the Gorner Grat, and on the Jungfrau Railway; (3) the phrase "as far as magnetic disturbances were concerned" is a useless limitation, seeing that in all cases where alternating currents are used electrolytic disturbances as well as magnetic disturbances, such as arise from the use of continuous currents with an earthed return, are eliminated. As it stands, the sentence which you credit to me is diametrically opposed to my views. If earth returns are *not* employed, the use of a three-phase system would involve *three* trolley lines or their equivalent. A single-trolley line is bad enough, except in a tunnel; a double-trolley line is very little worse; but a triple-trolley line no one has ever proposed. I consider it much worse, not "much better."—Yours, etc., SILVANUS P. THOMPSON.

London, Sept. 24, 1898.

ELECTRIC DISTRIBUTION OF POWER.

SIR,—Before I read Mr. Alexander Siemens's paper in your number of the 16th inst. I had always thought it *the* advantantage of electric motors that they were so specially suitable for driving separate machines or *small* groups of machines which do *not* work all day long, because no power is absorbed by this method, when the machine does not work, by shafting and gearing. But from the above paper it would seem that the very reverse is true, as it distinctly states that driving by electricity can only be used economically where the load is fairly constantly applied.

I now feel doubtful what would be the best in our works, where in the principal room we have three long lines of main shafting. Some of the machines driven from them only work for a few hours every day, so that I had considered it economical to couple those machines to separate motors so as to do away with the main shafting, but from the above paper this would seem to be a wrong plan.

According to it I should do best, I believe, by coupling each *entire* main shaft to a separate motor (as the load on any one main shaft, *as a whole*, will be fairly constant). But in that arrangement I can see very little or no advantage, for as long as the main shafts themselves must remain there can be very little gained in only altering the manner of moving them.

Must I then conclude that driving by electricity would be unsuitable in such case?

Of course, I am only arguing: "Suppose I had to rebuild the works, how should I make this then," for with all the shafting, etc., in place, as it is now, it would not pay to make such alterations.—Yours, etc., R.

ON THE DETERMINATION OF THE STATE OF IONISATION IN DILUTE AQUEOUS SOLUTIONS CONTAINING TWO ELECTROLYTES.*

BY PROF. J. G. MACGREGOR, DALHOUSIE COLLEGE, HALIFAX, N.S.

In the report of last year methods were described of determining the ionisation coefficients in solutions containing two electrolytes, with or without a common ion, and with no mutual chemical action other than double decomposition; and a statement was given of tests of accuracy which had been applied to the coefficients thus obtained by the employment of them for the calculation of the conductivity of the solutions. Since that date other tests have been applied by students in my laboratory as follows: E. H. Archibald has shown that the conductivity of solutions containing K_2SO_4 and Na_2SO_4 can be calculated within the limits of experimental error up to a total concentration of about 1 gr.-eq. per 1. T. C. McKay has obtained the same result for solutions containing $BaCl_2$ and NaCl. Archibald has completed his observations (referred to last year) on the conductivity of solutions containing NaCl and K_2SO_4 (and therefore also KCl and Na_2SO_4), and they show that the conductivity is similarly calculable up to a total concentration of about 0·5. Archibald has also shown that if the variation with concentration of the surface tension and specific gravity of simple solutions of K_2SO_4 and Na_2SO_4 be known, the surface tension and specific gravity of mixtures up to concentrations of about 1 and 0·5 respectively can be calculated, the method employed being that of my paper in the *Phil. Mag.*, vol. 44, and that with similar data as to the specific gravity of NaCl, KCl, Na_2SO_4, and K_2SO_4 solutions, the specific gravity of solutions containing all these salts up to a concentration of about 0·3 is calculable. It should be

*Abstract of paper read before the British Association at Bristol.

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noted also that calculations made by the aid of these coefficients, on the assumption that no double salt exists in solution of the conductivity and specific gravity of mixtures of K_2SO_4 and $CuSO_4$ solutions (Archibald), and of the conductivity of mixtures of K_2SO_4 and $MgSO_4$ solutions (McKay), have been found not to agree with observation, except at much lower concentrations than the above, a fact which is probably connected with the formation of double salts by these substances. The limit of experimental error in the above observations was about 0 25, 0·1, and 0 005 per cent. for conductivity, surface tension, and specific gravity respectively. For accounts of the experiments see current volumes of *Trans.* Roy. Soc. Can. and *Trans.* N.S. Inst. Sci.

Schrader, in his "Elektrolyse von Gemischen" (Berlin, 1897), has tried to determine the ionisation coefficients in mixtures of electrolytes with a common ion by means of electrolytic measurements, using expressions for the coefficients in terms of the conductivity of the mixture, the amounts of the distinctive ions transferred by the current and the Hittorf's transference numbers for these ions. He requires, however, to make a necessarily doubtful assumption as to the relation between the transference numbers in the mixtures and in simple solutions; and some of the quantities involved in his expression for the coefficients are incapable of exact measurement. We cannot, of course, test his values by calculating the conductivity of his mixtures. But if N_1, N_2 are their concentrations with respect to the two electrolytes, and V_1, V_2 the dilutions of their isohydric constituents, his coefficients (a_1, a_2) should satisfy the equations: $a_1/V_1 = a_2/V_2$, and $N_1V_1 + N_2V_2 = 1$ (see last year's paper). Inserting his values of the a's and N's, we may then find the V's and the corresponding a/V's. The a/V's corresponding to the V's thus found may also be obtained with great accuracy from Kohlrausch's and Archibald's observations of conductivity on the assumption that no double molecules are formed in solution, and that both the H's of H_2SO_4 act as cations. When Schrader's results are thus tested, his a/V's are found to be in error in the case of solutions containing KI and KCl by from 1 to 10 per cent., and in the case of solutions containing H_2SO_4 and $CuSO_4$ by from 3·6 to 60 per cent. In the former case the discrepancy is not greater than might be expected from the defects of the method. In the latter it is; and this result is interesting, as it is difficult to account for so great a discrepancy except by the assumption of the existence of molecules of the acid sulphate in solution.

ON THE RELATIONS BETWEEN THE VARIATIONS IN THE EARTH CURRENTS, THE ELECTRIC CURRENTS FROM THE ATMOSPHERE, AND THE MAGNETIC PERTURBATIONS.*

BY SELIM LEMSTRÖM.

The paper contains an historical sketch of the observations and researches made on the earth currents by Lamont, Airy, Wild, Blavier, and others. The author describes the method employed by him for measuring the E M.F. of the electric currents coming from the atmosphere, and gives the evidence of the fact that the variations of earth currents occur a short time (five minutes) before the magnetic perturbations, and that the former are more numerous than the latter. From the observations in Sodankyla it is, however, proved that all magnetic perturbations are not preceded by variations in the earth currents, but that these probably are caused by electrical currents from the atmosphere to the earth, or *vice versâ*.

The proofs of that conclusion are: (1) that the magnetic perturbations in polar regions have a contrary direction to those in more southern countries; (2) that at the times of auroras the electrical current from the atmosphere varies much, and must exert on magnetic instruments a marked influence, depending on their position relative to the space within which this current is moving. It follows from this that we cannot find the causes of the magnetic variations, or, rather, perturbations, before we have investigated the earth currents and the electrical currents in the atmosphere.

The author's experience shows that we must seek the key to these relations in the polar regions. Researches have shown that the magnitute of these variations of the earth currents increases with the latitude in a very high ratio. When the diurnal variation in Pawlowsk has a value of 0·0008 volt, it rises in Sodankyla (7deg. more to the north) to 0·06, or 75 times. Moreover, we find from the lately published third volume of the observations from the international polar stations at Sodankyla and Kuttala that the earth currents as well as the electric currents in the atmosphere depend intimately on the belt of the maximum polar light. It will be very clearly seen that we also have a maximum belt of the earth currents and even of the currents in the atmosphere. The paper finishes with a proposition that the International Conference on Terrestrial Magnetism and Atmospheric Electricity should discuss the two following questions: What signification must be attributed to the earth currents and the electric current from the atmosphere in the explanation of the causes of magnetic perturbations? What is to be done for the further investigation of the connection between the magnetic perturbations and the electric currents?

The author also proposes that the International Conference should take steps for establishing two international polar stations, one in the North of America, the other in the North of Europe, both situated in the southern border of the polar light maximum belt. In connection with both these principal stations there should be a northern by-station, in which, as well as in the principal stations, all the magnetic variations, the earth currents, and the electric currents from the atmosphere, besides all meterological observacions, should be made simultaneously, and with self-registering apparatus of the best construction, the details of which ought to be stated by the International Conference.

In connection with these observations it ought to be expressed as desirable that all magnetic observatories should, if possible, establish similar observations with as identical instruments as possible. Since the researches of the electric currents from the atmosphere require points elevated about 400m., it seems difficult to unite these observations with those in an observatory We, however, must remember that the electrical resistance in the circuit, from the earth to the atmosphere, is so great that one can put in several miles of wire without any sensible augmentation of it. It is well understood that the mountain on which an apparatus for out- or in-streaming of electricity is placed can without serious damage be far away from the observatory.

* Abstract of a paper read before the Conference on Terrestrial Magnetism at Bristol.

RAIL CONTACTS.

Mr. Robert Burns has devised the novel type of rail contact for signalling illustrated below. The idea seems to be a good one, as the brushes in the positions shown are not subjected to any shock in the longitudinal direction. We believe that wire brushes have been tried before for a similar purpose, but that they failed because they were placed on the train and made to rub against a fixed contact on the track. The only thing in the Burns contact arrangement which may give trouble appears to us to be in the skin resistance of the wheel surface. If the wheels get covered with a hard layer of oxide, the electrical connection will not be reliable. Still, we are assured that the "wire brush contact" has been tested on the Great Northern Railway at Finsbury Park Station, and has acted perfectly during rain, frost, and snow. An average of more than 200 trains per diem have passed over it in the six months during which it has been fixed—a total of more than 40,000 trains. The inventor also states that the brushes show no sign of injury, but stand up to their work as perfectly as when they were new.

In the illustration, A is the wire brush which conveys the electric current from insulated attachment, B, to portion of a wheel, C, of a locomotive or vehicle. The flange of this wheel bridges the gap between the brush and the rail, and completes the circuit through the rail to earth.

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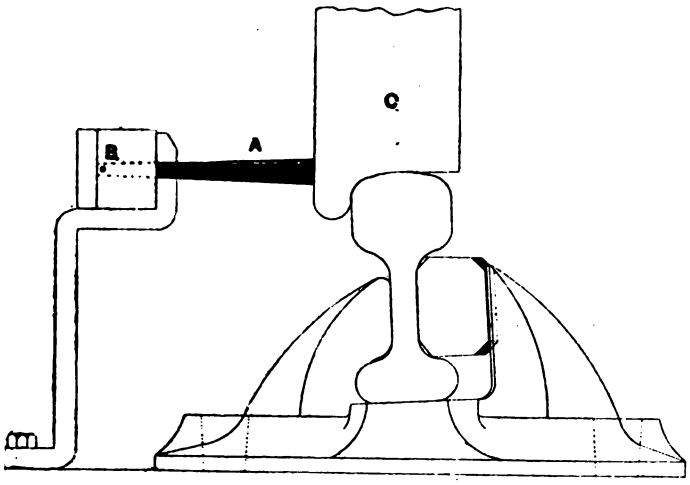
The use of rail contacts for railway signalling purposes is becoming more common, as such contacts are required for many automatic blocking operations. With the Burns brush contacts the length of the duration of the connection



is increased by using a number of brushes at intervals along the line.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.C.E.

LECTURE I.

The subject about which I have been announced to speak to you to-night is a very wide one, and you will understand that it is impossible in the short time allotted to cover anything but a very small area of the field of electric traction, and that it will be necessary to confine ourselves to some special branch of it. I propose, then, to direct your attention to some principles connected with the subject of the direct-current motor in its application to electric traction.

The old ideas that we used to have of the treatment of this subject are proving to be inapplicable to the solution of many problems that are now pressing upon the electrical engineer. If, for instance, you were to ask those who are designing the electrical equipment of the Central London Railway which is now being made from the west to the east of London, they would tell you that there were problems in connection with that enterprise which had not hitherto presented themselves for solution to electrical engineers. These problems are almost entirely connected with the motor element of the electrical equipment, and it is to them that I propose more particularly to direct your attention in the following lectures.

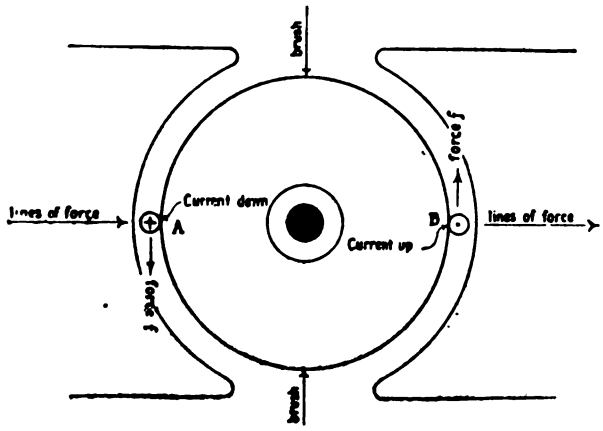


FIG. 1.

Although I have been announced to speak on the subject of electric traction, the first thing I am going to do is to ask you to consider the electric motor in a state of rest. This may appear to be unreasonable, but we are too much accustomed to consider the motor as being always in a state of motion, and the reason why I am going to confine my remarks to-night entirely to the motor in a state of rest is because a solution of the problems to which I have referred can be arrived at only by a thorough knowledge of what is going on in an electric motor when it is at rest. If we can understand what is taking place in an electric motor when it is at rest, it will be easy to understand its action when it is in motion.

At the risk of going over ground that must be familiar to many present, I propose to describe briefly the relation between the armature and the magnets of a motor. Here I have a direct-current motor, made by the Crocker-Wheeler Company, of Ampere, in New Jersey, and kindly lent me by the General Electric Company. This particular motor is not designed for electric traction, but I need not say that the principles on which it acts are identical with those that are so designed. Now, in the electric motor we have the two parts—the armature and the magnets. Let us briefly notice what takes place. Suppose that Fig. 1 represents a section of an armature and pole-pieces, taken at right angles to the shaft. All round the armature there lie a number of wires parallel to the shaft, which are called surface conductors, because they lie on the surface, being thus distinguished from those that lie inside the armature, and are of no use for producing force. Suppose that A and B represent two of these conductors lying on each side of the armature. When a current passes through the motor we have current passing in one direction on one side of the armature and on the other side in the opposite direction, as shown by the cross at A and the dot at B. When we send a current through the magnets we get lines of force through the magnetic circuit of the motor, the direction of which is indicated by arrows in the figure. The result is that we have a force on the wires, the direction of which is shown in the figure. Now on the other side of the armature the current is in the opposite direction, so that the mechanical force on the wire is reversed. We have thus a twist or torque tending to turn the armature to which the conductors are fixed.

To illustrate what I have been saying, I am going, firstly, to magnetise the magnets by passing a current through the shunt winding. These magnets are now strongly excited, and the lines of force are passing through the magnetic circuit. Now I am going to pass a current through the armature, and the current will be indicated on this ammeter. This is a Weston ammeter with an illuminated dial, kindly lent by Messrs. Elliott Bros. It is calibrated up to 15 amperes, and measures the current passing in the armature of the motor.

This spring balance is attached to a cord passing round this wooden pulley, which is keyed on to the shaft, so that we can measure the force. We have now got a current of five amperes passing in the armature, and we have a pull on the balance of 16lb. Here, then, we have the very simplest illustration of the twisting force produced by a current when it passes through the conductors of an armature in the presence of a magnetic field.

Now there are two elements which go to make up the force which we have here measured; the one is the current in the armature and the other is the magnetic field. Suppose that we write T for the pull on the spring balance, then we see that T varies in the first place as C, the current in the armature—that is to say, supposing we have a magnetic field of constant strength, and pass a current through the armature of gradually increasing amount, we should see this scale gradually pulled further down, indicating a gradually increasing pull.

On the other hand, we see also that if we keep the current in the armature constant, and vary the strength of the magnetic field, we find exactly the same effect as before—that is to say, the balance would be pulled down exactly in proportion as we increased the strength of the field. Now, for the present, I am going to express the strength of the field by the letter M, so that we may say that T varies as the product of C M, where C represents what is varying in the armature, and M represents what is varying in the magnets.

I want to say a few words about this quantity M. I have spoken of it briefly as representing the strength of the magnets, but we have to be very much more precise of course than that, and we must enquire more exactly what this quantity M represents.

It is always a help to give a thing a name, and we will call M the induction factor of the motor. Now the induction factor can be expressed by a very simple formula—namely:

$$M = p\,A\,N\,10^{-8}$$

This is a very easy formula to remember, and we shall find it very useful.

In the first place, A represents the number of conductors on the surface of the armature—that is to say, if we take this armature out of its place, and take off all the wrapping surrounding it, and find how many conductors there are lying on the outside surface of the armature, this would give us what we call A, the number of surface conductors. In this machine the number of surface conductors is very easily found, because there are 32 slots cut in this armature, and in each one of those slots there are 32 conductors, making in all 1,024 surface conductors, so that for this particular dynamo A is 1,024. We are sometimes liable to be misled in counting the number of conductors, because the conductors are sometimes arranged in parallel with one another, and two may only serve actually as one conductor, so that we have to be careful in counting the number of conductors round the surface of the armature not to count as two conductors two wires which are really simply acting as one. In this case each one of these 32 conductors in each of these 32 slots is carrying half of the whole current that

* Cantor lectures, delivered before the Society of Arts.

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goes through the armature, so that we know that we are not making a mistake.

The quantity p that I have written down depends upon the way in which the armature is wound. In the case of a machine with two poles p is unity, and in every bipolar machine p must be unity; but when you come to four poles, p may be one or it may be two, according to the way the armature is wound, whether in series or in parallel. Generally, we may define p as being the ratio of the number of surface conductors in series between the main terminals of the machine to the number of surface conductors lying between two adjacent neutral points. It is obvious that in a two-pole machine this ratio must be unity, but in a four-pole machine it may be two or may be one, according to the way the armature is connected.

The quantity N is of an essentially different nature to either of the two quantities A or p, since these are fixed for any given machine, and cannot be altered—that is to say, you cannot alter the number of surface conductors on a machine, and you cannot alter the way the armature is connected up. But N is not a fixed quantity, since it is the number of useful lines of force which enter the armature from any one pole, and consequently we are able to make N vary as we please by varying the current passing round the magnets.

Let us take this motor and see if we can calculate M roughly from the equation I have given you. Here we have $p=1$, and $A=1,024$. What is N for this machine? How many useful lines of force are there per pole? We know that the number of lines of force per pole, passing across the air-gap from the pole into an armature of a machine of this kind, must be somewhere about 4,000 to 5,000 lines per square centimetre; let us say 4,500. I have measured the area roughly, and find it to be about 8cm. this way and 17cm. that way, giving us about 136 square centimetres; multiplying this by the 4,500 lines per square centimetre, we get 610,000 as a rough estimate of the number of lines per pole. Hence we find the value of M to be 6·2—that is to say, this quantity that I call the induction factor has in this particular motor a value, roughly, of about 6. We shall find that the induction factor will form the basis of all our calculations about the action of a motor in electric traction, and it is absolutely necessary to have some such factor as this in our minds when we are talking about a motor. When you tell me that a motor has an induction factor of 6, I can tell you exactly what that motor will do under any conditions.

Hitherto I have attempted simply to calculate the value of M, assuming a certain value for the number of useful lines per pole. Let us see how we can measure this quantity M. One of the simplest ways of doing this is to measure mechanically the pull produced by a given current. We can then find M by a very simple formula which I will give you.

Suppose that t represents the twist or torque on the shaft in inch-pounds. Then if the motor has an induction factor of M, and the armature is carrying a current of C amperes, the torque in inch-pounds on the shaft of the armature is given by

$$t=1{\cdot}41\,C\,M.$$

We can use this formula in two ways; we can either take M as known and find the torque for a given current, or measure t and find M. We will suppose that we do not know what M is, and find M by measuring the torque for a given current. You will notice that the torque of which I am speaking is simply the pull indicated on the balance, multiplied by the radius of the pulley round which this cord is passing. In this case the diameter of the pulley is 5½in., so that the radius is 2·75in., and we have simply to multiply the pull as indicated on the scale by 2·75 to give the torque. We must be careful to notice that we get a small indication on the scale without any current in the armature; this is due to the fact that it requires a certain amount of force to turn the armature against the friction of the bearings of the machines and the brushes. There is no current passing now, and in this case it requires nearly 2lb. pull on the balance to turn the armature, so that you see when we want to find exactly how much torque is produced by the current we have to deduct this 2lb. from the pull as indicated on the scale.

I will first of all magnetise the magnets, and then I will send the current through the armature. There is now a current of six amperes passing, and the pull on the scale is 21lb. From this we have to deduct 2lb. for friction, giving us 19lb. as the effort actually produced by the action of the current on the magnetic field. We have to multiply this by 2·75, giving us 52·5 inch-pounds of torque. We have now simply to equate this to 1·41 C M, where M is the unknown quantity and C is six amperes, and we get the value of M, roughly, about 6.

You see this is a very simple way of measuring the induction factor of this machine. It has been done quite roughly, but it shows how it can be done in practice—that is to say, we have here a method of finding the value of M, the induction factor. When once we have determined the value of M for any machine, the number of useful lines of force passing through the armature being constant, we can tell exactly what mechanical effect we shall get from that machine for any given current by multiplying the current by 1·41 times M, thus obtaining the torque in inch-pounds for that current.

The quantity M varies with the number of useful lines of force passing from each pole into the armature. Suppose that we make an experiment, and vary the magnetising current in the magnets, and for each current that we have there passing, observe the pull on the balance, we could then, by the method I have just shown you, measure the value of M for each value of the current in the magnets. We could in that way get a curve, which I shall call the induction curve, such as we have here in Fig. 2. If we set off the values of the magnet current in amperes horizontally, and the value of M vertically, we shall get a curve which you will all recognise as being very much like what is called the characteristic of the machine. Perhaps you say, "Why do you not call it the characteristic of the machine instead of calling it the induction curve"? Well, in the first place, it is not the characteristic, and in the second place it has a great many advantages over what is called the characteristic, as I hope to show later on. You will have noticed that all this time I have assumed that the armature is at rest. Now, when we speak of the characteristic of a machine, we suppose that the machine is running at a certain speed. Hitherto I have said nothing at all about speed, I have considered simply the motor in a state of rest. I want you to understand that this induction curve represents the magnetic condition of the motor in a state of rest. I can obtain the characteristic from the induction curve by simply multiplying the value of M by the number of revolutions per second. The induction curve is the basis of all characteristics, and is entirely independent of speed.

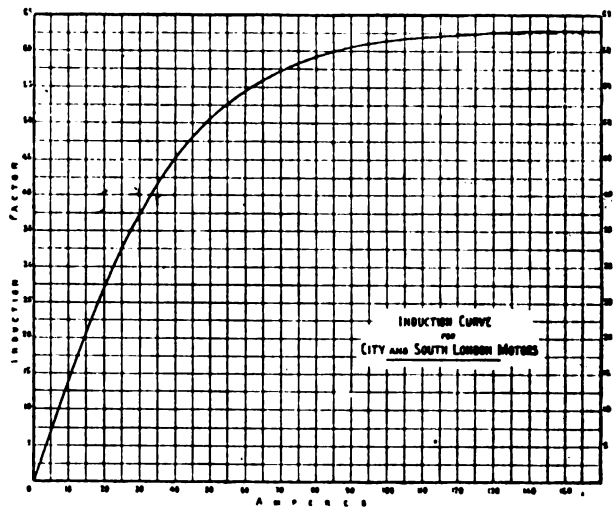

FIG. 2.

The figure I am now showing you on the screen is the induction curve of the motors used on the City and South London Railway. Amperes in the magnets are measured horizontally, and corresponding values of the induction factor vertically. You see that the current in the magnets goes up to 150 amperes, and the value of M increases from nothing to a little over 62. In the motor we have here on the table the magnetisation is produced by what is called a shunt winding—that is to say, that the current through the magnets is entirely independent of that through the armature. In the machine, whose induction curve is given in Fig. 2, the current through the magnets is the same as that which goes through the armature, and this has a very important influence on the mechanical effect produced.

Let us consider what result we should get if we increased the current in the magnets, and observed the value of the torque in a machine of this kind. If we could neglect the reluctance of the iron in the magnetic circuit, the induction curve would be a straight line passing through the origin—*i.e.*, M would be directly proportional to the current. Now, the torque is proportional to the product of M and C, hence the torque would vary as the square of the current. In practice we cannot neglect the reluctance of the iron, and the induction curve therefore bends over, as in Fig. 2, with the result that the torque increases as the square of the current only near the origin. If, however, we could make the iron portion of the magnetic circuit so massive that we could neglect the magnetic reluctance of the iron, the torque would increase as the square of that current. Herein lies the great advantage of using what is called series winding. We shall find that in the design of railway motors, this increase in the torque, due to series winding, is of the greatest value.

It is clearly of the utmost importance to reduce as much as possible the saturation of the iron, because if the value of M does not increase directly with the current, the curve bends over, and the torque does not then increase as the square of the current, but at a very much lower rate. I may illustrate this by the curve in Fig. 2. You see that instead of the induction factor increasing with the current in the magnets, it bends over rapidly. This is entirely due to the saturation of the iron. If

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this motor was going to be used with currents not exceeding 40 amperes, we should find the torque increasing as the square of the current, since up to that point M increases nearly directly as the current. As a matter of fact, this machine is used for currents ranging from about 75 amperes up to about 150 amperes, where you see the induction curve is very nearly horizontal, so that although this motor is series wound, it has none of the advantages of a series-wound motor. That is to say, instead of the torque increasing with the square of the current, it increases only very little more than the first power of the current.

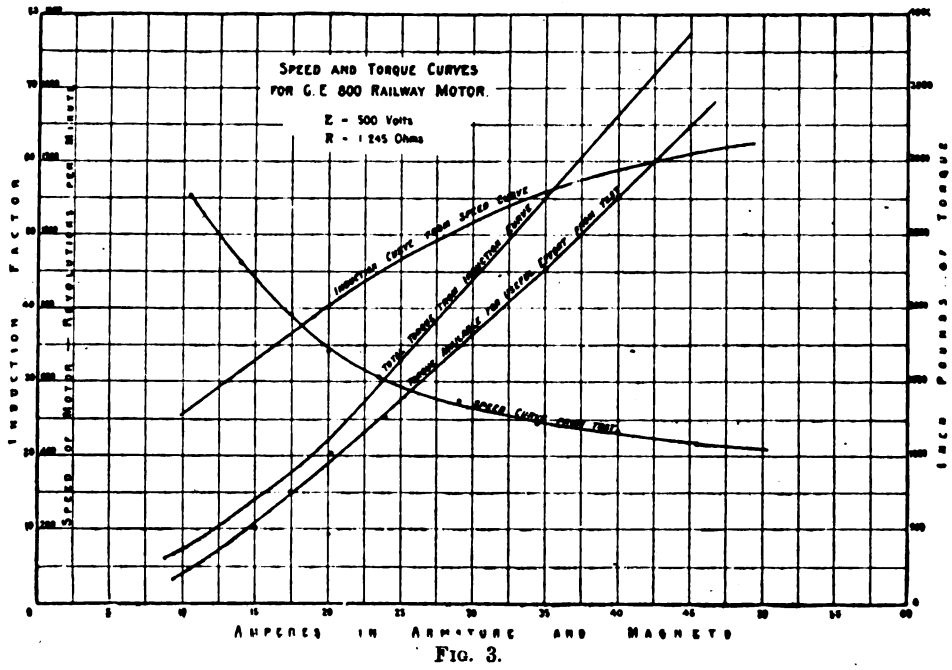

FIG. 3.

In Fig. 3 we have the induction curve of a well-known series-wound motor made by the General Electric Company, and called by them the G.E. 800 railway motor. The induction curve is obtained by a method that I shall describe later, not by the torque method. For a current of 20 amperes in the machine the induction factor is 40, while for a current of 40 amperes the induction factor is nearly 60. The maximum current in this machine is generally about 40 amperes, and the minimum is about 15 amperes. Between those limits the induction curve is fairly straight, though it is beginning to bend over owing to the saturation of the iron. You see that the induction curve is very much more straight between the limits of current through which this machine is being used than the curve in Fig. 2.

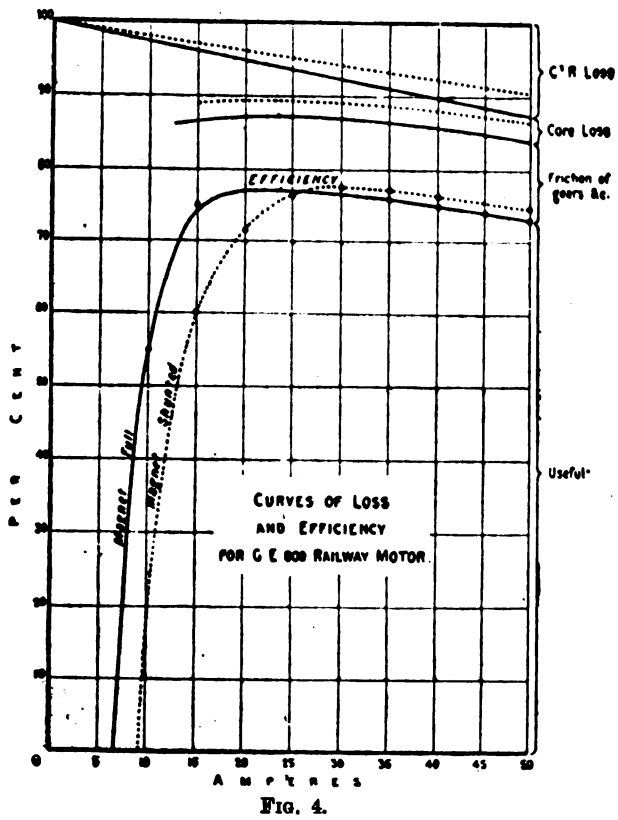

FIG. 4.

From the induction curve I have constructed a torque curve by using the formula giving the torque in terms of C and M—that is to say, I have taken different values of the current and multiplied by 1·41 times M, the corresponding value of the induction factor, and set up vertically a distance representing the number of inch-pounds of torque.

You see that I have here drawn two torque curves—one is the curve of total torque obtained from the induction curve, and the other is a curve which lies a little below it. This second curve is obtained from an actual test of the motor, and represents the number of inch-pounds of torque actually observed on a brake while the motor was running. The small circles in the figure are points of actual observation. You notice that this curve lies below the other curve. What is the meaning of that? It means simply that of the total torque produced by the action of the current on the magnets, and obtained by the equation 1·41 C M, a certain amount is lost in overcoming internal friction, hysteresis, gear loss, etc., so that the ratio of one ordinate to the other, for any given current, represents the mechanical efficiency of the motor for that current.

In Fig. 4 we have the efficiency curves for this motor for any given current, the loss due to the friction of the gears, etc., is set off vertically as a certain percentage of the whole amount of energy supplied to the motor, and you see that each vertical ordinate represents the percentage available for useful effort, after deducting that lost in heating and overcoming frictional and other resistance to motion.

Let us now make a short calculation about this motor; suppose that we take a current of 40 amperes. You see that the value of the induction factor for this current is about 59. If we multiply that by 1·41 times 40, we get a total torque of 3,320 inch-pounds available for all purposes. Now of this amount of torque a certain proportion, 540 inch-pounds, is lost in overcoming friction of gear and bearings, hysteresis, etc., leaving only 2,780 inch-pounds of torque available for useful effort. This gives us the mechanical efficiency, which is equal to 84 per cent. This is a small percentage, but it must be borne in mind that the loss of 540 inch-pounds includes the loss of the gearing, which is considerable, and that in a gearless equipment the percentage loss would be very much less, and the mechanical efficiency might be as high as 94 or 95 per cent. We have thus arrived at the stage at which we can calculate the precise amount of torque produced by a given current in a motor, when we know the number of surface conductors, and the number of useful lines of force passing through the armature. We must now proceed to consider how the torque on the shaft of the motor is communicated to the drawbar of the railway car in actual practice. Referring once more to the action of this motor on the table, it is obvious that it makes no difference whether this cord pulls a weight up vertically or acts against an equal force horizontally. Let us suppose that it acts horizontally — that is to say, that a cord runs off this pulley in a horizontal direction. It is clear that we should have exactly the same dynamical conditions if the end of the cord were fixed and the pulley free to roll along a horizontal rail. The function of the cord is now to ensure that the pulley rolls without slipping. We can effect this equally well by pressing the pulley on the rail. If the resistance to slipping caused by the pressure exceeds the original pull, the cord may be dispensed with, and we then have the conditions of an ordinary railway motor.

(To be continued.)

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

102. In laying out the plant on a direct-current three-wire system, which of the following makes the best and most economical arrangement: (*a*) one steam dynamo of 200 kw. and a balancing transformer; (*b*) two steam dynamos, each 100 kw.; (*c*) a steam engine to give 200 kw. total, two dynamos of 100 kw. being coupled to the engine?—X. Q.

103. In designing an electric light installation, show how you would calculate the size of the mains to allow for a given "drop" at the farthest lamp.—T. F. T.

ANSWERS.

Question No. 96.—How would air-space reluctance be calculated when designing a dynamo with toothed armature core discs? How would the length of the magnetic path through such an armature be determined?

Best Answer to No. 96 (*awarded* 10*s.*).—Several formulæ have been put forward for the calculation of the magnetic resistance of the air-space of toothed armature cores, but all are only approximate. The problem is so complex that practical designers adopt a short and ready method deduced from their own experience. The favourite design of toothed cores is to make the width of tooth equal to the width of slot. A mental conception of the distribution of the majority of magnetic lines is shown in Fig. 1, and attention

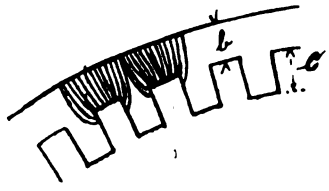

FIG. 1.

is drawn to the lines fringing round into the slots. Prof. S. P. Thompson gives a factor of ·8 for fringing, and if it be assumed that the majority of magnetic lines fringe ·8 of the width of slot—*i.e.*, ·8 of one-half of slot width—on each side of tooth, as shown in Fig. 1, the width of each tooth is *magnetically* equal to width of tooth plus ·8 of width of slot. This dimension multiplied by the number of teeth under the pole face and the length of core will give the magnetic area of the interferric space, and the magnetic resistance of path b is $\frac{b}{A}$, where b equals the clearance (Fig. 1) and A the magnetic area as calculated.

In calculating the magnetic resistance of the teeth, it is assumed that the lines emanating from one pole pass through *all* the teeth embraced by the pole-face. Neglecting the fringing in this case, as the resistance of the teeth is small as compared with the clearance or gap,

the resistance at the top of the teeth is proportional to $\frac{C}{A_2 \mu}$ . . . . (1)

and the resistance at the bottom of the teeth is proportional to $\frac{C}{A_3 \mu_1}$ . . . . (2)

where C = length of tooth;

A_2 = actual width of tooth at the top × number of teeth under pole × length of core;

A_3 = actual width of tooth at the bottom × number of teeth under pole × length of core;

μ and μ_1 respectively represent the magnetic permeability at these two sections. A mean of equations (1) and (2) will give the resistance of the teeth.

The magnetic length of the armature in a four-pole machine is usually taken as shown by the line d in Fig. 2, and the resistance of this path taken as $\frac{d}{e}$, where e is the section of the core below the teeth. Of course, the *total* resistance is *twice* the value of the above equations, as only

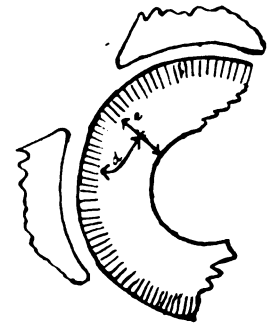

FIG. 2.

half of the path has been considered. In conclusion, it may be stated that the method described answers accurately enough for general practical purposes.—ZACKEN.

Answer to No. 96 (*awarded* 5*s.*).—The most general way to treat this question is to calculate separately (1) the reluctance of the air-space proper, or distance between the pole-face and the top of the teeth, and (2) the reluctance of the teeth themselves. The reluctance of the armature being reckoned at the minimum cross-section—that is, just as if the teeth had been stripped off—the reluctance of the air-space alone is

$$\frac{2\,l}{A};$$

where l = length of air-gap proper and A = area of air-gap. Now, this latter quantity is generally taken as somewhat greater than the area of the cored face of the pole-piece, owing to the fringing of the lines all round the pole-face. The amount allowed for this width of fringe in plain core machines is ·8 times the length of air-space, so that we are well within the mark in taking this amount for a slotted armature, as the fringing effect is much reduced in the latter case.

Calling total length of arc due to this cause λ,

$$\therefore\ \lambda = +\pi\,(D + l) \times \frac{\text{polar angle}}{360},$$

where D = diameter of armature and l = length of one air-space.

$$\therefore \text{ area of air-space} = (\lambda + \cdot 8 \times 2\,l)\ (w + \cdot 8 \times 2\,l),$$

where w = width of pole-face parallel to shaft. In the same way the reluctance of the teeth $= \frac{2\,l_2}{\mu\,a_2}$, where l_2 = length of teeth, μ their permeability at the definite flux density used, and a_2 their area.

Again, length of arc subtending polar angle + fringing effect $= \lambda_2 = \pi(D_2 + l_2) \times \frac{\text{polar angle}}{360}$, where D_2 = diameter of armature at the bottom of the teeth and l_2 length of teeth.

$\therefore$ total effective area of iron at this radius, presuming that there were no teeth, or if the armature were solid, is

$$(\lambda_2 + \cdot 8 \times 2\,l_2)\ (w + \cdot 8 \times 2\,l_2)$$

where u = length of pole-piece as before. Now, the actual area of the teeth is less than this; it is, in fact, the product of this quantity and

$$\frac{\text{width of tooth} \times \text{total number of teeth}}{\text{total perimeter of armature}}.$$

Having got the mean effective area of the teeth, and knowing the total flux through the armature, the permeability of the iron of the teeth, μ, can be found, and thus the reluctance, $\frac{2\,l_2}{\mu\,A_2}$, can be deduced.

$\therefore$ total reluctance of gap space and teeth

$$= \frac{2\,l}{A} \times \frac{2\,l_2}{\mu\,a_2},$$

and from the above it will be seen that all these quantities are determinate.

The solution to the first part of this question partially answers the second, for having treated the problem by

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splitting the various parts of the circuit up in this way, we necessarily have to find the mean length of path in each part; but if the path through the armature and teeth is required as a whole, then a diagram of the carcase of the machine is drawn. An approximation to the mean path through the solid part of the armature is made in the ordinary way, and to this is added twice the depth of teeth.—H. B.

Question No. 97.—Describe the best method of varying the speed of a motor-driven feed pump.

Best Answer to No. 97 (*awarded* 10*s.*).—A motor suitable for driving a boiler feed pump must be able to give a wide range in speed conjointly with practically constant torque, or turning moment. This necessitates careful consideration in the design of the electric motor, as it involves all the principles relating to speed and torque. Before proceeding to describe the most modern system of obtaining the above combination, it is advisable to ascertain upon what these two characteristics—speed and torque—depend. The speed of an electric motor varies directly as the applied armature terminal E.M.F., and inversely as the number of conductors and field strength—*i.e.*, speed varies as

$$\frac{\text{Armature terminal E.M.F.}}{\text{Number of conductors} \times \text{field strength}} \quad . \quad (1)$$

And the value of the torque varies as the continued product of the number of conductors, armature current, and field strength—*i.e.*,

Torque varies as number of conductors × armature current × field strength . . . . . (2)

Variations upon these formulæ are obtained as follows:

Speed.—It is admitted, to obtain an increase in the speed of a shunt motor of ordinary design, the most economical and efficient method is by introducing an additional resistance into the shunt circuit. The degree to which the magnetic field may be weakened must be carefully noted, for to obtain constant torque it will be seen from (2) the armature current must correspondingly increase, and this produces a double tendency to spark at the brushes.

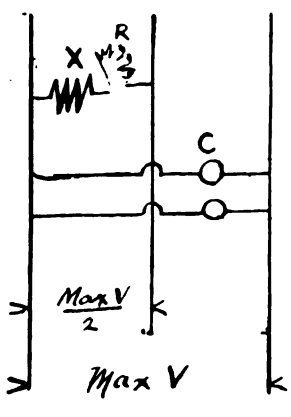

FIG. 1.—Connections for Maximum Speed.

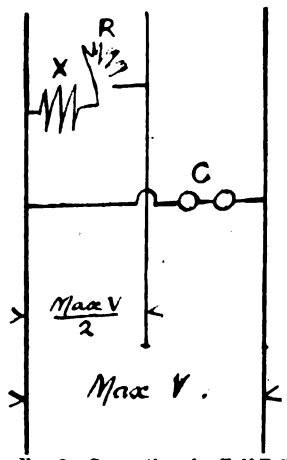

FIG. 2.—Connections for Half Full Speed.

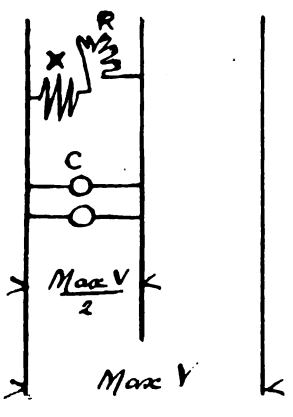

FIG. 2A.—Half Full Speed.

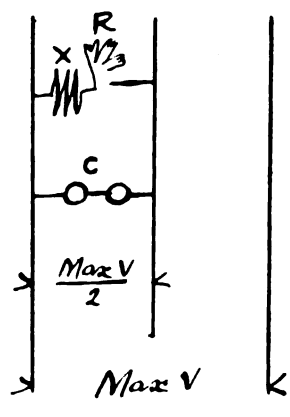

FIG. 3.—Quarter Full Speed.

Conductors.—The number of *effective* conductors can be varied only by splitting the armature winding into two separate parts, and then putting them into series or parallel by using two commutators.

Terminal E.M.F.—The armature terminal E.M.F. can be varied in the case of a three-wire system by connecting the armature terminals to the two outers, and afterwards one terminal to the middle and the other terminal to an outer. Of course, this principle of variation can be extended where more than three wires are used, the total E.M.F. between the outers being divided by the number of pairs of circuits.

The requirements in the design of the motor for maximum range of speed with constant torque are: shunt-wound field coils, two separate and similar windings on the same armature, each winding having its respective commutator, and a step resistance for the shunt circuit. The application of this motor will be considered where the supply is on a three-wire system, the field coils being constantly excited from the inner and one outer wires. The connections are as shown in the accompanying diagrams, in which X represents field windings, R shunt resistance, C commutators.

The intermediate speeds are obtained by introducing resistance into the shunt circuit. A perusal of these diagrams and the above formulæ will explain all interactions.

A simple method of regulating the speed and obtaining constant torque is to use a variable resistance in the armature circuit, but attention must be drawn to the fact that this method is very uneconomical or inefficient, as the power absorbed by the electric motor is the same for all speeds. In fact, the economy varies directly as the speed of the motor, or, in other words, inversely as the amount of resistance inserted.—PUMP MOTOR.

Answer to No. 97 (*awarded* 5*s.*).—The motor for driving the feed pump would probably be shunt wound. Undoubtedly the most economical way of varying the speed of a shunt-wound motor is by a regulating resistance in the shunt circuit. A fairly liberally designed motor can, as a rule, have its speed increased 30 per cent. by weakening the field before sparking will be troublesome. By special design with very heavy and highly saturated field it should be possible to increase this range to 40 per cent. In that case the motor would be geared to run the pump at about 71 per cent. of its full speed when the motor had its full strength of field. Lower speeds would have to be obtained by putting resistance into the armature circuit. If much low-speed running were likely to be required, it would be advisable to use a changeable half-speed gear for speeds of 50 per cent. and under, thus avoiding large resistances in the armature circuit.—F. O. H.

ELECTRIC TRAMWAYS IN LONDON.

The following letter has been addressed to the clerk of the London County Council by Mr. J. Clifton Robinson, the managing director and engineer of the London United Tramway Company. The letter is self-explanatory, but anyone who has seen the rapid and thorough work being done by the company in connecting their lines outside the county of London will wish them success in their application:

The directors of the London United Tramways are now engaged in carrying out the conversion and extension of the system authorised under their Act of the past session and the introduction thereon of overhead electric traction. It will be within the recollection of the London County Council that the three short portions of the company's system lying within its jurisdiction were omitted from the company's Bill as regards the compulsory introduction of the overhead trolley system of electric traction, while this method of traction was sanctioned, and is now being adopted, on the remainder of the company's existing lines and extensions.

These other tramway lines, existing and authorised (including the light railway to Uxbridge which the Light Railway Commissioners have passed), extend to about 20 route miles, the whole of which it is expected will be completed, and the electric power thereon put in operation, by June of next year.

There remain three fragments of tramway belonging to the company which lie within the London County Council's district—namely: (1) From the Askew Arms to Uxbridge-road Station, 1 mile 3 furlongs 3 chains; (2) from Uxbridge-road Station by Goldhawk-road to Young's-corner, 1 mile 4 furlongs

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3 chains; (3) from Hammersmith-broadway to Young's-corner, 1 mile 3 furlongs 7 chains—a total of about four miles in all, or one-sixth of the whole route covered by the company's new and existing lines.

A route plan is sent with the letter showing the extent of tramway on which electric traction has been authorised, and indicating the three terminal fragments lying between the system and London, for the electric equipment of which the Council's assent is now sought.

In view of the extreme disadvantage to the public of having these three "dead ends" to an otherwise through and complete system worked by horse haulage, in place of enjoying one unbroken mode of traction from end to end of the lines, the directors have instructed me once more to approach the Council asking its further and best consideration of this important public matter. They are the more readily induced to ask for this reconsideration in view of the tramway obligations now being undertaken by the Council. They feel that the system now belonging to the company, if completed as desired, would be in many ways of value to the Council, as the directors confidently point to their operations elsewhere as demonstrating the superiority of the overhead trolley system over every mode of mechanical traction now known.

It may be pointed out that the introduction of this method of working on these three short terminal parts of the company's completed system would not involve any question as to the right of the Council to purchase the lines at the expiration of the period of 21 years—*i.e.*, in 1908. So far from that being the case, the directors, with a view to facilitate an arrangement, would be prepared to hand over to the Council, free of charge, the whole property in the feeder cables, or mains laid down in the streets, together with the standards and overhead wires there, thus leaving the question of the purchase of the permanent way, etc., under the purchase clauses of the Tramways Act, 1870, absolutely unprejudiced.

The directors would further be willing to enter into an agreement to remove the standards and other electric apparatus at any time during the currency of the present term on receiving a year's notice from the Council so to do. The company would also undertake to adopt, subject to the approval of the Board of Trade, any other mode of traction which the Council may at any future time find in practical operation and acknowledged to be superior to, and more efficient than, the overhead trolley system, or, further, should the London County Council at any time extend tramways to be hereafter acquired or constructed by the Council so as to connect up with any of these portions of the London United Tramways, situated within the county of London, the company would then, if required by the Board of Trade, adopt on these lines such method of mechanical haulage as the Council may have adopted on the tramway lines with which such connections are made.

The whole of the company's existing tramways having recently been reconstructed on the most improved and modern lines (having in view the eventual adoption of electric traction) no alteration or conversion of the permanent way would be necessary, and the work of erecting the standards, laying the feeder cables, and placing in operation the overhead trolley wires would be a simple matter, involving not more than a month's work.

The directors approach the London County Council in this matter fortified by the approval of the Vestry of Hammersmith, as the local authority more immediately concerned, and they respectfully urge the Council to give effect to the proposal now put forward for the following reasons:

1. Parliamentary sanction to the introduction of electric traction on the company's lines was accompanied by a very strong expression of opinion in favour of this system on the part of an admittedly strong committee of the House of Commons.

2. Serious inconvenience will accrue to the travelling public if at the three termini of a large system of tramways a break in the method of haulage is encountered, cutting off direct communication with the points on which the company's traffic naturally converges.

3. While overhead electric traction is acknowledged at present as the most efficient, safe, and convenient method of haulage in existence, the directors offer such conditions as would compel them to adopt on these lines, on the County Council requiring them, any newer invention proving more efficient, economical, or acceptable.

4. The terms on which the directors offer, and are prepared to accept for the assent of the County Council, are such as to preserve in every way the statutory right of purchase held by the Council, and to leave the control of the streets unaffected in the Council's hands.

5. As the work with the remaining 20 miles of the company's lines will, it is expected, be completed in June next, an early determination of the matter now in hand would be distinctly for the public advantage.

I shall be glad to have the pleasure of appearing before the Council, or any committee of the Council appointed for the purpose, when I shall be ready to submit such further information and explanation of our proposals as may be deemed necessary. (Signed) J. CLIFTON ROBINSON.

ELECTRIC TRACTION AT WEST BROMWICH.

The West Bromwich Highway Sub-Committee on Electric Traction visited a number of towns in the early part of this year to inspect electric tramways. The places selected were Leeds, Blackpool, Bristol, Dover, Coventry, Wednesbury, Birmingham, and Kidderminster. The sub-committee were accompanied by the borough engineer, Mr. Albert D. Greatorex, and acknowledge the uniform kindness and attention with which they were everywhere received. The borough engineer also visited Prescot, where a system of underground conduit has been put down as an experimental line. The report describes what was seen at the various places, and concludes with the following summary, which is of more general interest:

The sub-committee emphasise the fact that they approach the consideration of the conclusions to be arrived at solely on the merits, with but one aim and object in view—the general well-being, development, and interest of the town. The chief advantages of the cable system are: the absence of overhead apparatus in the streets; the regular speed and the freedom from accidents which might be caused by the driver losing control of the car; the adaptability of a cable line to the demands of an increasing traffic—if extra cars are required at any time, the extra cost and power required are comparatively small in proportion to the number of cars so required; the economy of working; and cleanliness. The great objections to this system are: its great cost of construction, and the prolonged interference with the streets during construction and repairs, when the traffic and business is greatly impeded; the inflexibility of the traffic conveyed by it—if time is lost it cannot be regained, the speed of the cable limiting the speed of the car, and a car cannot be run back if required; the objection to the slot, which, although much narrower than with the electric conduit, is still objectionable, and the noise from the cable running in the pulleys below the ground is found to be a constant annoyance to residents on the route; and the fact that any breakdown of the engines or cable stops the traffic entirely on that particular section. The sub-committee are not prepared to recommend the adoption of the cable system in West Bromwich, as on account of the very heavy cost in construction it is prohibitive for the entire line. If the entire route were laid on the cable system it would be an enormous expense. Two power stations at least would be necessary, and the difficulty of getting over canal and railway bridges would have to be faced as in the conduit system, and if the portion from Carter's Green to the New Inns, Handsworth were laid down for the cable system, it would, they are informed, cost at least £75,000. There would then remain the difficulty of changing at Carter's Green for passengers to Great Bridge and Hill Top.

The Electric Conduit System.—The sole advantage of the electric conduit system seems to be that the overhead wires and poles are removed, while the principal objections to it are the great expense—more expense than the cable system—the prolonged interference with the streets during construction and repairs, when the traffic and business is greatly impeded; the difficulty in locating any defects in the underground part of the system; the difficulty and expense of carrying out any sewerage work in streets in which there are conduits, the danger to traffice through the presence of a slot in the street varying in width from $\frac{3}{8}$in. (the slot is wider than with the cable system); the difficulty and expense in keeping the conduit clean and maintaining satisfactory insulation, and the liability to stoppage through storms. If the apparatus in the conduit should require repairing, the work is of necessity much more difficult and expensive than with the overhead wires. No matter what precautions may be taken to ensure efficient drainage of the conduit in ordinary rain, in times of heavy storms, when the drains become overcharged, the conduit would be filled with water and mud, and the tram service stopped, and could not be restarted until the water and mud had been cleared away. Should a conduit or cable system be decided upon, it would be objectionable as regards the gas and water pipes, which are very near the surface, the concrete foundation would also be disturbed, and there would be considerable difficulty in certain parts of the town in draining the conduits owing to there being no surface-water drains, and the sinking caused through mining operations would very considerably interfere with the conduits. With regard to the chief objection against the cable and conduit systems, it is impossible to disguise the fact—a fact which must be patent to all—that the cable and conduit systems are most expensive in construction. It may be fairly and legitimately argued that the matter of construction, and the cost necessarily entailed thereby, is a matter for consideration by the directors of the

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tramway company, as being the parties most directly interested, and not for the Corporation or the ratepayers, who are but indirectly affected, and that consequently the argument as to the cost is not applicable. In the first instance, the question of cost is one which more particularly affects the company, seeing that the obligation to provide the necessary capital rests upon the company, but the sub-committee would point out that the fact is important, as the cost of construction may eventually be a serious and very important matter to the ratepayers, seeing that upon the termination of the concession the undertaking may be purchased at its "then value," and the capital to be provided to meet the "then value" of a cable or underground conduit system would surely be considerably in excess of that to be provided for the system of overhead wires. On the other hand, should the Corporation determine to municipalise the tramways, the extra cost in construction on either of these two systems would have to be borne by the ratepayers. With regard to the objection—namely, the expense involved in maintenance and keeping the system in a thorough state of efficiency and good working order—here again this objection appears to be equally fatal with the first as regards the two systems named. As regards the time taken to reconstruct the lines under these two systems, there is no doubt it would take considerably longer than the overhead system, and the inconvenience would, therefore, be greater. With reference to the difficulty experienced in speedily locating any defect in the conduit system, this objection is very important, and one which demands earnest consideration. If the apparatus in the conduit should need repairing—and repairs at times are imperative—the work is of necessity rendered much more difficult and more expensive than with the overhead wires; and the utility of the tramways system is frequently seriously imperilled, and in order to get access to the conduit, the provision of a very large number of manholes, etc., is rendered absolutely necessary. In connection with the conduit system, the hitherto insurmountable difficulty in securing and maintaining efficiency in all weathers has also to be carefully considered. In this connection it may be stated that it is not necessary to flood a conduit to bring down the insulation of the electric cable, and so cause leakage. The insulators by which the electric cable is held in position are composed of either earthenware or porcelain. These in themselves when clean are perfect insulators—that is to say, there is practically no leakage over them, but whenever they become covered with even a slight coating of moisture, the insulation immediately falls, and leakage begins. Again, the traffic is likely to be interrupted through the lines being blocked by snow. The conduit system has not, as yet, had an extensive trial in England, Blackpool being the only town where it has been laid down, and, unfortunately, the limited experience already acquired has not been very happy or assuring either to the corporations or companies to its ultimate success. Mr. W. G. Laws, city engineer of Newcastle-on-Tyne, in reporting to the Corporation, states that at Blackpool, where the conduit system was laid and promised well for a time, when taken over by the Corporation it gave so much trouble, owing to excessive leakage and consequent deterioration of the apparatus generally, that for some time it has to be worked by horses. A moist climate is unfavourable to the rather delicate apparatus, and promotes leakage of energy by keeping the conductors damp, and would presumably require very close attention to keep the tube clean. Taking, therefore, all the circumstances into consideration, and weighing the same with strict impartiality, the sub-committee have to report that they cannot see their way to recommend the adoption of any conduit system for West Bromwich.

Overhead Electric System.—The special advantages of the overhead electric system, as compared with other forms of electric traction, are: cheapness and simplicity (the latter allowing any necessary repairs to be effected with a minimum of trouble, delay, and expense); in case of an accident to a trolley wire on any part of the system, which is most unusual, only that section (a half-mile length) is thrown out of use, and it is very quickly repaired; the units of power employed in the engine-house are all coupled together, sending current through feeders to all sections of the trolley wire; an accident to one engine does not affect the running of the cars, as another spare engine can immediately be run to take its place; the rapidity with which the lines can be reconstructed, and the comparatively small interference with the surface of the streets and traffic, as compared with the conduit system. The overhead system is less liable to leakage than the underground system. The overhead system is the most efficient, taken as a whole, of mechanical traction which has hitherto been demonstrated by practical working. The disadvantages and objections usually urged against this system are: the unsightly and objectionable appearance of the poles and wires; the danger of overhead telephone wires, etc., breaking and falling on the highly-charged trolley wires; the danger of the highly-charged trolley wires breaking and coming into contact with persons passing near them, but the trolley wires are very strong, and breakages are almost unknown—these dangers can, however, be completely guarded against by the exercise of due precautions and the use of proper appliances (your sub-committee only heard of one case of wires breaking in the places visited by them); the danger of the electrolysis of gas and water mains owing to the return current being taken by the rails—this would also refer to the conduit system. With regard to the unsightly and objectionable appearance of the poles and wires, the deputation are of opinion that the advantages outweigh the disadvantages, and with neat and ornamental poles judiciously used for electric lighting, they rather add to, than detract from, the appearance of the streets, and they can be erected so as not to offend the eye; and your sub-committee feel convinced that the public will soon become reconciled to the poles and wires, and will cease to notice them as soon as they become acquainted with the advantages afforded by this mode of traction. The overhead system of tramways has been carried through the principal streets of Rome, and particularly through the magnificent ruins of the Capitol, without causing any adverse comment. At Milan the overhead system has been admitted almost into the precincts of its magnificent cathedral. If this system has not destroyed the beauties of these places, residents in West Bromwich and surrounding districts need not fear that the appearance of any street in this district will be spoilt. We started our investigations more or less in sympathy with this objection, but where the system is carried out in the most approved manner, we found that the wires gave only the very slightest offence to the eye, and that a few hours' familiarity removed the objections previously held. The simplicity which characterises the overhead system must be self-evident to anyone impartially studying the question. It is essentially clean, safe, and comfortable in its application, as well as being under perfect control. It has distinctly passed the experimental stage in every particular and in every detail. The very simplicity of the system enables any necessary repairs to be effected with a minimum of trouble, inconvenience, delay, or expense, being under all circumstances the most accessible for purposes of maintenance and repair. The rapidity with which the lines can be constructed or converted, and the comparatively small interference with the surface of the streets and general street traffic, is another argument which strongly demonstrates the superiority and efficiency of the system over the conduit system. Again, where standards of artistic design, with ornamental arms or brackets on either side of the centre pole, are placed in the centre of the roadway, arc lamps can be attached and the poles used with much advantage for the electric lighting of the streets, from the same station as would supply the power for working and lighting the tramcars, thus removing the necessity for another set of poles on the causeways or in the roadway. This would certainly be an advantage in more senses than one. There is little or no leakage from this system, and it is very little affected by either rain or snow, except that the rails must be kept clean, as they must be in any system of tramways. The municipal authorities of the most important cities in England and Scotland have, we are informed, after exhaustive enquiries and consideration, decided in favour of overhead electric traction—for instance, Liverpool, Manchester, Sheffield, Bradford, Hull, Leeds, Glasgow, Birkenhead, Nottingham, and Bristol. Your sub-committee are of opinion that this system is the best adapted for West Bromwich.

Recommendation.

Your sub-committee have considered the proposals of the British Electric Traction Company, and also the question of municipalisation of the tramways within the borough as instructed by the Highway Committee at their last meeting, and which was approved by the Council, and having carefully considered the matter, submit the following recommendation: Your sub-committee, taking into consideration the fact that the Corporation have lately obtained a provisional order to generate and supply electricity within the borough, and that the two schemes—namely, electric lighting and tramways—could be worked to the advantage and benefit of the town, unanimously recommend the Town Council to purchase the part of the tramway undertaking within the borough of West Bromwich on the expiration of the present lease, under Section 43 of the Tramways Act, 1870, and to apply for the necessary power to equip and work the said tramways when taken over. If the Corporation do not decide to municipalise the tramways, your sub-committee beg to submit the following recommendations:

1. That the permanent way of the whole of the existing system within the borough of West Bromwich requires reconstructing, including the sett paving. This work should, under any circumstances, be carried out by the town and leased to the company on terms to be arranged. The dual control, which causes continual annoyance, would then be done away with.

2. As to the form of mechanical traction to be adopted, your sub-committee have given the subject most careful consideration, and have unanimously come to the conclusion that overhead electric traction is the best known system of traction, having due regard to efficiency and cost, for West Bromwich.

3. That in adopting this system the poles, which must be of

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designs to be approved by the Corporation, should be placed in the centre of the roads where the width from kerb to kerb is not less than 36ft., and that the Corporation should be allowed to use them for arc lighting of the streets free of charge. The width from kerb to kerb in the streets is very suitable to centre poles. The following table gives the average maximum and minimum widths in the several roads :

Measurements of Main Roads, giving Average Maximum and Minimum Widths.

	Maximum.	Minimum.	Average.
	Ft. In.	Ft. In.	Ft. In.
Birmingham-road	42 3	35 4	39 0
High-street	48 6	37 5	39 4
Old Meeting-street	38 2	34 0	37 0
Black Lake	39 0	35 0	37 2
Hill Top	38 0	33 3	35 8
Dudley-road	38 8	35 5	36 8
Great Bridge-street	48 0	29 0	37 0

In the case of Boar-lane, Leeds, the average width from kerb to kerb is 38ft. 3in., and in Euston-road (east of Gower-street), London, which has an immense traffic, centre poles have been adopted for electric street-lighting every 240ft. apart; here the width is from 38ft. to 40ft. from kerb to kerb. Your sub-committee have not met with any street more suitable for the adoption of centre poles in the towns visited by them.

4. That arrangements should be made to supply the electric current to the company by the Corporation from their proposed electric light station.

5. The adoption of small cars of the most modern type, with a gangway inside of at least 2ft. 8in. (cars lighted by electricity are far more comfortable and convenient for passengers, and a very great improvement to the badly-lighted cars at present in use), and a frequent service at popular prices, which will be a very great benefit to the citizens. Your sub-committee recommend a five minutes' service from the New Inns to Carter's Green, with a 10 minutes' service from Carter's Green to Great Bridge and Hill Top; also that the conductors and drivers should be provided with proper and suitable uniforms.

Your sub-committee have had the very great advantage of carefully perusing the excellent reports on this subject prepared by many towns, especially the Corporations of Douglas, Manchester, and Sheffield, and also the valuable information lent them by the proprietors of the *Railway World*.

ROYAL PHOTOGRAPHIC SOCIETY.

The forty-third annual exhibition of the Royal Photographic Society of Great Britain opened on Monday, the 26th inst., in the gallery of the Royal Society of Painters in Water Colours. On Saturday evening last a soirée was given by the president and council of the society. There was the usual crush of visitors, who were received, in the absence of the Earl of Crawford, K.T., by the hon. secretary of the society, Colonel J. Waterhouse, I.S.C.

The tendency of producing artistic effects noticed in previous exhibitions is even more accentuated in the present one. Portraiture is strongly represented, and the specimens shown—excellent in their way—are most open to this objection: they really represent a miniature imitation picture gallery. Where the real aim of photography—viz., the true representation of actuality—is more closely kept in view, admirable results are produced, as, for instance, in a number of verascope positives shown in a magazine stereoscope holding 50 views. Here a truly remarkable perspective is achieved.

Mr. Thos. Manly exhibits examples of ozotype printing in pigment, being carbon printing without actinometer, transfer, or safe edge, and in which the pigmented gelatine does not come in contact with a chromic salt. This is an entirely new process, upon which the inventor has promised to read a paper before the society during this session. Close by we noticed "Mrs. Braddye" (after a mezzotint by Cousins of Sir Joshua Reynolds), by Mr. Reginald Craigie, which is a work of art in every sense.

On the apparatus table there is not very much new this year, the most interesting being specimens of pictures on daguerreotype plates, orthochromatised and treated with ordinary developers, alkaline, and acid, by Colonel J. Waterhouse. These are the results of experiments never before attempted. Much time and labour has been expended upon them by Colonel Waterhouse, and the orthochromatising of the old daguerreotype plate opens out a new field for the scientific investigator. There are some very ingenious contrivances; one, the Richard verascope, which allows a stereoscopic or a single picture to be taken by the same apparatus, which is a very useful little instrument. Another, the patent photo-concha, which is a changing bag, combined with a box, intended to be used as a portable developing chamber. We would have liked to know more about this apparatus, but no source of information was available. It was even worse with a number of—according to the catalogue—most valuable instruments. However, they were so valuable that they had to be kept religiously under lock and key, and neither at the Press view nor at the private view was there anyone in attendance to show them. We were previously under the impression that exhibitions were places where objects are shown or, at least, open to inspection, and must confess our error.

Stringer's photo-micrographic apparatus, exhibited by Messrs. W. Watson and Sons, is worthy of note. In this apparatus the whole condensing system is arranged to slide upon one rectangular bar firmly attached to a base-board. There being no continuous base-board, the camera is kept in line with the condensing system by means of two telescopic tubes attached to the sides of the base of the condensing system. It is claimed for this system that a more perfectly corrected and powerful illumination is secured in the following way: the light from the zirconium jet is made parallel by the doublet condenser, and from thence falling upon the lens, is converted into a converging cone, which, entering another lens, is again made parallel, the emergent beam being of such size as exactly to fill the back lens of the sub-stage condenser. A water-tank is interposed to take up the heat rays.

EDINBURGH ELECTRICITY WORKS.

The accounts of the Edinburgh electric lighting station for 1897-1898 have just come to hand, from which it appears that the total amount expended on capital account up to date has been £287,465. 14s. 6d. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.			£ s. d.
Generation of Electricity.			
Coal and other fuel	£4,175 16 1		
Oil, waste, water, engine-room stores, etc.	676 16 3		
Salaries of engineers	692 10 10		
Wages at station	1,384 0 9		
Repairs and maintenance—Buildings	144 8 11		
Machinery and plant	1,476 8 4		
Instruments	11 6 1		
			8,561 7 3
Distribution of Electricity.			
Salaries of engineers	100 0 0		
Wages	709 19 7		
Repairs and maintenance of mains and cables	577 9 1		
Repairs and maintenance of meters	69 16 6		
			1,544 5 2
Public Lamps.			
Wages	1,627 8 9		
Carbons	809 4 10		
Repairs	472 4 2		
			2,908 17 9
Rents, Rates, and Taxes.			
Rents	15 14 6		
Feu-duties of station, £20. 2s., less 13s. 4d. of income tax	19 8 8		
Rates and taxes, £1,535. 9s.; and insurance, £295. 13s. 9d.	1,831 2 9		
			1,866 5 11
Expenses of Management.			
Special expenses—Salaries of engineers	400 0 0		
General establishment charges	634 17 6		
Stationery, printing, and advertising	143 15 11		
General expenses of management—proportion	1,057 6 3		
			2,235 19 8
Law and other Expenses.			
Law charges, including compensation in respect of accidents	167 2 3		
Composition of stamp duties on transfers of Corporation stock	117 18 7		
			285 0 10
			17,401 16 7
Balance carried to net revenue account			20,647 8 2
			£38,049 4 9

Cr.	£ s. d.
Sale of current per meter—Private lighting, at 4d. per unit, less discounts	29,257 13 8
Motor power, at 2d. per unit	724 17 2
	£29,982 10 10
Arc lamps—public lighting, at £16 per annum, £7,993. 5s.; private lighting, at £16 per annum, £32	8,025 5 0
Miscellaneous receipts—rents, etc.	41 8 11
	£38,049 4 9

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GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Bank balances—capital account	6,579	0	11
Revenue account	2,941	5	10
	9,520	6	9
Temporary loans	66,796	5	2
Sundry creditors for outstanding accounts due by the Corporation	58	10	10
Reserve fund—amount at May 15, 1897, per last balance-sheet, £4,050; add interest thereon for year to May 15, 1898, £75. 17s. 3d.; and sum set aside during year to May 15, 1898, as above, £4,000—£4,075. 17s. 3d.	8,125	17	3
Surplus—contributions towards liquidation of debt for capital expenditure: amount to May 15, 1897, per last balance-sheet, £11,101; added during year to May 15, 1898, £7,686; net premium on Corporation stock — proportion applicable to £90,000 (part of issue of £500,000) of 3 per cent. stock, £2,859; less £409. 18s. of expenses of issue, £2,449. 2s.; less discount and expenses of issue of £120,000 (part of issue of £750,000) of 2½ per cent. stock, £1,895. 13s. 7d.	19,340	8	5
	£103,841	8	5

Assets.	£	s.	d.
Capital account, balance at debit thereof	92,715	14	6
Sundry debtors for outstanding revenues due to the Corporation—sale of current per meter	2,537	18	8
Stores on hand	461	18	0
Reserve fund investment—£330 Glasgow Corporation 3 per cent. redeemable stock, 1921, £344. 4s. 8d.; balance due by Commercial Bank of Scotland, Limited, on reserve fund account, £7,781. 12s. 7d.	8,125	17	3
	£103 841	8	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantities generated, units			3,313,460
Quantities sold	Private lighting	1,973,123	2,894,437
	Motor power	86,654	
	Arc lamps	834,660	
Quantities used in station			158,816
Quantity unaccounted for			260 207

LEGAL INTELLIGENCE.

DUBLIN ELECTRIC TRAMS.

Injunction Application.

Mr. Justice Kenny, sitting as vacation judge, heard last week the case of the British Insulated Wire Company, Limited, *v.* the Dublin United Tramways Company and the National Conduit Company, of New York.

The **Solicitor-General, Q.C., M.P.,** with whom was Mr. A. F. Blood (instructed by Messrs. D. and T. Fitzgerald), applied on behalf of the plaintiffs, who carry on business in England, for an interlocutory injunction to restrain the defendants from infringing certain patents owned by the plaintiffs for the manufacture of cables used in electric traction. The patents relied on were, according to the *Irish Times*, for an invention relating to the insulation of the copper wires of electric mains from the outer lead covering of the cables by spiral folds of oiled paper. The affidavits filed on behalf of the plaintiffs alleged that the New York Company were manufacturing cables of the description referred to under American letters patent, which were in terms copied from the specifications of the plaintiffs' British patents. It appeared also by the affidavits that the Dublin Tramways Company had purchased large quantities of cable from the New York company, and had been laying them down in the city.

Mr. Gordon, Q.C. (instructed by Messrs. Casey and Clay), on behalf of the defendants, applied for an adjournment of the case to the next sittings, on the ground that it would take the tramway company a considerable time to obtain materials for the defence from New York.

The motion was adjourned to next sittings on terms of the defendants filing the affidavits in reply to the application on or before Oct. 12 next.

COX THERMO-ELECTRIC COMPANY.

In the London Bankruptcy Court on the 22nd inst., Mr. A. S. Cully, assistant receiver, had before him the case of the Cox Thermo-Electric Company, Limited. A winding-up order having been recently made against this company, the statutory meetings of creditors and shareholders were now held at the Board of Trade Offices, Lincoln's-inn.

The **Chairman** said the company was incorporated in February, 1896, with a nominal capital of £100,000, divided into 10,000 shares of £10 each, to acquire certain patents from Mr. Cox at a price of £104,000, payable as to £100,000 in shares and £4,000 in cash. The directors were Mr. Roger Wallace, Q.C, Mr. Julius Möller, Mr. J. Brown Martin, and Mr. H. B. Cox. No prospectus was issued, and the whole of the share capital was allotted to the vendor in the purchase of the patents. A further £4,000 in cash had to be provided in order to carry out the agreement, and the directors subscribed £10,000 for debentures covering the whole of the company's property and carrying 6 per cent. interest. The freehold property at St. Albans wherein to carry on the work of the company was purchased with this money, but in February, 1897, the premises were destroyed by fire. They were only insured for £1,000, and in order to rebuild them the directors borrowed £3,000 from a bank against the deeds, and giving their personal guarantee. The premises were rebuilt, and the development of the patents proceeded with. This did, however, not prove a commercial success. In consequence, a debenture action was commenced in March, 1898, and a receiver was appointed, who was now in possession of the property. The draft statement showed unsecured debts £5,206. 17s. 10d., and assets likely to yield £257. 9s. Then there was the £3,000 due to the bank, which had a charge over the freehold premises, and, lastly, there were the debenture bonds for £10,000. One point which naturally struck one was that the whole of the share capital had been allotted to the vendor. He thought that was illegal, because the Companies Acts provided that a company must consist of not less than seven members. The directors held their shares as nominees of the vendor.

Mr. Webster, representing the directors, was asked whether an offer of 13s. 4d. in the pound made to the creditors a few months ago would be repeated. He stated his clients were out of town, but they did not want the creditors to suffer, and if the meetings were to be adjourned an offer would in all probability be submitted.

The meeting was adjourned for a fortnight in order to allow the directors to make an offer.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Almayo (Spain).—The Administration of the town will receive tenders to light the town by electricity by Oct. 3.

Braila.—The term for tenders for an electric lighting installation for the Corporation has been extended to Oct. 13.

Ghent (Belgium).—The Corporation are advertising for tenders for public and private electric lighting on Oct. 27 and 29 respectively.

Paris.—The Post and Telegraph Department, rue de Grenelle, 103, will accept tenders on Oct. 13, at 11 p.m., for 78 miles of paper-insulated electric cables.

Madrid.—The Post and Telegraph Department invite tenders for 40,000 insulators for telegraph posts. Offers must reach the above department at Madrid or the office of the Civil Government, either at Barcelona, Cordoba, or Leon by Oct. 12. The maximum price is 1 peseta 7 c. per piece. 10 per cent. deposit is required, 5 per cent. to accompany tender.

Dundee.—Tenders are invited by the Dundee Gas Commissioners for lead-covered cables and underground conduits for the extension of feeder mains. Specifications and forms of tender may be had on application to Mr. Walter H. Tittensor, electrical engineer, Dudhope-crescent-road, Dundee. Tenders to be lodged with Sir Thos. Thortnon, clerk, City Chambers, Dundee, by Oct. 4 at noon.

Plymouth.—Tenders are invited for the supply of an enclosed (iron-clad) continuous-current motor, shunt-wound, for 10 b.h.p. at 850-950 revolutions, for 520-volt circuit, complete with spare armature, starting switches, and resistances. Specification and form of tender may be obtained by actual manufacturers on application to Mr. John H. Rider, borough electrical engineer, East-street, Plymouth, to whom sealed tenders must be delivered by Oct. 6.

Ashton-under-Lyne.—The Market Committee of the Corporation are prepared to receive tenders for the installation of the necessary wires, fittings, etc., for the electric lighting of the public market. The current will be supplied from the town mains. Specification, etc., can be obtained on application to Mr. John Neal, borough comptroller, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender and specification. Tenders by Oct. 3.

Bangor.—Tenders are invited by the Corporation for erection of buildings, chimney shaft, etc., for its electric lighting station. Plans and specification may be inspected at the offices of Mr. John Gill, A.M.I.C.E., borough surveyor, and at the offices of Mr. F. Hastings Medhurst, B Sc., M.I.E.E., the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., from the latter of whom the bill of quantities can be obtained on payment of a deposit of £5. 5s., which will be returned on receipt of a bona fide tender.

Sydney (N.S.W.).—The Department of Posts and Telegraphs are inviting tenders for a steam-engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1 000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Particulars, etc., are to be obtained from, and tenders addressed to, the Secretary, General Post Office, Sydney. Tenders by Oct. 17.

Hull.—The Electric Lighting Committee invite tenders for the supply of the following cars, etc.—viz, 45 electric motorcars, 20 trail cars, 2 sprinkler cars, 2 traversing platforms. Specifications and forms of tender may be obtained of Mr. A. E White, city engineer, Town Hall, Hull, upon payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Cheques

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to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Rolling-Stock," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Sept. 30.

Leigh (Lancs.).—Tenders are invited by the Urban District Council for the supply and erection of the following plant: (Section 1) steam dynamos, steam and exhaust pipes; (2) main switchboard; (3) accumulators; (4) mains, etc.; (5) meters; (6) overhead crane; (7) water softener. Tenderers are at liberty to tender for any section or sections, but not for part of a section. Plans may be seen and copies of the specifications, forms of tender, and further particulars may be obtained at the office of the engineer, Mr. John Foster, Leigh, Lancashire, on the deposit of £3. 3s., which will be returned on the receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Machinery, etc.," to be sent to Mr. P. Thomas, clerk, Town Hall, Leigh, by 12 noon on Oct. 14.

Hull.—Tenders are invited by the Electric Lighting Committee for the supply and erection of certain plant in connection with their electric lighting works. Forms of tender and specifications for the following are now ready: (Contract 4) high and low tension mains, casings, trenchwork, etc.; (5) switchboards, continuous-current rotary transformers, motor-generator, etc.; (6) centrifugal pump, condenser (ejector type) steam-pipes, etc. Specifications for any one of the above three contracts may be obtained from Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Cheques or postal orders to be made payable to Thos. Geo. Milner, city treasurer. Tenders, endorsed respectively "Tender for Mains," "Tender for Transformers," "Tender for Steam-Pipes," to be delivered to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on Oct. 27.

Rathmines.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pumps, ejector, economiser, electric motor; (B) engine-house plant—high speed steam dynamos and accessories; (C) condensing plant and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) underground work—trenching, cables, etc.; (H) posts for incandescent street-lighting; (I) lanterns and incandescent lamps for same; (J) meters. Tenderers are at liberty to tender for any section, but not part of a section, and applicants must state for which section they wish to tender, in order that the requisite drawings may be forwarded. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, 64, Victoria-street, London, S.W., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders, sealed and marked "Tender for Electricity Works," must be addressed to Mr. F. P. Fawcett, secretary to the Township Commissioners, at the Town Hall, Rathmines, co. Dublin, and be delivered on or before Oct. 5.

RESULTS OF TENDERS.

Belfast — The tender of J. Spencer, Limited, Wednesbury, for supply of 50 electric light tubular masts, has been accepted by the Belfast Harbour Commissioners.

Chiswick.—The following tenders have been received for providing an electric lighting installation at the pumping station: Thornycroft, £280; Warburg, Dymond, and Co., Regent-street, £264. 8s. 8d.; Laurence and Butcher, Old Bond-street, £175. 10s. (accepted).

BUSINESS NOTES.

New Zealand.—The Government budget for the next year comprises £32,000 for telegraph work.

Chiswick.—An expert is to be engaged to look after the work of installing the electric lighting station.

Walthamstow.—The District Council have decided to apply for powers to run electric cars in the district.

Scarborough.—A proposal is at present before the Town Council for the establishment of 14 miles of electric tramways.

Wallsend.—The District Council will oppose the proposed application by the gas company to supply the district with electric light.

Lancaster.—The Town Council have resolved to apply for sanction to borrow £20,250 for extending the electric lighting and for various improvements.

Cork.—The Corporation and the electric tramway company are having a little controversy about repairing the damage done to the streets of the city while the line was being made.

Broughty Ferry Light Railway.—At a special meeting of the Dundee Town Council on Saturday last, it was decided to support the scheme before the Light Railway Commissioners.

Northfleet—The Gravesend Corporation have fallen in with the suggestion of Northfleet, and have appointed a committee for conference on the subject of the proposed electric trams.

Cromer.—Messrs. O'Gorman and Cozens-Hardy have been appointed by the Urban District Council consulting engineers for the electric lighting scheme which is now in course of preparation.

Direct United States Cable Company.—The directors have resolved to declare an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ending 30th inst.

Eastern Extension Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share, free of income tax, payable on 15th prox.

Whitechapel.—The Electric Lighting Committee have acquired the property in Wentworth-street and George-yard which is to be taken over by the Board for the purpose of enlarging the destructor premises.

Romford.—The brewery company have applied to the Urban District Council for permission to lay wires for electric lighting under the roadway from the brewery to the Coach and Bell Inn, and from the Star Hotel to the Rising Sun Inn.

Waterloo.—Colonel W. Langton Coke, M.I.C.E., Local Government Board inspector, held an enquiry on the 28th inst. into an application of the Urban District Council for sanction to the borrowing of £750 for the purpose of public lighting.

Hackney.—The report on the proposed increases in the salaries of the engineer and electrician and his staff, which had been referred back, was submitted to the Vestry on the 28th inst. Various increases are recommended to date from June 1, 1898.

Removals.—We note that Mr. Percy Griffith, A.M.I.C.E., M.I.M.E., F.G.S. (late Mr. Jabez Church), has removed to 54, Parliament-street, Westminster.—Messrs. O'Gorman and Cozens-Hardy have removed their offices to 66, Victoria-street, Westminster.

Cheltenham.—A special meeting of the Town Council is announced for the 24th prox. to consider the question of applying to the Board of Trade for an amendment of the Cheltenham Electric Lighting Order, 1890, enabling them to extend the area of supply to the whole of the borough.

Presentation.—Mr. E. Cross, of the Bradford Corporation Electricity Department, has been appointed assistant to Mr. J. A. Bell, the city electrical engineer at Aberdeen, and on Saturday last he was the recipient of a very handsome writing desk, which had been subscribed to by the whole staff.

Barnsley.—Tenders for the execution of the various works required to carry out the proposed scheme of electrical supply in the borough are to be advertised for. Twenty-three thousand three hundred pounds is the estimated cost, and £25,000 is to be borrowed. The work will be commenced as early as possible.

Bromley.—At the last meeting of the Urban District Council there was a discussion on correspondence relating to objections to the proposed chimney shaft at the electric light works. The Clerk remarked justly, that if the shaft was in accordance with the by-laws, the Council had no power whatever to prohibit the erection of it.

Gloucester.—At a meeting of the City Council on the 27th inst., it was agreed to purchase an additional piece of ground, adjoining the site on which it is proposed to erect the electric light works and ash destructor, for £4,000, subject to the approval of the Local Government Board, bringing the total for the site to about £12,000.

Falcon Works Cycle Club.—The Falcon Works Cycle Club, Loughborough, mustered a record attendance on Saturday last, when, at the invitation of Mr. Percy Sellon, a run was made to St. Bernard's Monastery, Charnwood Forest. Here refreshments were provided, and the club returned home in the evening after an enjoyable outing.

Hythe.—In consequence of an application having been made by the Folkestone Electrical Supply Company to supply Hythe with electric light, the Town Council have decided to take the preliminary steps to apply for a provisional order themselves, it being understood that before incurring any expense the resolution should be confirmed by the Council.

Longton.—At a special meeting of the Town Council last week it was decided to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the supply of electricity by the Corporation for public and private purposes within the borough of Longton. The Gas Committee has been entrusted with the matter.

Anglo-American Telegraph Company.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending 30th inst. of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less income tax, payable on Nov. 1 to stockholders registered on the books on the former date.

Weston-super-Mare.—At a meeting of ratepayers, convened by the chairman of the Urban District Council, a resolution was passed in opposition to the carrying out of the electric light scheme by the Council. It was also resolved to form a committee of townsfolk to oppose the application by the Council to the Local Government Board for money to execute the work. Copies of the foregoing resolutions were ordered to be sent to the Board of Trade and the Local Government Board.

Debenham.—The Parish Council have received a letter from Messrs. Jeyes and Godden, engineers, London, enquiring whether a proposed light railway from Ipswich, running north, and touching Debenham, Southolt, Stradbroke, Laxfield, and Cratfield, with branch to either Halesworth or Harleston, or both, and junctions to the Great Eastern Railway, would be likely to meet with local support. It has been decided to hold a public meeting on Wednesday next to discuss the question.

Vienna.—As previously announced, the preliminary contract for introducing electric power on the Vienna tramway system has

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been concluded between the Vienna Municipality and Messrs. Siemens and Halske. The system will be further extended, and the fares are to be lowered. Under the contract the city will receive a fixed share of the gross profits and a gradual share of the net profits. The Town Council has yet to give its final decision, which, it is expected, will be done next month.

Walsall.—The total number of electric light consumers supplied on Aug. 31 last was 111. An oil filter is to be purchased at a cost not exceeding £75. With a view to encourage the use of electric motors, and so endeavour to secure a day load for the generating plant, a special charge of 2½d. per unit will be made for current supplied for motor purposes only. An enquiry has been made as to whether an extension of the cable should be made to Lichfield-road, but the committee do not at present recommend such extension.

Brazilian Submarine Telegraph Company, Limited.—The directors have decided, after transferring £25,000 to the reserve fund, to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30 last, and also the payment of a bonus of 2s. per share, both free of income tax. The balance of the account, subject to audit, is carried forward. For the purpose of paying the dividend and bonus on Oct. 27, the register of transfers will be closed from Oct. 18 to 26, both days inclusive.

Turkey.—The *Standard* correspondent wires from Constantinople that Sir Ashmead Bartlett, M.P., has obtained a concession from the Porte for the electric lighting of Smyrna and Salonica, together with the electric traction for tramways. He was also promised the preference, if ever a similar concession were granted, for the same purposes in Constantinople. The principal value of the concession for Smyrna and Salonica consists in the priority of right which it establishes in Constantinople, where alone a large profit from the use of electricity could be expected.

Rhyl.—The District Council have under consideration draft schemes for supplying certain parts of the town with electric light, also for laying down a tramway from near the entrance to the Grand Pavilion to Prestatyn. Plans have been submitted by the engineers, Messrs. Alfred Dickinson and Co., and the firm has been invited to submit a detailed scheme for consideration. It has been resolved that the members should in a body visit some of the Lancashire seaside towns, including Southport, Blackpool, Morecambe, and Fleetwood, to inspect similar works.

Bo'ness Docks.—The work of fitting up the installation of electric light at Bo'ness Docks has now practically been completed, and, after being tested and inspected by the harbour engineer, all the lamps were lighted last Saturday. The installation consists at present of 16 arc lamps of 2,000 c.p. round the harbour and docks, but lamps of less illuminating power will be fitted up on each of the coal hoists and at the dock gates, etc., and a connection will be made with the town clock, which the Harbour Commissioners have resolved to light up, as it is a guide to vessels entering the harbour at night. The contract was carried out by the Brush Company.

Liverpool.—Arrangements have been concluded for the improvement of the electric tram service at an early date. The night trials made on the line from the Dingle to Warwick-street with the new cars are stated to have been very satisfactory. The *Liverpoo' Daily Post* says the Liverpool City Council have passed the scheme for an experimental electric tramline between St. George's Church and the Dingle, on the distinct assurance that the cost would be £50,000. The Tramways Construction Committee, however, have already "outrun the constable," and are coming before the next Council meeting with a supplementary estimate of £35,000, bringing up the total to £85,000.

St. Marylebone.—The Vestry have received applications from two firms for permission to erect electric standard lamps on the public footway in front of their premises, and to remove two public gas lamps. The Works Committee recommends that the applications be granted upon the following conditions: (1) the lamps to remain during pleasure of Vestry only; (2) the lamps to be erected near to site of the public lamps intended to be removed to be kept alight during the same hours as the public lamps, provision being made for gas to be burned when electric light is extinguished; (3) the whole of the work to be carried out to the satisfaction of the Vestry's surveyor and at applicants' expense; (4) applicants to give written undertaking to the Vestry to reinstate, at their expense, existing public lamps, and to restore pavement, should Vestry call upon them to do so.

Wimbledon.—The report of the Electric Light Committee, adopted by the Urban District Council last week, recommended that the tender of Messrs. Babcock and Wilcox for pipe work be accepted, subject to their allowing the Council to withdraw the water-tanks and floor-plates from the contract and laying them elsewhere, thus reducing their tender to £1,104. Also that the Council authorise Mr. Preece to obtain additional cables at a cost of £3,000, to be included in a loan to be taken up later. The committee reported the reception of a letter from the Local Government Board with sanction to a loan of £4,050 for the dust destructor. They recommended that Messrs. Donaldson, Crimp, Clarke, and Caswell and Surgeon-Major McSheehy should be appointed a deputation to interview the Local Government Board with regard to the loan for the additional boiler.

Newark.—It is probable, says the *Newark Herald*, that the subject of supplying Newark with electrical power will come before the meeting of the Urban Authority on Monday, or if not then, at no distant date. The Electrical Power Distribution Company, Limited, London, have sent to the members of the Corporation copies of correspondence that has taken place concerning the introduction of the electricity supply into Newark, which they desire to do with as little delay as possible. The company ask for an opportunity of explaining to a committee more fully than is possible within the limits of a letter the nature of their proposals. They state that they are prepared to inaugurate an electricity supply, both for lighting and driving machinery, within 12 months of completing formalities, and ask for the consent of the Corporation to the grant of a provisional order to be applied for during the next session of Parliament.

Leamington.—According to the *Cheltenham Chronicle*, electric lighting matters at Leamington are just now attracting a good deal of attention. The Town Council have decided to apply to the Board of Trade for the grant of a provisional order to light the town with electricity, but meanwhile the Midland Electric Light Company, which already supplies numerous private consumers in Leamington, and is in possession of the field, is laying down new mains. The British Electric Traction Company, and the Warwick and Leamington Tramways Company, are agitating at the same time for permission to reconstruct the trams now plying between Warwick and Leamington, by substituting in place of horse traction the electric overhead system; but to this method the powers that be are unanimously opposed. The Progressive party in the town is looking forward with confidence, in spite of the difficulties which have to be surmounted, to illumination in the near future by means of the electric light.

Acton.—The *Daily News* publishes the following letter from Lord George Hamilton, M.P., in reply to a request from the Acton District Council asking him to oppose the Bill promoted in the last session of Parliament by the General Power Distributing Company. His Lordship writes: "I have to acknowledge the receipt of your letter. I am in favour of local authorities having control over the lighting in their districts, and, where practicable, applying the profits of such enterprise to the reduction of the rates of the locality. On the other hand, private enterprise will often develop experiments and initiate improved methods of lighting which the local authority may not be able to conduct themselves, and it is by the combination of the two methods that the community at large may be most benefited. The Bill to which you call my attention is postponed till next session, and I shall be glad, when it comes up in a new shape, to hear what the views of the Acton District Council are."

Bermondsey.—At the last meeting of the Vestry it was decided: "That application be again made to the Board of Trade for a provisional order authorising the Vestry to supply electricity for public and private purposes within the parish; that a special meeting of the Vestry be held on Oct. 24 to consider this recommendation, and, if so desired to pass a resolution to apply to the Board of Trade, as provided by the Electric Lighting Act, 1882." A notification was received from the London Electric Supply Corporation, Limited, of their intention to lay high and low tension distributing mains in Bermondsey New-road, Star-corner, Grange-road, Spa-road, and Jamaica-road. The plan showed mains on both sides of the street. It was resolved, on the motion of Mr. Cox to inform the company that the Vestry disapproved of the works and plan so far as related to the low tension distributing mains and to the laying of mains on both sides of the street; and that they (the Vestry) had appointed a special meeting in order to pass a formal resolution to apply for a provisional order.

Huddersfield.—The electrical engineer's report presented to the Town Council last week, showed that from August to September the number of consumers had increased from 707 to 720, and of lamps connected from 47,348 to 48,045. The units metered in August were 31,337, as compared with 18,330 last year. This increase of 13,007 is equal to 71 per cent. In response to a request from the Tramways Committee, the Electric Lighting Committee have recommended the adoption of electric traction upon the Lindley, Edgerton, and Outlane section; that the system should be the overhead trolley one; and that the charge to the Tramways Committee should be 1½d. per unit. Details of the scheme to be adopted have been given in a report by the electrical engineer, who estimates the cost—adding £599 for contingencies—at £31,500. The accounts amount to £1,781. 3s. 3d. The Tramways Sub-Committee have recommended, in the event of additional rolling-stock being required, that electric traction on the overhead trolley system should be adopted as an experiment on the Lindley, Edgerton, and Outlane routes.

Lewisham.—At the last meeting of the District Board a letter received from the Board of Trade referring to previous correspondence on the subject of the Blackheath and Greenwich District Electric Lighting Order, 1897, and stating that after giving careful consideration to the representations of this Board they had decided to consent to the supply of energy by the undertakers on the alternating-current system within that part of the area of supply under the order which was not included in the area of supply under the London Electric Supply Corporation Electric Lighting Order, 1889, was referred to the Works Committee, as was a communication from the Blackheath and Greenwich District Electric Light Company, Limited giving notice that after the expiration of one month from the service of the notice they, in exercise of the powers conferred on them by their Electric Lighting Order, 1897, intended to commence the laying of mains from the boundary of Greenwich parish along Lewisham-road, Lewisham-hill, Aberdeen-terrace, Haddo-villas, Eliot-vale, and Eliot-place. At the same meeting it was decided to apply for a provisional order empowering the Board to provide electric lighting for the district.

Catalogues.—We have received from Messrs. Armitage and Co., Mount-pleasant, Clerkenwell, particulars of their incandescent lamps, for which they claim small consumption of current per candle

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power, combined with increased durability and a brilliant, white, and uniform light.—Under the title of "Electric Light Fittings," Messrs. Drake and Gorham, London (Manchester, and Glasgow) present a list of about 600 various lamps and candelabra and a large number of well-executed half-tone plates illustrating the same. One of the latter is especially remarkable, depicting a fitted dining-room, and showing an improved system of dining-room table lighting which obviates the necessity of cutting the cloth. The arrangement, which is patented, consists of a flat multiple connector of a special pattern, which lies in the centre of the cloth and enables any number of adapted candlesticks to be fed from the distributing centre. The wires pass from a floor plug up the leg of the table, and thence by means of a white silk cord under a serviette to the ornamental table centre for ordinary work. On special occasions the serviette is replaced by a covering of flowers taken to each corner, there being, of course, a wire under only one of these. This apparatus is listed at a comparatively very low figure.

Ipswich.—The "Friendly House" (Messrs. Edward Brand and Sons' drapery and furnishing business) has been fitted with electric light. The public will participate in this improvement, for two 1,500-c.p. arc lamps have been placed outside, thus practically lighting the whole street. Messrs. Crampton and Co., of Cambridge and Great Yarmouth, have carried out the work of installation, and have put down a Crossley electric light high-speed self-starting engine, which has but one heavy flywheel, of 2¼ tons weight, giving 32 h.p., and one dynamo for 300 lights. The electricity is distributed all over the large premises, from distribution boards to their lamp circuits. From 250 to 300 lamps can be lighted at one time. The features of the installation are great steadiness of the light, it being impossible to see the pulsation of the gas engine, and the absence of noise from the exhaust. The latter is silenced by means of a concrete pit filled with rubble, an ordinary flagstone being cemented over the top, and a relief pipe 6in. in diameter provided. There is also a self-starting apparatus, thus saving at least the labour of three men. It is stated that the plant is being run at a remarkably low cost, the test on Saturday evening, when the new light was turned on for the first time, working out one-third less for the total number of lamps on the old form of gas-lighting—*i.e.*, taking candle-power for candle-power.

Haslingden.—The *Observer and Times* publishes an interview with Mr. Musgrove, the town clerk, on local matters. With regard to the Council's resolution to make application to the Board of Trade for a provisional order for the establishment of an electric lighting system, Mr. Musgrove referred to a notice of application made by the Electrical Power Distribution Company, of London. The Council had not yet considered whether they would supply electric power for the running of small works for private people in the town. They would probably generate electricity during the day to be used at night. The motive power to be used in connection with the refuse destructor would work the electric plant. Both the destructor and the electric lighting station would be worked as a joint undertaking at the town's yard in Hud Hey-road, near the railway station. They had to get the consent of the Local Government Board to utilise a portion of that site for the joint scheme. They were about to appoint an electrical engineer to advise as to the cost of the project and other matters connected with it.—The Accrington Corporation own the tramways up to the boundary between Baxenden and Haslingden, the remainder of the system to Rawtenstall belonging to a company. If the motive power in Accrington borough is changed into electricity, probably arrangements will be made to supply a similar power at Haslingden.

Middlesbrough.—The introduction of the electric tram service on Tees-side has not been an unmixed benefit. The public have almost now entirely forsaken the means of transit by water between Stockton and Middlesbrough, in consequence of which it has been decided by the owners to discontinue running their passenger steamers between these boroughs at the end of the present month. These boats have been used by the public for the last 40 years.—At a special meeting of the Middlesbrough Corporation Streets Committee on Friday last, a letter was read from the Local Government Board enclosing a copy of the regulations as to speed affecting the borough of Middlesbrough. The tramway company had applied for permission to run at the rate of eight miles an hour in most of the district, and 10 miles between certain points, while the Corporation contended that nowhere should the rate exceed eight miles an hour. The regulation fixed by the Board gave powers for running at eight miles an hour throughout, except at certain corners, and at all points fixed or movable, where the speed is not to exceed four miles an hour. The three months allowed for the settlement of the paving, to the height of which above the rails three months ago the Corporation objected, expiring the next day, the borough surveyor was asked to make an inspection of the lines, and to report to the next Streets Committee. A letter with reference to the proposed tramway extensions from Mr. Clifton Robinson was also read, but was deferred to the next meeting.

Hull.—The apparent delay in the matter of the construction of the Hessle-road section of the new electric tram system at Hull engaged the attention of the committee on the 22nd inst. The *Leeds Mercury* states that an erroneous impression has got abroad that the time allowed the contractor for the completion of the section had expired. Had such been the case, it would have been unfortunate for the contractor, because a large portion of the road still remains to be taken up, and the accumulated penalties for non-completion within the specified time would have been enormous. But Mr. Nichols, by the terms of his contract, was allowed until Nov. 1 next to complete the section named, and so sanguine is he that the work will be done by the date named that he sent a letter to the committee expressing the opinion that under ordinary circumstances there will be no delay. If such proves to be the case, the inhabitants of Hull will soon see electric tramcars running in their midst. When the Hessle-road section is completed, Anlaby-road will be taken in hand, it being the intention of the committee to have this work completed in time for the Yorkshire Show at Hull in 1899, this being the main thoroughfare to the exhibition grounds. Steps will be taken probably to have this work carried out in sections, as greater expedition will be ensured, and the work completed easily within the desired period. After Anlaby-road, there will be taken in hand the reconstruction of the Spring Bank and Beverley-road routes, the Holderness-road, which will be the last, completing a service which altogether will cost nearly half a million of money.

Coventry.—Considerable progress is being made with the construction of the new lines of tramway in the city by the contractors (Messrs. Pauling and Co., 28, Victoria-street, Westminster) to the General Traction Company. Mr. H. C. Elliott is the contractor's agent, and Mr. McMahon is in charge of the electrical work. Nearly the whole of the lines have been laid with the exception of the 15 turn-outs. The extensions now being carried out comprise 5¼ miles, and it is not now proposed to extend the system to Chapel Fields. There will be 12 cars, each 18ft. long, with garden seats on the top instead of the longitudinal seats as on the present cars. There will also be four trail cars, to be used in case of pressure of traffic. The turn-outs are about a third of a mile apart, considerably wider apart than on the existing route. The feed cable will be carried in conduits built underground at the side of the rails. The rails are welded together on the Falk system. The whole route will be provided with bracket poles erected on one side of the road only, the brackets varying from 12ft. to 24ft. The generating station and depôt now being erected near Priestley's Bridge comprise a car-shed, repair shop, generating station, etc., and offices. The depôt will contain two boilers of 100 h.p. from the old depôt, supplemented with two new ones of 172 h.p. each. There will be two of Messrs. Browett and Lindley's tandem compound-condensing horizontal engines, capable of developing 150 h.p., and two engines from the present depôt of 125 h.p. The erection of the poles and the overhead wires, it is expected, will be finished within five weeks.

Dewsbury.—The *Dewsbury Reporter* publishes an interview with Mr. W. Gumbley, the Electric Traction Company's engineer, who is reported to have said that the company's proposals were, apart from Bradford-road, to run from the Dewsbury Market-place up Halifax-road, through Staincliffe to Heckmondwike, and then forward to Liversedge and Cleckheaton. They also proposed to run from Dewsbury, along Huddersfield-road to Ravensthorpe. The question of continuing the latter line to Mirfield had been considered, but he thought that would be held in abeyance for a while. Mr. Gumbley went on to say that although the Dewsbury Corporation had decided to oppose his company, the application would certainly be proceeded with in November next. Then if the order was granted the company would lose no time in carrying out the work. The paper continues to say that local opinion is in favour of the authorities taking up the question and promoting a local scheme. Representatives of the electric company have also had an interview with the Dewsbury, Batley, and Birstall Tramways Company, the object being to arrange, if possible, for the taking over of the local company's system, and the two companies are still negotiating on the matter. Should the electric traction company obtain the powers they are seeking, and also take over the present concern, a splendid system of electric tramways, connecting all parts of the district, could be established. Failing an arrangement being come to regarding the Bradford road system, the electric traction company will proceed with their application to Parliament, and seek for powers to construct lines from Dewsbury to Heckmondwike, Liversedge, Cleckheaton, and Ravensthorpe. The Dewsbury Corporation has decided, as previously noted, to oppose this latter application.

Newcastle.—The New Tramways Committee of the Corporation held a meeting on the 23rd inst. and discussed the special provisions they deemed advisable should be inserted in the omnibus Bill the Corporation will promote in Parliament next year. Amongst other items the following were agreed to be recommended for inclusion in the Bill: Provision that notwithstanding anything in the Tramways Act, 1870, to the contrary, the Corporation may place or run carriages on, and may work and may demand and take tolls in respect of, any tramways for the time being belonging to them within the city, and with the consent of the urban district council of the district in which the same shall be situate, any tramways outside the city which may for the time being be connected with any tramway of or worked by the Corporation, and may both, within and without the city, provide such stables, buildings, carriages, trucks, harness, engines, machinery, apparatus, horses, steam, electric, cable, and other plant, appliances, and conveniences, and may construct and place in, under, and over any public streets all such works, apparatus, and appliances as may be requisite or expedient for the convenient working or user of such tramways by animal or mechanical power, and whether such working or user be by the Corporation or by any lessee of the Corporation, but as regards any streets in the district of any urban district council not without the consent of such council, and may sell, exchange, or dispose of such of the before-mentioned articles and things as from time to time may no longer be required; and that Section 13 of the Act of 1892 be repealed. That the provisions for the time being in force with respect to the working of the tramways and

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the taking of tolls, rates, and charges therefore shall extend and apply to the tramways for the time being, so worked by the Corporation and to the Corporation in relation thereto. That "mechanical power" shall, for the purposes of the Act, include steam, electric, and every other motive power not being animal power. Provision that the Corporation may use the lands——for the purpose of generating electric energy, and may thereon erect, construct, and maintain all such buildings, engines, dynamos, machinery, apparatus, and appliances as may be necessary or convenient for the generating, distributing, and transforming, and supplying electric energy for any purpose for which electric energy is by the Act authorised to be used or supplied. Provision that if any of the tramways are worked by electricity the Corporation shall have power to light by electricity the streets within the city in which such tramways are constructed, and all buildings, etc., where public money is spent for the lighting of the same. It was suggested that a visit should be paid to Leeds and Sunderland in quest of further information, but the proposal was not carried, it being felt desirable to wait until the sub-committee had reported on the communications from the experts.

Leicester.—According to the half-yearly financial statement of the electric lighting department, adopted by the Town Council on the 27th inst., the total amount borrowed on capital account for electric lighting was £42,748. During the half-year £7,620 was spent, making a total expenditure to June, 1898, of £53,074, the department having overspent its capital account by £10,725. The total receipts for the half-year amounted to £3,559, against £2,402 for the corresponding half of the previous year, an increase of £1,157. The total expenditure was £1,804, against £1,402, or an increase of £402. The receipts from the sale of current amounted to £1,138, meter rents £33, and on the fittings account there was a decrease of £14. All the other items of expenditure showed a slight increase. The total profit for the half-year was £1,755, against £999 for the corresponding half of last year, an increase of £756. The profit on the capital employed was equal to 6·61 per cent., against 5 per cent. for the corresponding half. The interest for the half-year amounted to £1,127, against £635 for the corresponding half, an increase of £494. The sinking fund remained the same, therefore the committee employed during the half-year £13,387 more capital than in the corresponding half-year. The Chairman of the report, who presented the report, said that if they had borrowed that money at 2½ per cent. it would have cost them £117 only. As it was, they paid £494 for it. They suffered from this at present, but would get the benefit of it in the future. The net profit available for disposal by the Council was £46, as against a net loss in the corresponding half of last year of £215. Their business was continually increasing, and they were in a position to take on all the consumers who wanted the current. The extensions of their plant had been going on most satisfactorily, and the committee were exceedingly pleased with the progress made and with the results they had already obtained. Whatever the demand might be this winter their plant would be quite equal to it. Their first dynamos had by no means been a loss to revenue through not being able to supply all that was required. They were designed and delivered to them as being capable of supplying 11,199 8-c.p. lamps. Up to the end of June last, depending solely on those machines, they had wired in Leicester lamps equivalent to 35,000 8 c.p., and they had supplied lamps at one given time equal to 25,000 8-c.p, with these machines delivered to them as equal only to supplying 11,199. They were very satisfied, therefore, with the proved capacity of the machinery they had had, but their business grew so big that it became absolutely necessary to increase their plant. Referring to the capital charges, he thought they had come to an end of any special expenses chargeable to revenue account. In future anything which could reasonably be charged to capital account would be dealt with in that way, this account being so low. He compared it with other towns of a similar size to Leicester, and quoted the following figures: Portsmouth stood at £124 per kilowatt, Salford £115, St. Pancras £114, Stafford £95, Glasgow £87, Nottingham £79, Huddersfield £79, Hull £71, Bristol £73, Bradford £66, as against Leicester £45. The average of the towns he had mentioned was £90. They had reduced the price of current within the last three years to the extent of £1,400 a year. They could easily reduce it still further if the Council did not mind foregoing profits. Although there was still a deficiency on the revenue account of £1,323, they had got a sum put away in their sinking fund account of £3,923. In conclusion, he complimented the engineer and his staff, as well as the committee generally, upon the successful working of the department.

PROVISIONAL PATENTS, 1898.

SEPTEMBER 19.

19824. **Improvements in means or apparatus for facilitating calculations relating to secondary electrical batteries.** Morton Blencowe Cotterell, Waverley, Gravelly Hill, near Birmingham.

19827. **Improvements in electric arc lamps.** Bennard Henry Pomeroy, 55, Chancery-lane, London.

19855. **Improvements in the manufacture of electrodes for electric accumulators.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (La Société Roger et Rathier, France.) (Complete specification.)

19856. **Return signal device for electric bells and the like.** William Phillips Thompson, 322, High Holborn, London. (The firm of Ohl and Dieterich, Germany.)

19828. **Improvements in electric arc lamps.** Bennard Henry Pomeroy, 55, Chancery-lane, London.

19875. **Improved joint for telegraph and other wires conveying electricity.** Henry William Neild, 24, Southampton-buildings, Chancery-lane, London.

19876. **Improvements in the electrolytic separation of zinc from zinc oxide.** Oscar Julian Steinhart, Julius Leonard Fox Vogel, and Henry Ernest Fry, 24, Southampton-buildings, Chancery-lane, London.

19877. **An improved cell for the electrolysis of fused metallic chlorides.** Oscar Julian Steinhart, Julius Leonard Fox Vogel, and Henry Ernest Fry, 24, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 20.

19911. **Electric door lock for opening doors and gates at a distance.** Oliver Melville, Mosshill Cottage, Larkhall, Lanarkshire.

19913. **Improvements in arc lamps.** William George Heys, 70, Market-street, Manchester. (The Manhattan General Construction Company, United States.) (Complete specification.)

19936. **Improvements in controllers for electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

19937. **Improvements in or relating to electric braking apparatus adapted especially for use in electric tramways.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John B. Linn, United States.) (Complete specification.)

19938. **Improvements in safety devices for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

19939. **Improvements in electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Caryl D. Haskins, United States.) (Complete specification.)

19940. **Improvements in circuit breakers for three-wire electricity distribution systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

19941. **Improvements in electrostatic measuring instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

19942. **Electric engines.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Marcy Lelland Whitfield and Charles Clifton Cowan, United States.) (Complete specification.)

19951. **Improvements in electrical gas lighters.** Eugen Seiler, 18, Buckingham-street, Strand, London. (Complete specification.)

19959. **Improvements in systems of electrical distribution.** Charles Felton Scott, 322, High Holborn, London.

19960. **Improvements in or relating to electric railways.** Reginald Belfield, 322, High Holborn, London. (The Foreign Electric Traction Company, United States.)

19972. **A switch worked by clockwork or by electricity, or both, or by hand independently of either.** Joseph Hooper, 77, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, S c. 103, Aug. 9, 1898, being date of application in Natal.) (Complete specification.)

19974. **Improved carbon filaments for electric incandescent lamps.** Fritz Dannert, 40, Chancery-lane, London. (Complete specification.)

SEPTEMBER 21.

19983. **Improvements in searchlight projectors for electric arc lamps.** Talbot Duckitt and John Isaac Hall, 16, Fearon-street, Loughborough.

19985. **An improved incandescent electric light lampholder.** Alfred Howell, 4, Sandown grove, Lozells-road, Aston, near Birmingham.

20008. **Improvements in the manufacture of metallic covers for electrical switches, cut-outs, and the like.** Mark Lawton, 24, Temple-row, Birmingham.

20027. **Improvements in electrical apparatus for exhibiting and changing advertisements, signs, and the like devices.** Arthur Douglas Douglas, 12, Astey's-row, Islington, London.

20029. **Improvements in electric batteries.** William Stepney Rawson, 21, Greycoat-gardens, London.

20049. **Improvements in electric safety fuses.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Actien-Gesellschaft Elektricitaetswerke (vorm. O. L. Kummer und Co.), Germany.) (Complete specification.)

SEPTEMBER 22.

20068. **Improvements in electric arc lamps.** Haldame Gwilt Cotsworth, 123, Merton-road, Wimbledon, Surrey.

SEPTEMBER 23.

20154. **An improved form of electrical resistance.** Frederick Henry Royce and Ernest Alexander Claremont, Cook-street, Hulme, Manchester. (Complete specification.)

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20178. Improvements in or relating to switches for controlling electrical currents. James Booth, 50, Cherry-street, Birmingham.

20202. Improvements in electrical apparatus for operating railway points and signals. Théophile Ducousso, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 24, 1898, being date of application in France.) (Complete specification.)

20206. An electrical alarm to warn two vehicles approaching each other upon rails. Friedrich Pegelow, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 24.

20221. Improvements in the means or methods of signalling on electric tramways. James Kay and Alfred Horswill Gibbings, 2, Market-street, Bradford.

20227. Improvements in electric lampholders. Alfred Watson, 24, Temple-row, Birmingham.

20259. Improvements in or relating to electric railways. Louis Minturn Aspinwall, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 25, 1898, being date of application in United States.)

20262. Improvements in posts and bars applicable for telephone and telegraph posts, railway sleepers, and the like. Bror Olof Viktor Hellström, 6, Lord-street, Liverpool.

20274. Improvements in systems of controlling electrically-propelled railway trains. Frank E. Case, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 28, 1898, being date of application in United States.) (Complete specification.)

20275. Improvements in controlling electric motors and electrically-propelled railway trains. Elihu Thomson, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 28, 1898, being date of application in United States.) (Complete specification.)

20276. Improvements in systems of train control for electrically-propelled vehicles. William B. Potter, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883 Sec. 103, Feb. 28, 1898, being date of application in United States.) (Complete specification.)

20279. Improvements in telephonic call registers. Reginald Haddan, 18, Buckingham-street, Strand, London. (Heinrich Eichwede, Germany.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

20666. Dynamo-electric machine and motors. Brown.

20919. Electric signalling systems, such as fire alarms, telephones, and telegraphs. Walker and Walker.

21484. Electric motors. Lake. (Arno.)

22022. Manufacture of insulating material for electrical purposes. Beadle.

22276. Electrical propulsion of barges and boats on canals and rivers. Handcock and Dykes.

22375. Apparatus for effecting silent electrical discharges. Ortt.

23296. Indirect regulation of dynamo-electric machinery. Fairweather. (The Crocker-Wheeler Electric Company.)

23352. Manufacture of electrodes for electrolytic processes. Zimmermann. (Chemische Fabrik auf Actien vormals E. Schering.)

24520. Overhead lines of electric railways or tramways. Dawson.

25235. Roller bearing, locking, or undercarriage, applicable especially to electrical and other motor vehicles. Brougham.

25364. Electric switches. Lironi.

25816. Insulators. Sinclair and Aitken.

26827. Electric arc lamps of the enclosed type. Davis.

29852. Underground duct for electric railway leads and a contact slide to work therein. Hillischer.

1898.

242. Electric timepieces or clocks. Richard and Leutz.

4317. Trolley connection for canal boats. Shewring.

4820. Electric arc lamps. Siemens Bros. and Co., Limited, and Booker.

9340. Electric safety fuses or cut-outs. Verity's, Limited, and Steele.

9960. Electric meters. Boult. (Cauro.)

10437. Cut-outs and switches for electric motors and other electrical apparatus. Mower. (Cutler.)

13194 System of, and appliances for, outdoor electric lighting. Wilkinson.

13308. Electro-thermic incubator. Greville.

13895. Method of reducing the energy of magnetisation of electrical transformers when the output is small. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

15976. Electric arc lamps. Johnson and Wunderlich.

16029. Electric furnaces. Palmer and Williams.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Sept. 24	3,943	3,658	+ 285	—	—
Blackpool and Fleetwood Tramroad	,, 24	870	—	—	10,786	—
Bristol Tramways and Carriage Co.	,, 23	2,993	2,584	+ 409	—	—
City and South London Railway	,, 25	926	891	+ 35	12,814	11,694
Dover Tramways	,, 24	217	132	+ 85	6,207	—
Dublin U.T., elec. cars	,, 23	460	—	—	—	—
Dublin S.D. Electric Tramways	,, 23	1,041	563	—	—	—
Halifax Corporation Tramways	,, 21	295	—	—	3,432	—
Liverpool Overhead Railway	,, 26	1,680	1,407	+ 273	—	—
South Staffordshire Tramways	,, 23	646	618	+ 28	23,946*	24,084*

* Receipts since Jan. 1.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	14-15
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9½-10½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	10-10½
——	6	6-6½
—— Pref. Half-Shares	1	1½-1⅝
—— " "	5	4½-5
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24½-25½
—— 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	2¾-3¼
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	13-14
—— " " "	6	8½-9½
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	1¾-2¼
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2¼-2⅜
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅝-¾
Elmore's Wire Company	2	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22½-23½
—— 4 per cent. Debentures	100	101-105 xd
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5¾-6¼
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5¾-6¼
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oriental, Limited, £1 shares	1	1¼-1⅜
—— £5 Shares	5	7½-8
—— £4½ shares	4	6½-7
Oriental Telephone and Electric Company	1	1-1⅛
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	10	143-148
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	2¾-3¼
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	13	39-43
—— 5 per cent. Bonds	100	140-143
Waterloo and City Railway, Ordinary	100	125-130
Westminster Electric Supply, Ordinary	5	15-17

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NOTES.

Argentine Exhibition.—The arrangements for this exhibition, to which we have already called attention, are progressing. Exhibitors of electrical apparatus are asked to show their machines working during the whole time the exhibition is open.

Volta Centenary.—The Italian telegraphists have issued a pretty postcard, printed in three colours, to commemorate the Volta festival. The illustrations contain a cell in its primordial stage, a medallion of the inventor, a telegraph line losing itself in the distance, Como with its lake, and the arms of Volta's native city, where the first congress of telegraphists was held.

Telegrams to Klondike.—Reuter's correspondent in Ottawa announces that the Hon. James Roche, M.P., representing British capitalists, says that he has acquired the charter granted by the Dominion Parliament last session for the erection of a telegraph line to Dawson City, and that he has arranged with the Government for the construction of the line, which will be commenced forthwith.

Mica.—India, Canada, and the Ural provinces of Russia were until recently the only sources where mica could be obtained. There are some deposits in Australia, but they have not been worked. The output of the former mines is small, but it was sufficient for the demand for this material until mica came largely in use for insulating purposes. It appears, however, that a mica deposit has now been discovered in Bohemia, which is of an extensive character as well as containing material suitable for this special purpose.

The London School of Economics.—We have received a prospectus of the courses in statistics now commencing at this school in Adelphi-terrace. The usual saying, that "statistics can be obtained to prove anything," is so often quoted that too much credence may be attached to it. A systematic course in political economy and statistics is of great value to all, and perhaps it would be well in future to make our representatives on local authorities show evidence of having taken such a course before allowing them to tamper with public funds.

The Sweets of Office.—We learn from the *Electrical Review* of New York that H. J. Dolan, a lineman employed by the local telephone company of Flushing, L. I., climbed a 60ft. pole the other day to repair a switchbox. As he got near the box he heard the buzzing of honey bees and discovered that a swarm of them had located in the box. Dolan came down, made a torch of old rags, ignited it and climbed the pole again. He held the smoking torch underneath the box until all the bees were driven out. He then opened the box and found several pounds of honey.

Ferraris's Memorial.—The movement to collect a sum sufficient to erect a permanent memorial to Galileo Ferraris has not taken well in Italy. Neither the Government nor the provincial and municipal authorities have subscribed to it; in fact, the whole of the subscriptions up to date amounts to about £600, hardly enough to build a college, as some of the promoters had proposed. The international jury which was to adjudge between the schemes sent in, for which competition a prize had been offered, has not yet announced its decision, but *L'Elettricità* has learned that it will not fix upon any of the proposals, and that the competition will be advertised again.

Practical Science in the Calcutta Corporation. The following in an excerpt by *Indian Engineering* from the reported debate on the Calcutta tramways question at the municipal meeting: "Mr. Baker had just one word to say in reply. Mr. Apcar had stated in his speech that electricity was neither an animal nor a mechanical power, and therefore under the contract the company would be acting illegally in introducing electric traction. He maintained that electricity was a mechanical power, and in this he was supported by the chief engineer to the Government and Babu Behary Lall, the legal remembrancer. Mr. Apcar had, therefore, found a mare's nest."

Telephones for Municipal Purposes.—At the last meeting of the Paddington Vestry a resolution was brought forward "that six or eight telephone stations be established at suitable points within the parish of Paddington, with lines converging to the Vestry Hall, for communication with chiefs of each department on parochial matters by the staff, vestrymen, or ratepayers, free of charge." Mr. Waycott, the mover, argued that Paddington should thus lead the way with regard to the establishment of municipal telephones. He believed that by setting up telephone stations a great benefit would be conferred upon the parish. The matter was finally referred to the Works Committee to consider the costs, etc. Surely this is a case where public call offices could be used to advantage if the vestry already subscribed to the National Telephone Company.

Enamels.—The use of enamel as the insulator for the resistance wires of electric heating and cooking apparatus is now general, and manufacturers have found out which enamels give the best results. The desiderata are, firstly, that the expansion of the enamel shall be about the same as that of the metals employed, and, secondly, that the enamel shall not be very brittle. Mr. Saglio's researches on highly-expansive enamels, contained in his paper to the Société d'Encouragement de l'Industrie Nationale, are of interest in this respect. He found that silica, kaolin, petalite, and zircon impart to the enamel infusibility and insolubility, but lessen the expansiveness; that calcic phosphate increases the expansiveness, gives viscosity to the enamel in fusion, and imparts to it a certain insolubility; that cryolite, fluorspar, and, above all, rutile (which seems to fix the boracic acid well), increase the expansiveness and the fluidity of the enamel.

Electrically-Propelled Carriages.—Mr. Walter C. Bersey sends us a well-got-up volume on the above subject, which gives a full history of development of such carriages as far as the author is concerned. Of course, the London electrical cabs take a prominent part in the book, the first illustration being of a line of these cabs extending almost to infinity. The preface demands a high position for the art of electric carriage building. The author says: "The world has taken a great and decisive step forward in the process of that development which is decreasing the importance of the physical powers of men and the other animals, and unchaining and utilising the stupendous slumbering energy of inanimate nature. There has been no revolution and no great fundamental discovery; there has only been a wonderful and sudden application of the long accumulating knowledge of electric science." After this the author gives an elementary theory of the action of electric motors, and then describes a number of electrical vehicles. The illustrations make the book a most interesting one.

The Institution of Junior Engineers.—The annual general meeting of this institution will be held on Friday, Oct. 14, at 8 p.m., at the Westminster Palace Hotel. After the council's report has been read and considered the meeting will proceed to elect officers for the new session, which is the eighteenth session of the institution. On Saturday, 24th ult, a party of about 100 members of this society availed themselves of the opportunity kindly afforded by Sir David Salomons, Bart., to inspect his engineering workshops, laboratories, lecture theatre, etc., at

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Broomhill, Tunbridge Wells. The numerous scientific instruments and special appliances employed for electrical and other experiments were examined with evident appreciation. Sir David showed the members the general mode of working with them, and in many other ways devoted himself to rendering the occasion interesting and enjoyable, for which, at the conclusion, Mr. H. B. Vorley, the chairman, expressed the cordial acknowledgments of the institution. Sir W. H. White, F.R.S., is to deliver his presidential address on Friday, Oct. 21.

Electricity on the Metropolitan.—At the recent extraordinary general meeting of the Metropolitan District Railway Company, held to authorise the directors to proceed to connect up their lines with those of the London, Tilbury, and Southend Railway, in the course of his remarks as chairman, Mr. J. S. Forbes said: "The extraordinarily fine weather and the coal strike in Wales had terribly punished their traffic, as the tunnels had been abnormally disagreeable. The adoption of electrical traction would get rid of those disadvantages. He thought the salvation of the District Company, and of the Metropolitan Company too, depended to a certain extent on the substitution of electricity for steam. They had powers to adopt the electrical system, and one of the objects of the resolutions before them was to put that into effect. It would involve an outlay of £500,000 in the case of the District Railway, but the directors did not desire to ask the shareholders to incur that cost until they had before them the report of such eminent electrical authorities as Sir J. Wolfe Barry and Mr. Preece, the electrician of the Post Office."

Electric Snow.—Lieutenant John P. Finley, who is said to be one of the best informed meteorologists in the United States, encountered an electric storm in making an ascent of Pike's Peak. He says the storm could best be described as "a shower of cold fire." In reality, it was snow charged with electricity in such a way as to present a scene more easily imagined than described. At first the flakes of this wonderful snow only discharged their tiny lights on coming in contact with the hair of the mule on which the lieutenant was mounted. Presently they fell thicker and faster, each flake emitting its spark as it sank into drifts of the snow, or settling on the clothing of the lieutenant, or the hair of the mule. As the storm increased in fury and the flakes became smaller, each of the icy particles appeared as a trailing blaze of ghostly white light, and the noise produced by the constant electric explosions conveyed an impression of Nature's power which Lieutenant Finley says he will never forget. When the storm was at its height and each flake of snow was like a drop of fire, electric sparks were shaken in streams from the lieutenant's finger tips, as well as from his ears, beard, and nose, and a wave of his arms was like the sweep of flaming sword blades through the air, every point of snow touched giving out its little snap and flash of light. We fancy that the description is too vivid to be quite reliable.

Presentation to Mr. Frank King.—An interesting ceremony took place at the works of the Electrical Power Storage Company, Limited, Millwall, on the 29th ult., in the presence of some 300 of the staff and employés of the company, on the occasion of a presentation to Mr. Frank King on his retirement from the post of manager of the company. The presentation, which represented the joint contributions of the directors, staff, and workmen, consisted of an illuminated address, together with a silver centrepiece for the dinner-table. Mr. John Irving Courtenay, chairman of the company, in making the presentation, alluded to the enormous progress the storage battery industry had made since Mr. King became connected with the company in 1886, and in which the Electrical Power Storage Company had so largely participated. Mr. Courtenay pointed out how much the company was indebted to Mr. King's efforts for the position it now occupied. While expressing their unanimous regret that the state of Mr. King's health had necessitated his resigning the post of manager, he had much pleasure in stating that the company would continue to have the benefit of Mr. King's services as a member of the board of directors. Mr. King briefly replied, expressing his deep sense of the compliment that had been paid him, and his sincere appreciation of the kindly feelings that had always been manifested by all those with whom he had worked for so many years.

The Optical Exhibition.—The Spectacle Makers' Company is to be congratulated on the exhibition it has organised at the Mansion House. The exhibition is, says the *Chronicle*, a very comprehensive one, and includes specimens of the work of most of the best makers. Nearly every firm has some curio to show, such as "the spectacles of General Sir Charles James Napier" (Carpenter and Westley); the giant Chang's spectacles; astrolabes of the fourteenth to the seventeenth centuries, being the earliest form of scientific instrument in general use; also a French "Speculum Geographicum," or sailor's astrolabe, about 1590, with the motto, "Sic vita per horas" (Mr. Lewis Evans, F.S.A.). This gentleman, a collector, has by far the most interesting collection of obsolete instruments. There is among them Sir Samuel Norland's adding machine, invented in 1666, of which Pepys, in his diary, says, "Very pretty, but not very useful;" a Siberian loadstone, mounted in silver, 1741; and an English steel bar magnet, date about 1730, similarly mounted, and showing the transition from the loadstone to the present form of magnet. A large collection of portable sundials from England, France, Germany, Italy, and even Japan, showing the development of the various types from the fifteenth century to the present time, is perhaps the gem of Mr. Lewis Evans's collection. They show how, by means of a compass and a pocket sundial, our ancestors of 400 years ago were able to tell the time almost as correctly as we can nowadays. Mr. W. H. Cox exhibits a good collection of X-ray apparatus. The exhibition will close on Saturday evening next.

The London County Council Again.—The Highways Committee of the London County Council is again laying a rod in pickle for its own back. The Blackheath and Greenwich District Electric Lighting Company have sent in the usual formal notices of intention to lay mains in Blackheath-road, Lewisham-road, and elsewhere. The company also submitted six plans giving full details of the proposed works. These notices are sent to the London County Council as a highway authority for approval before the roadway and footpaths are disturbed. The Highway Committee reports, however, that "it appears that the intention of the company is to obtain from the London Electric Supply Corporation's mains at Deptford Bridge the supply of electrical energy for the areas referred to in the notices, which course seems to be inconsistent with the provisions of the order. They have therefore formally disapproved the works referred to in the notices, and have instructed the solicitor to report on the questions involved." They add that it will, of course, be open to the company, after further consideration, to serve fresh notices in respect of the works. Still, delay is caused, and an interview with the engineer of the company would, we expect, have removed the supposed inconsistency, and probably the London Electric Supply Corporation will only be supplying the current till the new station is ready. Apart from this, what has the Highway Committee of the London County

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Council, or the Council itself, to do with the question of where the current is generated? The Board of Trade will again have to rebuke the Council for their interfering and obstructing policy.

The United States Patent Office.—The report of the Patent Department of the United States of America for 1897 shows that in that year there were received 45,661 applications for patents, which is a greater number than for any previous year in the history of the office. Twenty-three thousand seven hundred and twenty-nine patents were granted, which number was only exceeded in 1885, 1890, and 1891, the highest, 26,292, being reached in the last-named year. It seems that the department is much behind in its work, as some 7,858 applications filed in 1897 had not been even examined at the end of the year. The Hon. A. P. Greely, in his report, commends the classification of patents such as is practised by the English Patent Office, and says that no public money is asked for or needed for this purpose. The income of the Patent Office is ample for this and every other need. He urges the enlargement of the library so as to increase the efficiency of the search department, which is also inadequate in numbers. He also points out that the British Patent Office publishes in book form abridgments of patents relating to the various classes of invention. Nearly every commissioner of patents for the past 40 years has recognised and urged the necessity for the publication of like abridgments of United States patents. They would be of very great value not only to the examiners in the office and to inventors, but to the general public.

Electricity in Entertainments.—A great advance in animated pictures is shown by the entertainment provided at the Alhambra Theatre, Leicester-square, by means of the Fregoligraph. This instrument is an improved Lumiére's cinematograph, the improvements being the work of Mr. Frégoli (of prestidigateur and lightning-change fame), and they consist mainly in arrangements producing increased steadiness and security against fire. They are as yet Fregoli's secret, but anyone may judge of their effect by witnessing the performance. Although the pictures are enlarged about 300 times, the originals being 1in. × ¾in. and the projecting screen 20ft. 6in. × 16ft., they are, besides being exceedingly funny, very clear, and an absence of the objectionable flickering is observable. The lense is kept perfectly cool by the insertion behind it of a large vessel filled with water. A hand-fed arc lamp taking 40 amperes supplied is used in the lantern. A feature of the entertainment is that the auditorium is supplied with light, during the intervals between the pictures, by a huge frame of coloured incandescent lamps, which are switched on simultaneously with the termination of the views. This relieves the monotony of waiting and gives the operator time to change the films. The installation at the theatre has grown so much of late that the plant has proved entirely insufficient for the demands made upon it. As further space for machinery was not available the current is now supplied by the Charing Cross and Strand Electric Supply Company. There are about 2,000 incandescent lamps (mostly 16 c.p.) and eight powerful arc lamps for stage purposes, two of which have been added this week. All the latter are hand fed.

Gas Engineers at Manchester.—The Lord Mayor of Manchester (Alderman Robert Gibson), speaking after a luncheon with the members of the Institution of Gas Engineers last week, referred to the honour done by the institution to the chief engineer under the Gas Committee of the city by choosing him for the position of president for this year. Passing to a consideration of the question of gas *versus* electricity, the Lord Mayor said that, in his judgment, there never was a time in the history of the country when it was more important that gas engineers should be very much alert to their duties and responsibilities than now. There was no very great difficulty about making gas; it was a very simple matter, but it was not so simple to make pure gas of a high illuminating power, and when they stood face to face, as they did, with that extraordinary and brilliant illuminant which was known by the name of electricity, it was of the first importance that gas engineers should exercise all the intelligence and ingenuity they possessed in order that they might not be run absolutely out of the field by electricity. It was a very extraordinary thing that not only in Manchester but everywhere else, as far as he knew, where electricity had become a great and potent factor, the increase in the production of gas had kept pace with the increase in the demand for electricity as a lighting power. In Manchester some four or five years ago they started an electric installation, which they thought was a large one, with a maximum of something like 20,000 16-c.p. lamps, and they also thought it would last for a decade at least, but it did not last 12 months. Now they had 70,000 lamps in Manchester alone, whilst at the same time there had been a considerable increase in the consumption of gas.

Financing Electrical Works.—Some idea of the way in which Continental banks support the electrical undertakings which they have floated may be gathered from the fact that the capital employed in the 60 electric companies financed by the Allgemeine Elektricitäts-Gesellschaft of Berlin is over 21 million sterling, added to which there are loans of about six million sterling. Banks have been most liberal in this respect, as last year, for instance, the paid-up capital of the Bank für Electrische Unternehmungen at Zürich has been doubled. By far the larger part of the undertakings of this bank are now controlled by the Allgemeine Elektricitäts-Gesellschaft, as when the Zürich Bank called in the other 50 per cent. of its capital, shareholders had the option to exchange their £200 shares against £100 shares of the Allgemeine Elektricitäts-Gesellschaft, and most of them availed themselves of that privilege. The balance-sheet of the Zürich Bank shows a gross profit of over £72,000 and a net profit of over £42,000 for the year 1897. A dividend of 5 per cent. has been paid, as in the previous year. None of the works controlled by this bank were in working order in 1897, so that at the end of 1898 a large dividend may be expected. The bank controls about a dozen electric light and tramway companies in Genoa, Seville, Barcelona, Chili, etc., including the Seville Tramways Company, London. Its assets amount to £1,178,000 (a considerable increase from the £1,303,500 of last year). A good deal of light is thrown into the working of this system of financing by the details of that sum. It is composed of £440,160 advances on works, £632,000 shares for sleeping partnerships (the latter arrangement having given place to former mode of giving credits), £220,000 advances on accounts current, and £5,000 advances against securities. The smallness of the latter amount, as compared with the sum total, is very significant.

Electric Traction near London.—Our esteemed contemporary, the *Journal of Gas Lighting*, has much to say about the letter from the London United Tramways Company to the London County Council we reproduced last week. The idea permeating the criticism is that the company should have included all their lines in the Bill and fought the London County Council in Parliament. This would have been a good thing for the parliamentary counsel, but bad for everyone else. After condemning the policy of the company, the editor proceeds as follows:

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"The world may consent to endure the overhead trolley system of tramway working for want of something less unsightly and dangerous, but it is a reproach to modern electrical science, not a credit, that nothing of the kind is available. None but the most perfervid of enthusiasts for electric traction at all costs would consent, say, to Piccadilly-circus being delivered over to the overhead trolley system. In resisting the threatened encroachments of the system on the outskirts of the town, the London County Council are only acting consistently with the principle underlying the objection to its advance into Piccadilly-circus. They are waiting for something better, and until this appears they are justified in protecting the region committed to their charge from unnecessary inroads." Our contemporary must surely be aware that the reproach to modern electrical science is most unmerited. Less unsightly systems than the trolley are available, and are in regular use in the central parts of many towns, but for suburban roads the trolley is best, and much the cheapest. The argument about Piccadilly-circus is a futile one. The trams and tramrails would be nuisances here, whatever system was adopted; and although we should not advocate the trolley in such a place, even were trams admissible, the unsightliness would be less than that of the telephone cables now overhead.

An Electric Contact Line at Leeds.—An interesting trial of a novel system of current distribution to electric cars was tried last week at Leeds. The system has been devised by Mr. Christopher Anderson, of Leeds. The Leeds Corporation have allowed him to put his plan into practical operation on half a mile of the tramway line in Harehills-road, and there it was publicly tested the other afternoon. Mr. Anderson calls this arrangement a closed-conduit system. We do not gather from the description before us that it is a conduit system at all. Along the track and between the rails iron boxes are sunk to the level of the road and some 18ft. apart. These are 3ft. long by 1ft. broad, and they enclose the circuit-making mechanism. As the car passes over each of these little chambers a rod rises 4in. above the level, and, coming in contact with the long collector on the car, transmits electricity to the motor. This done, the rod drops into the chamber, and the one immediately ahead of it rises automatically, and renders the same service, after which it also descends. This operation is continued along the whole of the track. It is only when the rod is elevated that it is alive; the lowering of it breaks the current, and as it falls before the car has quite passed over it there is no danger of anyone receiving a shock, though the top of it is level with the surface. As regards starting, when the car is about to leave the shed, the rod in the first box has to be raised; the rest depends upon the automatic action described. For his experiments Mr. Anderson has obtained the electrical current from the Corporation's station. From the above it is not clear whether the rods are actuated electrically, but the rising plunger seems to us likely to be a source of trouble when the streets are covered with snow or thick mud. The trials so far are reported to have been very successful, and we hope shortly to have an opportunity of inspecting the system *in situ*.

Measuring the Efficiency of a Dynamo.—Mr. Taeuber published lately in the *Elektrotechnische Zeitschrift* a description of a test made to determine the electrical losses in a 220-kw. three-phase generator with a vertical axis, coupled with a turbine; the object of determining the losses was to find the efficiency. Under the circumstances, the dynamo could not be uncoupled from the turbine, and, moreover, the design was such that the water pressure in the turbine relieved the pressure on the bearings; the generator could not, therefore, be run without also running the turbine. A motor whose efficiency was known or determined was belted to the dynamo shaft, and the current required for this motor was measured; a diagram of the connections is given. The turbine was first brought to normal speed by means of water power, after which the water supply was kept quite constant, and the turbine, therefore, generated the power to turn itself, the dynamo, and all the friction and air losses in the dynamo and the small motor; the field was then excited, which reduced the speed; current was then supplied to the motor to bring the speed back to the normal, and the electrical energy was measured; the results are given in curves, which give one of the factors in determining the efficiency. Similar tests were then made to determine the copper losses, and the Foucault currents caused by the armature current, the three-phase generator being short-circuited through three ampere-meters; this gives the other factor for calculating the efficiency. The motor was then uncoupled, and the energy measured to bring it up to the same speed as it had in the tests. Although a change of speed could not be observed for a less difference of energy than 1,000 watts, the results are not as inaccurate as it might at first appear; the losses of about 5 per cent. were determined with an accuracy of about 8 per cent., so that the efficiency of the generator was determined to within less than half of 1 per cent. The above is taken from Mr. Carl Hering's digest in the *Electrical World*.

Autocars.—The *Weekly News* publishes a prophecy that within five years there will be—in our cities, at least—more motor carriages than vehicles drawn by horses. Within 10 years from now our old friend and ally, the horse, will doubtless have disappeared from all communities possessing fairly good roads or streets. In support of this glorious prospect, the results of trials recently conducted by M. Michelin for the Public Cab Company of Paris are quoted. It was found that an electrical cab carrying three persons, including the driver, consumes an average of about 8s. worth of fluid (electric juice?) per hundred miles of city streets, traversed at the speed of 12 miles an hour, which is double what the best cab horse is likely to do. A petroleum motor coach ran the same distance, at the same speed, with four occupants, on a total expenditure for fuel of about 7s. 6d. Of course, to this must be added the cost of repairs and several other items. "It is also," says the editor, "of vital interest to consider that an automobile will go in the most crowded thoroughfares three times as fast as the best horse, and more easily. A motor wagon may be driven on stretches of 300 miles a day without a single stop, if necessary, on the fuel it carries, and that at a speed which will average, on country roads, where there is not too much traffic to interfere, 30 and 40 miles an hour. During the races from Paris to Amsterdam, the capital of Holland, many of the competing machines were driven, on favourable stretches of road, at the rate of 50 miles for several hours in succession." So much for untechnical literature and disregard for public by-laws. In crowded thoroughfares in London, at least, the speed of all the vehicles is practically controlled by the slowest, and even the hansom cab gets no chance. Hence the motorcar will never get up to three times the speed of the hansom. We believe that the motorcars will come more into use, but as yet there is ample field for new and improved design. In oil-driven vehicles this need is very apparent, as both smell and vibration must be reduced.

Electrical Manufacture in America.—The official announcement that the Westinghouse Electric and Manufacturing Company has purchased all the stock and bonds of the Walker Company puts all the large electric firms

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under one management and control. The Westinghouse Company and the General Electric Company settled their differences in the same way some two years ago, and since then the Walker Company has gained prestige from the very fact of its independence. It was, of course, harassed by patent litigation, but in spite of that did good work, and obtained an increasing supply of orders. We cannot believe that this gigantic combination can have a good effect on the electrical industry in the United States as a whole, as all the stimulus of competition is lost. Still, we learn from the *Electrical World* that "there are electrical engineers who think that, looking at the matter from the technical standpoint, the general effect of the coming together of these companies will be beneficial. One reason for this opinion is the peculiar patent situation. Where in many cases one of the companies had broad fundamental patents, preventing the others from manufacturing a certain style of apparatus, the others in turn, or one of them, had patents on detail improvements which in effect prevented the first from constructing a modern machine under the original patent, so that in some instances neither one of the companies could manufacture the most suitable apparatus, and each was obliged to resort to makeshifts to avoid the claims of the other. Now all three companies can pick and choose the best combinations of principles and details patented by the designers of any, giving in many instances more satisfactory and less expensive construction. The cost of manufacture can also be reduced by proper distribution and differentiation of the combined work between the establishments, while the cost of selling may be much lessened by the elimination of the considerable expenses attendant on competitive struggling for contracts." This may be fairly true, but yet we do not think that the advantages outweigh the disadvantages ensuing from want of competition. The financial departments may gain, but the electrical departments and technical staffs will suffer from the combine.

Lord Armstrong's Experiments.—Prof. Stroud delivered an interesting lecture on "Lord Armstrong's Experiments on Electric Discharge," on Friday last in the lecture theatre of the Durham College of Science, Newcastle. The lecture was a most useful one, and at the same time the many lantern slides exhibited made it a popular one. Prof. Stroud gave a brief history outlining Lord Armstrong's research. Thus, in June, 1892, Lord Armstrong described in a paper, published in the *Proceedings* of the Royal Society, a series of beautiful experiments on electric discharge, illustrated by dust figures. The discharge was obtained by means of special arrangements with the Ruhmkorff induction coil. His lordship's book on "Electric Movement in Air and Water" enabled the reader to appreciate the further experiments on dust figures that had been made, as well as the beautiful results obtained by electric discharge over photographic plates. Several illustrations of these figures were thrown on the screen and described. The discharge for these experiments was obtained by Lord Armstrong at Craigside with his specially-constructed 16-plate Wimshurst machine, the arrangements being such that the discharge was of the "impulsive rush" type, as distinguished from that produced after "steady strain." Continuing, the lecturer said Mr. J. W. Swan, F.R.S., suggested to Lord Armstrong the expediency of applying the Lichtenberg method for distinguishing between negative and positive in his electric figures, and he also furnished him with various varnishes for surfacing the glass plates used in the experiments by this method. Some figures of the Lichtenberg type were exhibited. At the conclusion, Prof. Stroud, in considering the question of the use of such experiments as these, quoted Lord Armstrong's own words, "The more we pry into the mysteries of electricity, the more we shall be able to apply it to the service of mankind, but, apart from that consideration, knowledge, for knowledge's sake, is a worthy object of pursuit." This was the spirit in which Michael Faraday investigated, and just as his patient work in the laboratory brought forth an abundant harvest in the dynamo, induction coil, and transformer, so, within the past few years, they might point, on the one hand, to the long series of investigations of the electric discharge in a so-called vacuum tube by Sir William Crookes, leading to the important discovery of the X-rays by Prof. Röntgen; and, on the other hand, to the important research of Hertz on electric oscillation set up by discharge in air, leading, in the hands of Lodge and of Marconi, to the system of telegraphy without intervening connecting wires.

Brazed Rail Bonds.—We gather from the *Electrical World* that some novel track bonds are in use on the system of the Brooklyn Heights Railroad Company. The peculiarities of these bonds are that they are brazed to the rails, and the brazing is effected electrically. As they could not conveniently be brazed in place the bond is divided into two places, each half of which is brazed to the proper rail end in the yard, and when the rails are in place the two halves are riveted and soldered together. A valuable feature of these bonds is the fact that they are not, as are many bonds, longer than the tie-plate, but make use of the steel of the rail for return current conduction up to within 2in. or 3in. of the rail end, thereby greatly reducing the amount of copper for the same bond resistance as that of the cross-section of any electrical conductor, its examination being solely dependent on whether any increase in the copper would cost more in the long run than the saving effected, or *vice versâ*. Further consideration shows that the cross-section of the bond should be practically the same as that of the conductor which would be used to carry the same current to the station were the steel in the track not utilised for that purpose. This is due to the fact that the short sections of the track return, consisting of bonds, cost as much per foot of length as would a bare return conductor of the same section, and the drop within them is the same per foot of length. The size of long bonds is therefore determinable by the same rule which would be followed in fixing the size of a return feeder, the proper cross-section of short bonds being influenced perhaps to a certain extent by that necessary for contact with the rail and structural considerations. The bonds might in certain cases be of more than equivalent cross-section of the rails, and in any case should increase in size on approaching the power-house, or, in other words, be proportioned to the current flowing. Our contemporary goes on to point out that as the rails themselves serve another purpose beside that of supporting the cars, the determination of their cross-section becomes influenced thereby. The use of a light rail and a return feeder is in the present state of the art a great mistake. The return copper costs as much or more than the equivalent increase in rail section, and by putting the same investment in the latter the resultant mechanical improvement in the road-bed is practically obtained for nothing. Where return currents are extremely heavy, as in the neighbourhood of power-houses of large systems, rail sections of weights much greater than those now used would be advisable were such rail sections obtainable without extra expense for their rolling. A 200lb. per yard rail, if it could be obtained at the same cost per ton as a 100lb. rail, would be much more satisfactory when properly bonded up than the 100lb. rail if with the latter a return feeder costing as much as the extra 100lb. were necessary.

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ELECTRICAL DISTRIBUTION ON BOARD SHIP.

BY J. C. RAFFT.

The underlying principles requiring consideration in fitting up vessels with electric light are, generally speaking, outside the experience of the average electrician engaged on land; in fact, the requirements are unique in this department of electric lighting. The methods adopted for distribution on land are generally applicable on board ship, but the system that is chosen, "where practicable," in the majority of cases is the single-wire system, in which case the negative pole of the dynamo is placed in contact with the iron of the vessel, which serves for the return circuit. The precautions to be taken are set down in Lloyd's rules affecting electric light on board vessels, but the arrangement of the circuits will depend to a great extent upon the design of the vessel and the places to which the current is required to be carried. The conductors are in almost every case divided into mains, sub mains, and branches. The dynamo should be situated as nearly in the centre of the vessel as possible, so that the lights and the mains may be divided into two sections, one running forward and the other astern. If the installation be a large one and two dynamos are employed, these two sections may be independently supplied, for by this arrangement an accident in one machine will not affect the working of the other; also reducing the length of the runs of the leads and the loss due to fall of potential, and consequently a reduction in the cross-section of the conductors employed. This is also true if one machine only be employed, providing the divisions are equally balanced between the two sections. The forward and the astern mains can also be divided into two portions, one running on the port side and the other on the starboard side of the vessel; then the ends of these two branches are joined further on, forming a loop circuit. The following lights are generally what are required on board ship:

1. *Ordinary Lights.*—These lights are placed in such positions where there is plenty of light during the day, such as the cabins, which have large portholes; and the time during which these circuits are in use is usually from 6 p.m. to 11 p.m., at which hour they are switched off from the main switchboard, so that no lights which are liable to be required at irregular hours should be connected to this circuit. The ordinary lights are distributed over four decks generally—namely, the promenade deck, the upper deck, the main deck, and the lower deck—with a separately controlled circuit from the dynamo-room.

2. *All-Day Lights.*—These will probably be required on each deck, so that each circuit must be separately controlled. The time during which these lights are required is from 6 a.m. to 11 p.m.

3. *Detective Lights.*—These are used for giving a very feeble light when all other lights are extinguished in the passenger part of the vessel; consequently they must be placed so as to show a continuous light through the length of each deck. These have a circuit of their own.

4. *Cargo Lights.*—The arrangement of these lights will depend upon the position of the hatchway to the holds and the shoots to the coal bunkers. The branches from the mains in these cases will run to terminals instead of lamps, for flexible connections are used in such places, in order to allow the lamps to be lowered in the hole when taking cargo.

5. *Gangway and Passage Lights.*—These are used on the outside of bulkheads of deckhouses, and are arranged as nearly as possible at equal distances.

6. *Masthead and Side Lights.*—The main circuit for these lights will run to the forward portion of the vessel, only they must in no case be connected with any other circuit, and it should pass through the wheel-house or steering-house, where the switch should also be placed. These lights are fitted with a positive and negative lead complete, irrespective of the system adopted.

7. *Engine-Room and Boiler Space.*—The main circuit for these spaces are nearly always distinct from each other, and the branches are taken from them by means of specially constructed distributing boxes to meet the requirements of the case.

8. *Search-Lights.*—The circuits for these on board ship are special; they are directly controlled from the main switchboard, and should always have a positive and negative lead.

The general arrangements of the mains and sub-mains are shown in part in Fig. 1. The mains are shown running along the under side of the upper deck, which, of course, is the top of the main deck. The first advantage gained by selecting this position is that the cables are under a watertight cover, and by placing the casing which carries them with grooves downwards no water can lodge in them. Secondly, all the connections of the sub-mains and branches can be made on one deck, which also enables the fuses and switches to be placed near to the joints, with the advantage of being able to control every deck and group of lights from one deck, and there will be less difficulty in tracing any set of wires from its fittings in the event of breakdown.

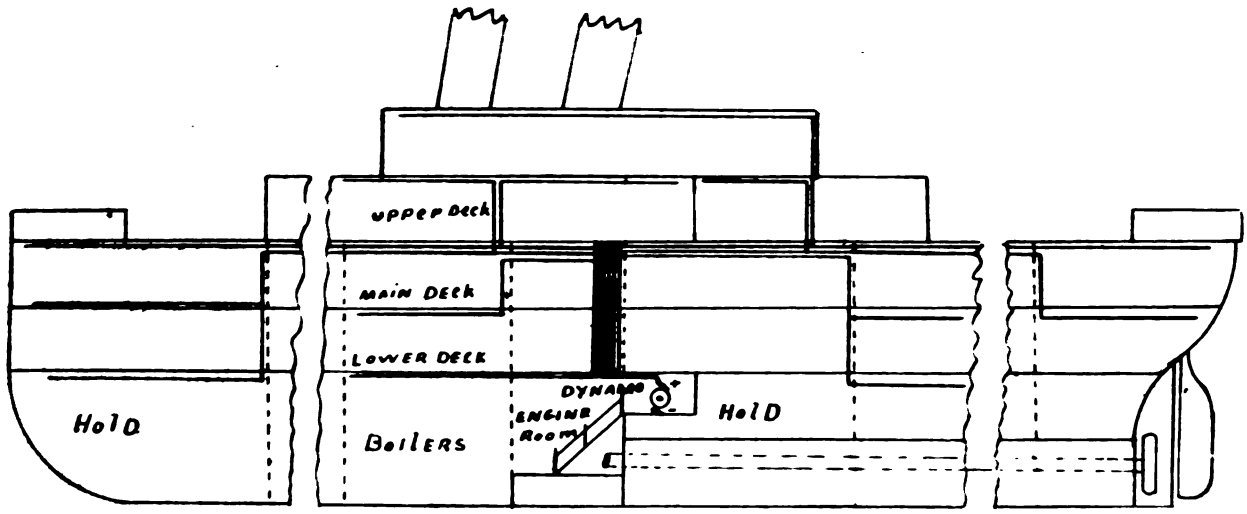

FIG. 1.

Before proceeding to put up any casing, the holes through the beams and other ironwork which cross the boat should be drilled. These holes must be large enough to take easily all small cables it is found necessary to carry through, after the holes have been well insulated by a vulcanite or papier maché ring. When the leads are run through watertight iron bulkheads, a special piece of apparatus is necessary where several cables are to be carried through. This consists of a cast-iron trough with holes in the sides just large enough for the cable to pass through; then the trough is filled with some insulating compound. But for small cables, and where there is no great number, the method shown in Fig. 2 is adopted. After the cable is placed in the proper position, one end of this tube is stopped, and melted insulating compound is poured into the open end. This is done and the compound allowed to set before the tube is placed in the hole.

In respect to the casing, several methods have been tried to render the casing impervious to moisture by the application of insulating substances which will fill up the pores

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of the wood. The most practical substance has been found to be a wax with a high melting point. The method of applying the wax is to melt it in an iron trough long enough to take the greatest length of casing, which will rarely require to be more than 10ft. for shipwork. Where the mains or sub-mains have to pass from one deck to another, whether of iron or wood, wrought-iron tubes are

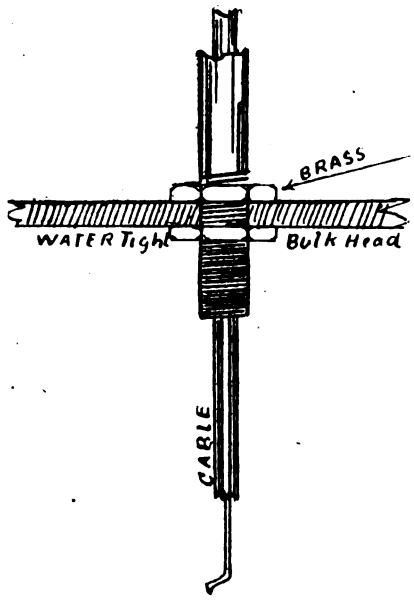

FIG. 2.

employed as represented in Fig. 3. These must be galvanised, and stand 6in. above the deck. When these tubes are fixed, the surplus thread at the bottom is cut away, and the casing is so fitted as to completely cover the nut.

The chief cause of failure to be guarded against is the action of the salt water, which in the form of vapour soon finds its way into every part of the vessel, and causes the greatest damage to the fittings by lodging in places which cannot easily be got at, forming rust on ironwork and rendering woodwork a good conductor, which increases the risks due to leakage, and the insulation resistance is soon found to be below the standard. The water will soon penetrate through the joints in the deck, which, if it has not also an iron deck beneath, will expand and contract by the influence of the water and the sun. This is always the case in a new vessel, and the fact should be remembered

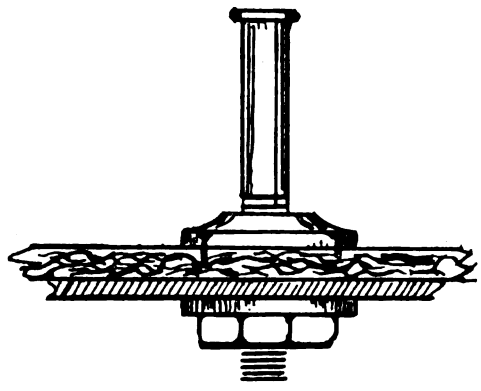

FIG. 3.

in choosing the positions for switches, fuses, and other fittings; also the strain to which every part of the vessel is subject when rolling, which opens crevices in bulkheads, straining casing and fittings, and loosening nuts and screws.

In the methods above considered it is assumed that ordinary insulated cable is employed, for there are other precautions to be taken, which principally arise from the nature of the cable employed and under what conditions. These conditions will be different in almost every ship. But the most important consideration is the variation of climate through which the vessel passes, so that when selecting the most suitable cable all the above items respecting the insulating material must be considered. When the installation is finished, "and if the separate circuits have been carefully tested during the progress of the work," there will be very little fear when the current is finally switched on. But, in addition, a final test should be made for insulation resistance. The directions for making such tests are always given with the instruments, but the voltage used in testing must be above the working pressure. In the above notes the general details and minor considerations affecting all installations are assumed to be well known.

ELECTRIC LIGHT ON TORPEDO VESSELS.

BY B. PONTIFEX.

The chief principle in naval and military electric light work is the use of the searchlight; consequently, when this is in action, all other lights are switched out, unless the vessel is big enough to carry more than one dynamo. This is never the case in torpedo vessels, owing to the imperative necessity of keeping down weight to enable them to attain their high speed; therefore the dynamo is made of just sufficient size to supply current to the projector only. The incandescent lighting in the engine-room and stokeholds is merely regarded as a luxury for use in the tropics or when under steam, since oil lamps are fitted for service. Foreign Governments show a good example to the British Admiralty in that they fit incandescent lighting throughout the boats, in stores, magazines, and cables, instead of compelling the use of oil or candle lamps everywhere, with the above exceptions. It naturally seems more sensible to enter a magazine with an enclosed and guarded incandescent lamp than with an oil light, reflected light being disregarded as requiring too much gear.

The dynamos on British boats, or foreign boats built in British yards, are usually two-pole, under-type, compound-wound machines of the well-known "Admiralty" pattern, though nearly every type which will allow direct driving has been tried. Multipolar machines, even in the smaller sizes, take up too much deck space, which is sometimes more valuable than any saving in reduced weight. The British Admiralty place the dynamo in the galley aft, and simply cover it with a wooden cupboard, but when machines are fixed in the engine-room the enclosed type is preferable. On English boats the machines are wound for 80 volts, an example followed by a few other nations—the Japanese, for instance. The Germans use 65-volt machines, but the abolition of a resistance in series with the projector, which they do not fit on all their boats, is more than counterbalanced by the extra weight of copper used in the incandescent wiring.

The type of steam-engine now coming into favour has also been adopted with a view to saving deck space. This is the tandem compound, single-crank, high-speed enclosed pattern. It takes up less space and is more economical than the steam-turbine, though, of course, more subject to vibration, but this last quality is not noticeable when the boat is under steam. Cylinder lubrication is not used in order to prevent oil being carried through the condensers back into the boilers. The crank splashes into an oil bath, from which a force pump, working from an eccentric, feeds oil on to the bearings. Steam is fed from the main boilers through the auxiliary steam-pipes, and reaches the dynamo at a pressure of about 195lb. per square inch, passing through a separator fixed close by the engine and exhausting either into the condensers or directly into the air above water-line. This last arrangement is only used when in harbour or when the condensers have broken down.

Wiring.—Ordinary two-wire circuits have been adopted because single wiring with return through the ship's hull has been condemned, owing to the effect on the ship's compasses and the difficulty of preventing corrosion and of making good contact with the "earthed" wires. Lead-covered cables are used, except in the officers' quarters of some foreign boats—*e.g.*, the German—where ordinary wires are run in wooden casing for the sake of neatness. Lead-covered wires are fixed by brass saddles bolted to the ship's framing and plates. The mains from the dynamo to the projector and section box or switchboard are $^{80}/_{20}$

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vulcanised rubber, taped and lead-covered, the lead being also covered with bitumen tape and preservative compound. The sub-mains to the distribution boxes are $^{11}/_{20}$ on

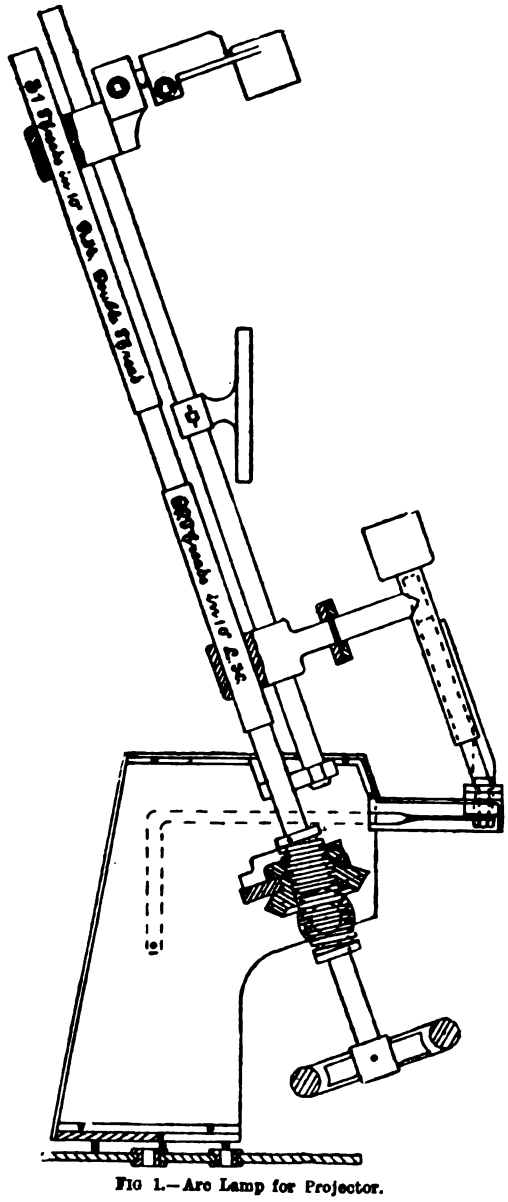

FIG 1.—Arc Lamp for Projector.

British and $^{7}/_{16}$ on many foreigh boats, and are of a similar character to the above. The lamp leads are $^{1}/_{16}$ insulated with vulcanised rubber, taped and lead-covered portable lamps the British Admiralty use $^{6}/_{28}$, and foreign Governments $^{37}/_{40}$ and $^{40}/_{40}$. These are covered with vulcanised rubber, twisted together and then heavily braided. Concentric wiring with an insulated and lead-covered outer would appear to be the most suitable system for use on board ship, as it can be made absolutely watertight, and in passing through bulkheads only one hole would be necessary, instead of two, and the increase in the size of the stuffing box would be hardly appreciable. But this improvement, like all others, is hampered by the labour and expense that would be incurred in changing the immense stocks of every requisite kept at all the different naval stations by our own and every other Government.

Searchlights.—Mangin's hand-feed lamp is generally used on smaller war vessels everywhere, carried in a 20in. projector. This projector has a body of wrought-iron plate, cylindrical in shape, with a concave mirror at one end and a plane glass door at the other. This is carried on swivels fixed to a revolving base, and is so arranged that a beam of light can be thrown in every direction and that the whole projector can be instantly locked in any position. A single-pole switch is fixed in the base. The lamp (Fig. 1) is carried inside on two grooved slates, and is held by a spring stop fitting into either of two insulating collars in the base-plate. This spring stop can be moved by an adjusting screw, so that the arc can be brought into focus on the mirror by shifting the lamp bodily along parallel to the axis of the projector. The carbons are separated and brought together by a handwheel actuating the upper and lower carbon-holders by two screw threads cut in the driving spindle. The screw working in the upper carbon-holder has a double thread, with a pitch of 31 in 10in., right-handed, the lower screw has a pitch of 62 in 10in., and is single-threaded and left-handed. By this means the arc is kept almost steady, as the upper or positive carbon burns nearly twice as fast as the lower. Any further focussing of the arc is obtained by means of a bevel-nut working on a screw cut on a sleeve, kept in place on the lower end of the driving spindle by two collars. This raises or lowers both carbons together without altering the arc.

The frame of the lamp is positive, and the negative carbon is therefore insulated by mica strips at the terminal, and by an insulating union on the driving nut. Both carbon-holders work on a guiding rod, and the positive is capable of adjustment by a small rack and pinion, which in turn can be moved sideways by means of a screw. The positive carbon is cored, and 28mm. in diameter; the negative is 25mm., solid. The resistance frame is wound to carry 100 amperes, and reduces the voltage from 80 to 50. Stranded wires of platinoid or manganin are stretched tightly over earthenware bobbin insulators, carried on bolts in a galvanised iron frame. The frame is covered with

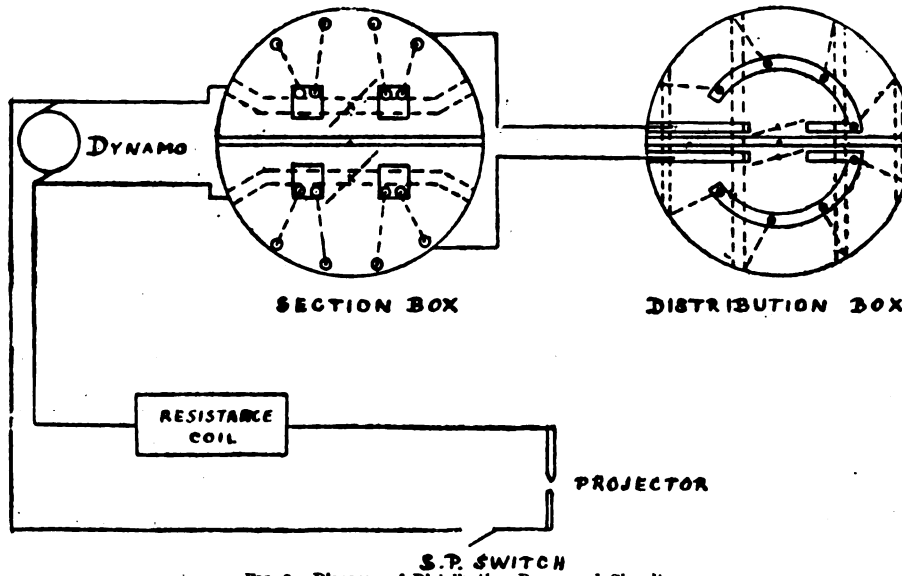

FIG. 2.—Diagram of Distribution Boxes and Circuits.

only, to the joy of the ship's carpenter, who always complains that the covering on the larger wires shows through any paint he may put over it. For perforated zinc sheet, which is strengthened in places by stout brass wire and steel cross-pieces. The resistance is usually fixed near the dynamo, while the projector is either

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placed on deck just aft the engine-room, on the bridge, or on top of the chart-house.

Fittings.—In torpedo vessels and other small warships the British Admiralty make use of what is termed a "section box" (Fig. 2) instead of a switchboard. This is a water-tight circular box of gunmetal or aluminium lined with slate; on this, in turn, is bolted a single slate slab carrying a double-pole switch and double-pole fuses. The switch works horizontally with laminated spring contacts, and has a loose handle fitting on a spindle projecting through the lid of the box. The different cables are brought through gunmetal plates, to which the lead covering is sweated, the plates being fastened to the side of the box with small screws. A slate bridge separates the positive and negative poles. The distribution boxes in each stokehold and engine-room are of similar construction, with an ingenious system of cross connection, shown in sketch, which gives a double-pole fuse to every lamp, at the cost of extinguishing *two* if *one* fuse breaks. In the distribution boxes the switches make and break vertically to save space. For smaller compartments with only three or four lights a distribution box of the above pattern would be too heavy and costly; in that case small joint-boxes (Fig. 3) are used to group the joints and protect them without the necessity of covering them with lead, which is apt to impair the insulation through overheating. These are simply oblong boxes of brass or aluminium split in half, with the wires let into each portion and then bolted together. With these, however, all switches must be provided with a fuse, and to do away with this on some boats small fuse boxes are fitted, carrying a slate base, with 'bus bars and double-pole fuses. These, of course, have the great advantage of abolishing joints. All switches and sockets are of gunmetal or brass, as they are often in exposed positions and liable to receive a heavy blow. The wires are led in through small plates to which the lead covering is sweated, as mentioned above in the case of distribution boxes. The British Admiralty still cling to a prehistoric pattern of lampholder. It is simply a small block of slate held in a brass sleeve, with two holes through which the wires pass,

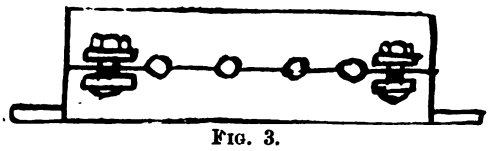

FIG. 3.

the hooks to engage in the bottom loops of the lamp being formed in the wires themselves. A spiral spring forces the loops and hooks to make contact. Other Governments usually adopt the Ediswan bottom loop-holder as used in merchant ships, although if the spring were shaped more like that in use in the British Navy—an inverted cone—it would be better adapted to steady the lamp against the shock of gun firing. The Germans use the Siemens and Halske holder with plaster-capped lamps, a combination that seems particularly ill adapted to withstand the shock of firing and the effects of heat and damp in the engine-room and stokeholds. Batten holders are fitted outside the binnacles and telegraph and steering pedestals on a gun-metal base with a brass cover. The usual method is to mount an oil lamp on one side of each dial and an electric light on the other, though the British Admiralty trust to oil only. Plain and bracket pendants are usually screwed to take gas-barrel, and are fitted without wooden bases, since these have been found to split quickly if subjected to heat. They are made of gunmetal, with a stout brass or copper guard over the well glass, which is held in india-rubber rings.

The British bulkhead fitting has a large teak base, with a polished reflector and a similar guard. Other Governments prefer a cast-iron oyster fitting with an enamelled reflector. Standard portable lamps are generally not used, unless there are catches fitted to tables, etc., to hold them in their places. The Germans use a very neat lamp of this pattern, with a joint which permits of it being hung up and used as a bracket. Portable hand lamps for use in the bunkers and stores are usually of the same pattern as pendants, with a handle and four feet, made by continuing the guard wires, to enable users to put them down on the deck.

ON THE PACIFIC CABLE.*

BY CHARLES BRIGHT, F.R.S.E., A.M.I.C.E.

The chief object of this paper is to bring the subject once more to the fore. It is hoped, moreover, that by lightly touching on some of the main features of interest and importance that a useful and interesting discussion will result in some sort of activity on the part of the British Association. An endeavour will be made to emphasise the fact that, notwithstanding the views that have been advanced in certain quarters, there are no engineering or electrical difficulties standing in the way of realisation.

Let us first of all see what has been done in the matter up to date. Various proposals for telegraphically spanning the Pacific Ocean have been brought forward for a number of years. As a matter of history, we can even go back as far as the year 1870, when Cyrus Field and other American capitalists promoted a scheme for connecting California with China by way of Alaska and Japan. The route was, however, an impracticable one, partly on account of the prevalence of ice, partly owing to the difficulty of erecting and maintaining land lines in connection therewith. Since then, Pacific cable projects have been developed in this country from a national rather than from a private commercial standpoint. The route which has up to the present found most favour in the English mind is naturally that which connects British Columbia with Australasia—known as the "all British" route. Her Majesty's Government and the Colonial Governments most concerned have been urged from time to time to consider the matter from a naval and strategic aspect. Finally, only two years ago the Colonial Office called together a conference to thoroughly sift the question, advised by Mr. W. H. Preece, C.B., F.R.S., as consulting engineer. A number of experts were called to give evidence, and a report on the whole in favour of the line was duly arrived at after a lengthy deliberation. Since then, so far as our country is concerned, inactivity has prevailed. And here ends a rough outline of what has gone before, or, rather, of what which has not so far got beyond the sphere of debate.

Let us now consider the matter under its different heads, partly by way of dealing with the various objections that have been raised from time to time, according to circumstances. First, then, it should be known that cables have been previously laid and repaired in depths over 3,000 fathoms. The 1869 Atlantic cable runs into about 3,200 fathoms, and this is only one of several examples of a similar depth. The deepest water in which the cable on the proposed route would require to be submerged is 3,300 to 3,400 fathoms, near Fiji Island. There are indications of some 5,000-fathom depths in these latitudes, but well clear of the suggested cable line. The matter is touched on here owing to the extraordinary statements that have gained currency that the cable could never be laid, much less repaired, if only on account of the depths being so much greater than anything hitherto experienced.

Survey.—A sufficient knowledge of the nature and depths to be met with are already at hand to decide in favour of the possibility of the undertaking and for the determination of the types of cable to be employed. The portion of the route which more particularly requires a further and more detailed survey, is that between the Fiji Islands and Australia on the one hand, and New Zealand on the other. I venture to think the series of soundings here involved could well be made, on the return journey by the ship dispatched to land the shore ends at the further points, immediately previous to laying the main sections. Though many dark hints have been thrown out as to the unfavourable composition of the bottom by those who, perhaps naturally, do not want a Pacific cable, the statements are not supported by facts, so far as the actual route is concerned.

Type of Cable.—In designing a cable for the greatest depth to be met with, special care would of course require to be observed to adopt a type which would combine the requirements of safe laying from the contractor's point of view, with those of durability looked at from the aspect of the proprietor. The latter includes the necessity of the

* Paper read before the British Association at Bristol.

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cable readily accommodating itself to any irregularities at the bottom, and, at the same time, being a good subject for recovery—not only when new, but also a number of years after submersion. Those interests are sometimes a little conflicting; naturally the most important point is to select a type which, if carefully and properly laid, will permit of being picked up several times over—and a number of years hence. Such a cable must be of a character which lends itself well to paying out with a sufficiency of slack to meet all subsequent cable operations. Again, its specific gravity must be limited by considerations of recovery. When the difficulties of raising a cable to the surface in deep water first presented themselves in connection with Atlantic telegraphy, a low specific gravity cable was adopted with the special object of meeting these difficulties.* This type consisted of each iron wire being enveloped in manilla hemp. Such a cable is now, however, entirely ruled out of court as lacking in durability, and the result of experience all goes to show that for types of this character a close-sheathed cable, with the iron wires more or less firmly butting against one another, is almost a *sine quâ non*. Each wire would be separately coated with preservative compound and covered with a thin cotton tape. Such a cable combines durability with a reduction of rigidity which renders it well adapted to the general requirements of cable operations. For the purposes of securing a given actual strength, the wires, which would, of course, be galvanised, must be made of homogeneous iron of the greatest possible breaking strain—now up to about 90 tons per square inch. Having regard to pliability, there is a limit to the size of each wire, neither must they be below a certain gauge with a view to durability after submergence. The outside covering of the cable should be composed of compounded hemp cords or of jute (or hemp) yarns—in preference to canvas tape—on account of having greater durability and as binding the whole cable together more firmly and permanently. For recovery purposes, from a skin-friction point of view, the outside circumference of the cable should not be greater than is absolutely necessary to meet other qualifications, and, in some respects, the same remark holds good from an efficient laying point of view. Finally, a smooth outside surface is of more importance in this sense than might be supposed.

On the other hand, as the author has previously suggested, a flexible riband sheathing of aluminium bronze, with substantial washers on each side, might with advantage be adopted instead of iron wires, thereby enormously reducing the weight and imparting freedom from corrosion, in the event of an abnormally large core being employed. The riband—¼in. in breadth—would be laid with a very long lay, with a small turn between the edges, sufficient to allow a slight play. The low specific gravity of aluminium and its alloys is an obvious point in its favour—provided that it will support an equal length of itself, and that it is equally durable. It permits a much greater length being carried by a given ship, besides taxing the machinery less. Aluminium bronze is suggested in preference to aluminium on account of its much greater strength. It has, in fact, about six times the breaking strain, and very nearly the same as that of steel, while it has a weight scarcely a third of iron. Aluminium is only equalled by copper as regards pliability. It will be readily understood, therefore, that this renders it, or any alloy of it, admirably suited for the sheathing of a submarine cable. The riband form is preferred on account of the increased flexibility thereby ensured in a large cable. It is on these grounds, moreover, that the metal tape is not allowed to overlap, or even to meet. Again, such a taping could under no circumstances damage the core under tension or pressure.

Laying.—For paying out the cable efficiently in the deepest water, special attention would have to be observed to the character of the brake apparatus; and if the ordinary friction brakes now in vogue can be supplanted by something more free from the chances of undue heating, an advance will have been made. Such an innovation would be especially valuable in this connection on account of the length of one of the sections—that between Vancouver and Fanning Island—being considerably greater than anything previously dealt with. This section, with a proper allowance for slack, etc., would run into some 3,500 nautical miles or more, as against 2,717 nautical miles for the Brest-St. Pierre cable of 1869, the new French Atlantic line just laid being materially longer. The brakes and holding-back gear must, again, be of a character that will allow of rapid changes in the retarding force. They must also be of ample strength to prevent what would be a comparatively heavy cable from running away in the deep water, and coiling itself at the bottom so as to form kinks when afterwards being lifted.

Repairing.—It has been argued by some that if a cable were ever laid on the suggested route it could not be subsequently recovered. In reply to this contention it may be pointed out that cables have already been picked up and repaired in depths of over 3,000 fathoms in the open sea—this not, of course, on a single bight, but by first cutting it at the bottom, and then, having thus taken a great part of the strain off, lifting the cable elsewhere. Such a system is, of course, capable of extension *ad libitum* by buoying the line in festoons at different points and in gradually increasing heights from the bottom until the strain at another position is sufficiently low to permit of the bight being raised to the surface. Again, objections have been raised as to the length of time taken in the recovery of a cable in such depths. It must, however, be borne in mind that cables have been picked up and repaired in upwards of 2,000 fathoms within the course of two or three days.

Electrical Working.—It has been asserted that if the Pacific line were laid it would not work satisfactorily. This suggestion is not, however, in agreement with facts, though it is true that the maximum speed obtainable on the long section, say 3,500 nautical miles, with a large core would be low as compared with that attained on the Atlantic cables, which are, of necessity, kept heavily burdened with traffic more or less continuously. Nevertheless, with a core of the same proportions as that adopted in the Anglo-American Company's last cable—650lb. copper to 400lb. guttapercha—under ordinary conditions a speed (in five-letter words) could be attained up to the minimum required by the Canadian Government in 1894.* The above would be by ordinary manual transmission, whereas all the latest improvements in machine transmission with curbing arrangements, as well as condensers, would naturally be applied with something like a 35 per cent. increase in the speed, not to mention the circumstances that the adoption of Muirhead's duplex system would nearly double the working capacity of the cable.

As a first venture the above cable would probably be sufficient to meet the ends in view. It is conceivable that a larger core would be out of the question on the ground of cost. Moreover, increases in the dimensions made beyond this would have the effect of still further increasing the mechanical difficulties as regards a suitable type of sheathing. Experiments have, it is believed, already been made on two Atlantic cables looped together to test this point of the possibility of working through a considerably greater length than that to be dealt with here, the results being perfectly satisfactory. In the construction of the first cable to India (*vid* the Persian Gulf), Messrs. Bright and Clark, as engineers to the Indian Government, adopted a conductor in which four ordinary wires were drawn down so as to form the four quadrants of a true circle with a ring outside to embrace the whole. By this means, with a given weight of copper, they reduced the electrostatic (inductive) capacity of the core without increasing the conductor resistance, the result being a very material increase in the attainable speed of signalling, whilst sufficiently maintaining the mechanical requirements as regards pliability, etc. Messrs. Siemens Bros. have since to a great extent approached a similar end in their compromise between the single solid wire and the strand conductor, and this has

* At that time this type of cable was also in much favour, from a laying point of view, owing to its low specific gravity tending to materially simplify the requirements in the way of holding back gear and brake power, the efficient working of which, in controlling the cable's egress, was, for the lack of experience, in some doubt.

* It should, however, be remembered that though seven letters is still often taken as the equivalent of a cable word, it nowadays more usually averages up to nine letters. Such discrepancies go to prove the futility of expressing a required speed in words only.

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proved a great success on a number of Atlantic cables. It would seem as though a plan of drawing the wires down to a smaller total area might, in this undertaking, be advantageously adopted. In the case of the Persian Gulf cable an economical method of securing any particular speed was not of the same vital importance. Moreover, in that instance, the length not being of an abnormal character, the extra cost of that type of conductor was probably scarcely made good by increased working value. Here, however, the author is of opinion that this plan would be found to more than repay the increase in initial cost, especially as it would also materially reduce the quantity of guttapercha required to obtain the same minimum thickness throughout for fulfilling the mechanical as well as electrical qualifications, this being the *bête noire* in the cost of an ocean cable, as also in its design.

A moral is surely to be gleaned from the recent Spanish-American war such as cannot fail to have an important bearing on the question of spanning the Pacific Ocean. Here, indeed, we have a striking suggestion of what we may expect as regards telegraphic interruption in the event of war with another European Power; and a consideration of the prospects reveals the urgency of a system of telegraphically uniting the entire Empire without touching on foreign soil. The present lines to India and Australia are as follows: (1) Lisbon, Gibralta, Malta, Egypt, and the Red Sea; (2) France, Italy, Greece, Egypt and Red Sea; (3) France, Austria, Turkey, and Persian Gulf; (4) Germany, Black Sea, Turkey, and Persian Gulf; (5) Russia, Persia, and Persian Gulf; (6) Russia, and coast of China; (7) Lisbon, or Cadiz, and the West and East Coasts of Africa, *vid* the Cape. It may be added that our colonies have been known (comparatively recently) to be dependent on the Russian-Siberian land lines for communication with the mother country.

Viewing the proposed line as a necessity to meet the political requirements of the age, attention may be drawn to the circumstance that in the very fact of the great depth and length in the open sea lies a source of security for the cable from a strategic standpoint. In a depth of over 3,000 fathoms a man-of-war, with all the implements ordinarily at her disposal, would experience considerable difficulty in interrupting such a line, especially if the precise route be unknown. On the other hand, a line submerged in shallow water is extremely prone to interruption of this character as well as to that of a rough bottom. Again, there are several ways in which cables can be and have been interrupted at and near the water's edge. In introducing comparatively few landing places, the route under consideration would be, relatively speaking, free from the latter source of danger, especially as such stations would be (or should be) under our own Government surveillance and away from the path of the foreigner. But any scheme for further and independently reducing the chances of a total breakdown of telegraphic communication with our Colonies can scarcely fail, in the interests of the Empire, to commend itself to all British subjects, no matter what the efficiency of the existing system may be.

With regard to the effect of the Pacific cable on the cost of telegraphic communication, it may be observed that whereas at present if anyone in Victoria, say, wishes to communicate with Canada, his message traverses about 12,000 miles, and costs him 6s. a word. By a direct Pacific cable, this tariff would be reduced to about 2s. 6d., the length of line being little more than half. It may be added that the message would reach its destination within an hour, instead of taking sometimes nearly 24 hours to reach the hands of the individual to whom it is addressed. With the immense commercial field of China about to be thrown open, it may be fairly surmised that if we do not span the Pacific soon in one direction or another some other Power will, and possibly obtain a naval supremacy there; thus no time should be lost in carrying the project through. The French have actually laid what they term "the first link of the chain destined to connect Australasia with North America." Their Australasian landing is the French convict settlement of New Caledonia, and it is said that they do not care on what American territory they land.

We will now pass on to a scheme that appears to have been suggested by the Eastern Extension Telegraph Company as an alternative for the Pacific line—*i.e.*, their proposal to lay a system of all-British cables to the Cape and Australia *vid* Gibraltar and other important naval stations. Though an admirable line in its way, if only as a superior duplication of existing systems, this proposed cable can scarcely be regarded as a substitute for the Pacific project. It does not meet the case from an Imperial and strategic standpoint because it does not include in its scope the largest and most populous of all our colonies, the Dominion of Canada. Again, it passes through foreign waters. Moreover, landing on the wrong side of Australia, it is largely dependent on the good behaviour of Australian land lines.

The weak point in the "all-British" line, as considered by the Colonial Office in 1896, is undoubtedly the land lines through Canada; but there is an alternative which, in view of recent ideas, will probably commend itself to many. If, in fact, a permanent and reliable understanding could be arrived at with our American cousins, any difficulties in the "all-British" Pacific cable scheme might be effectively overcome—still more, if that coming nation, Japan, were included in any such alliance. It is known that the Americans are actively considering a project for a Pacific cable to Japan *vid* Honolulu and various islands. This is shown on our map. A glance at the route reveals the fact that by a comparatively short branch to New Guinea the "all-British" interests could be combined with the Anglo-American-Japano, and that thus two Pacific cable schemes could be practically realised by one Pacific cable. Moreover, not only would the share of the cost to each country be enormously reduced, but the actual total cost would be materially less than in the case of the all-British route, owing to the long section therein being avoided such as involves an extra heavy core to attain a fair working speed. A project of this character would do much towards more firmly binding together the two countries—and, indeed, all English-speaking countries—as the author has endeavoured to show in the course of an article in the current number of the *Fortnightly Review*.

In conclusion, with regard to the various schemes for a Pacific cable, it should be remembered that 40 years ago the feasibility of Atlantic telegraphy was the subject of incredulity—partly in Section A of the British Association meeting of 1855—at the hands of many of the greatest authorities until the cable was actually laid and worked in 1858. In that instance there was practically no data to go upon; whereas the proposed Pacific line may be regarded as but a further extension of what has already been done, though certainly involving special arrangements and precautions. In this paper the author has only dealt with the technical side of submarine telegraphy in its present state of practice. If, however, some of the shining lights of Section A could get their ideas into shape, or on the basis of actual experiment furnish us with new material, the whole difficulty, in a financial sense, might be solved at once. By way of improving the present means of signalling upon cables, Mr. Oliver Heaviside, F.R.S.—who treated the subject mathematically in the *Philosophical Magazine* in 1879—has advocated the introduction of both "leak" circuits and self-induction into cable lines. To put this idea in practice, electrical engineers—including Mr. Preece, Dr. Thompson, and others—have devised new forms for the insulated conductor, accompanied by devices which to a certain extent realise the said theoretical advantages. In some instances, however, the initial cost of these devices would prove an objection, even where otherwise practicable, and the only conclusion arrived at in regard to the application of leaks on the ordinary cable circuits of to-day is that, when suitably disposed along the line, in obviating the choking effect of retardation they secure increased definition for the signals, though not sufficiently to permit of any substantial increase in the working speed, even with the battery power raised within reason.

A number of other proposals have been made, but so far as concerns any further substantial increase in the speed attainable for submarine telegraphy under given conditions, it seems probable that if this is to be effected it will be by an entire revolution in the form of conductor, dielectric, and completed cable, rather than the signalling apparatus.

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The latter has probably reached its limit of sensitiveness. Any further increased sensibility of the instruments is likely to be at the expense of steadiness, and would tend to bring them within the range of influence of other surrounding forces. It is even now quite beyond that required or justified by the cable itself under present conditions.

THE EQUIPMENT AND MAINTENANCE OF ELECTRIC CARS.*

BY M. S. HOPKINS.

Car Bodies.—For years car builders have attempted to devise a car body which would be equally durable in both summer and winter, but judging from the character of equipment now in use on the majority of roads, such a car has not yet been produced. The combination car with movable parts is not satisfactory for winter use, is troublesome, noisy, and cold, and is lacking in many of the essential features of the open car for summer service. The open cross seat car of the barge type, with running boards on the side, seems by far the most desirable type of car for summer service, offering the largest seating capacity and the best facilities for receiving and discharging passengers, which is a great advantage in city service. Considering all features, the box car with side seats, large windows, wide end door to the side of a roomy platform, and vestibules closed on one side, seem best adapted to the average conditions of winter service. The long car body seems to be growing in favour with the railway manager, due to the comparatively small increase in operating expenses, in comparison to increased carrying capacity, and its allowing of the increase of headway or decrease in number of cars run, resulting in a large decrease in operating expenses per passenger carried.

Trucks.—Under the average conditions a 22ft. closed car or eight reversible seat open car body should be the limit for a single truck. Although there are single trucks which will carry a longer body fairly well, yet the increase in maintenance will in most cases warrant the use of double trucks. The local conditions should govern the type of double truck used, the bolster type in most cases being preferable for long cars on high speed, suburban service, while for city service, where heavy grades and quick starts demand maximum traction, and short curves make it necessary for the wheel to turn under sill, the bicycle type must necessarily be used. This type of truck is no longer an experiment, and while they possibly require more careful inspection and adjustment, very efficient service can be secured from trucks of this type. Trucks should be made up of a small number of parts. Cast and malleable pieces should be the lightest consistent with strength. Springs should be so arranged as to prevent oscillation, and give an easy-riding car under all conditions, from no load to full load; and when style of truck is of such design as to prevent the use of an under truss, spring base must be exceptionally long and end springs so arranged as to relieve strain on car sill.

Electrical Equipment.—In the selection of electrical equipment the main point is to secure equipment of ample capacity and proper design for service required. In a railway motor, the mechanical and electrical features which influence its maintenance should receive very careful consideration. The bearings should be large and lubricated by oil from below and cup grease from above, and so designed that drip from bearings will fall outside of frame; the armature so constructed as to permit shaft being pushed out without disturbing commutator and winding. I am glad to note that the importance of light weight and slow peripheral speed of armature has been recognised in recent design of railway motors. The inertia or flywheel capacity of armature should be the smallest possible consistent with the work required. Engineers differ as to the best method of suspension. From a theoretical standpoint, the cradle or side-bar suspension has the lead. The deadweight is largely removed from axle, thereby eliminating to some extent the hammer blow on rail-joints, decreasing the wear on axle brasses, and securing the better alignment of gears; yet, in practice, the nose suspension is still preferred by the writer, as the car starts more smoothly—the weight of motor on spring supports overcoming the jerk and quiver so common in other methods of support. The specifications for railway motors as drawn up by leading manufacturers of to-day amount to practically nothing, and would suggest that the purchaser of motors in his specifications clearly define the rating, heat limit, and efficiency. The series-parallel controller is in most respects a satisfactory device, the chief objection being the narrow range of speed on running notches. Specifications for resistance should provide that the last two points of resistance be of sufficient capacity to allow of their continued use as running notches, especially where cars are operated in city service. There are several types of magazine fuse boxes or cut-outs and single cut outs using a special fuse which possesses a number of points of merit. Without going into detail, it is the opinion of the writer that, under average conditions, the standard magnetic blow-out fuse box, using a link fuse, is preferable. Each car should be equipped with a thoroughly reliable lightning arrester. Points to be noted in selecting this device are as follows: the kicking coil should always be installed; the air-gap should be as small as possible; a positive and quick device for interrupting the current after discharge, and which will not be injured by discharge; a non-inductive resistance in circuit which will limit the flow of current and thereby prevent the opening of circuit breaker at station when several arresters operate at the same time.

Maintenance of Equipment.—The cost of maintaining equipment depends on various complex conditions, some of which are beyond control of the manager, and others for which he should be directly responsible. Heavy grades, numerous railway crossings, sharp curves, dirty and unpaved streets, imperfect and poorly constructed equipment, long and severe winters, all affect cost of maintenance unfavourably, and are beyond control of the manager. But the character of the men who operate the cars, the manner of operation, the way in which repairs are made, and the character of men engaged in repairs, and the material used, are the controllable elements, and in most instances the chief features affecting cost of maintenance.

Care of Equipment in Car-Houses.—Generally one of the following three methods are used for daily inspection of car equipment—namely, inspection of cars each trip; inspection of equipment at night by motor inspectors; and inspection of equipment during the day by motor inspectors and repair men. In regard to the first case—that of the trip inspection—I would say that in the present degree of perfection attained by manufacturers of railway equipment trip inspection should not be necessary, and excepting in interurban lines operating at high speed over long runs is of doubtful value. It is expensive, requiring the services of an inspector, who is necessarily a man of some ability, for each line of cars. The period of time for making this inspection is necessarily very short, and the entire time is taken up in mere inspection—little or no opportunity being afforded in which to make repairs. In regard to night inspection, the experience of the writer has been such as to absolutely condemn such a method as expensive, slovenly, and unsatisfactory. It is impossible to make a thorough inspection of cars at night, no matter how well lighted the car-house may be, and the efficiency of the work done by the men is very far below that of the work during the day. Therefore, when local conditions will admit, inspection of cars during the day seems by far the most advantageous. For making inspection and running repairs such as should be made in car-houses, it is a safe rule to have one man to seven cars. It is, however, important to have a man in all car stations, known as chief inspector of that division, who is thoroughly conversant with practical electrical and mechanical matters. Bearings should be run "close" at all times, the time of their renewal being determined by the effect of the wear on the gear and pinion, as the wear on these parts is largely affected by the wear of the bearings. After a series of tests covering quite a period of time as to the wear of various materials used in motor bearings, the writer feels warranted in

* Paper read before the American Street Railway Association, Boston, September, 1898. Abstracted by the *Electrical World* (New York).

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making the statement that either the best grade of babbitt or brass bearings should under the ordinary condition give a longer life than six months, and when a bronze bearing of the proper mixture is used and properly lubricated a life of 12 months can safely be expected. The method of lubrication largely influences the life of brasses. The writer has, after long tests with various lubricants, discontinued the use of grease entirely on armature brasses, and in most cases on axle brasses, a good grade of engine oil, supplied through wicks, being more satisfactory and economical. In order to reduce the maintenance of brasses to a minimum the use of phosphor bronze is strongly recommended. Street railways operating 25 or more cars will find it economical to cast and machine their own brasses. This may be discouraging to the supply men, but it means money on the right side of the ledger when the expenses are footed up. A small brass furnace can be cheaply erected, and after suitable jigs, which can be attached to any lathe, have been provided for boring and turning the cost of casting and boring is very little more than the cost of rebabbitting, especially where babbitted brasses are machined after boring, while the life of the bronze bearing is far in excess of that of any babbitt yet tried. Rough and burnt commutators are too frequently the cause of expensive motor repairs, and usually indicate imperfect motor design or inexcusable neglect. Well-designed motors in good condition, even under the hardest service, provided, of course, the average work is within the rated capacity of the motor, should not require turning oftener than once in eight months. There is nothing that so well indicates to the practical man the condition of the motor as the condition of the commutator. Whenever the commutator shows signs of burning or blackening, steps should be at once taken to prevent it. It is not advisable to try to prevent this by the continual sanding of commutator by motor inspectors, though the occasional cleaning up of the commutator with sand-paper is necessary with all motors. The causes of trouble of this character are so numerous that mention is made of only a few of the more important. The kind of brush used is an important factor. Brushes should be soft, close-grained carbon treated with a good lubricating compound—one which does not flow too freely from the heat from the motor, and which will not burn and carbonise on commutator. The price of brush is not a material consideration, as a brush which is slightly superior to another will prove economical even at quite a large increase in first cost. The tension on the brushes is, as a rule, too light on railway motors. It is a common belief that heavy tension causes wear of commutator, but experience has shown that the actual wear of commutator due to friction of the brush is very small, and that increased tension will in some cases materially decrease the sparking, which causes the greatest wear. Improper alignment of brush-holders frequently causes sparking. In recent practice the use of side contact springs on brushes has been generally abandoned. On motors carrying heavy currents this spring is quite essential, as excessive heating of brush is caused by limited contact in the holder. Commutator insulation should be made of what is known as the built-up mica segments of the very softest grade of amber mica. A hard, clear mica should never be used in commutator, as this mica will not wear away as fast as the copper, and there is nothing so disastrous to the life of the commutator as high mica insulation. In some motors it may be necessary to change the winding of armature and field coils in order to avoid the burning of the commutator. First, determine by actual experiment what change in winding is necessary, and then equip with the new winding every armature or field that comes in burned out. This will permit of change being made without any great expense, as the greatest part will be borne by the maintenance charge.

The Electrical Testing of Railway Equipment.—Elaborate systems for the periodical testing of insulation on railway equipment seem to be growing in favour with some electrical engineers, but the practical value of these elaborate tests is not fully demonstrated. Experience has shown that tests of this kinds are very misleading, and frequently cause the tearing down of equipments which under ordinary conditions, had no tests been made, would have continued in service for a long time. Judging from my own experience, it is neither necessary nor advisable to periodically test the insulation on the equipment, but to make such tests only in cases where motors are not working properly. The proper training of motor inspectors as to the little points about railway equipment which clearly indicate trouble with motors will in nearly all cases locate trouble due to weak insulation, so that it can be remedied before any serious damage has resulted to any other part of the equipment. All armature and field coils repaired should be carefully tested as to resistance and insulation to ground, and on all armatures having coils repaired, new commutator put on or commutator turned, resistance between commutator bars should be very carefully measured; using preferably a portable Wheatstone bridge testing set, capable of showing clearly a variation in resistance of $\frac{1}{1000}$th of an ohm. This is one of the most important tests to be made in the care of railway equipment, as more burn-outs of armatures are caused by the slight short-circuiting coils, due to solder, acids, or copper turnings bridging over insulation between bars under leads than from any other cause, which can only be located by a test of this kind. Any mistake in connecting up the leads or a bad joints will at once be detected before any damage has been done. For testing insulation to ground, I consider a first-class magneto of 10,000 ohms resistance all that is necessary.

INSPECTION AND TESTING OF MOTORS AND CAR EQUIPMENTS BY STREET RAILWAY COMPANIES.*

BY F. B. PERKINS.

In no direction can a railway company save money or increase dividends more rapidly than by having its equipments thoroughly inspected by competent men, working systematically under intelligent direction. Instead of examining cars once in 30 or 60 days, a daily inspection is necessary. I have thought it expedient for the purpose of setting forth my views on inspection to describe the work as being carried on in a modern car-house containing 50 equipments, and arranged for the easy handling of the cars, so that no extra help will be required for that purpose.

In dealing with the inspection of cars in this car-house we believe better results can be obtained by giving to each man some particular branch of the work rather than assigning to him a certain number of cars and expecting him to do all the work required thereon. Two men would be required to grease and inspect the motors, one to keep the controllers in repair, one to take care of the trolleys and to assist in the care of trucks and car bodies, one to have charge of the trucks and car bodies.

The most vital parts of the equipments are the different parts of the motor—viz, armatures, fields, bearings, brushes, and brush-holders. The care of this part of the equipments should come under the head of greasing, and on the manner in which this part of the work is done depends to a large extent the frequency with which the cars will break down while in service, and also the amount of repair necessary to keep them in operation. Oftentimes the most ignorant and cheapest men are given the place of greater. On the contrary, it is a position where intelligence and thoroughness are imperative. The car should pass into the greaser's hands the first day after it is on the road, and every second day thereafter. He should examine thoroughly brushes, brush-holders, gears, pinions, bearings, and commutator. Of these parts, the care of the bearings and commutator is the most important, and should therefore receive the greatest amount of attention. The manner of caring for the bearings is very simple. They must be well supplied with grease or oil, and care must be taken that they are kept free from dust and grit, and also that the grease feeds properly.

In the matter of the care of commutators, electricians seem divided in their opinion as to whether they should be sand-papered or not; personally I am not in favour of it.

* Paper read before the American Street Railway Association, Boston, September, 1898.

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Instead of temporising the commutator by sand-papering it, and thereby simply putting it in shape for one more day's work, I would get at the bottom of the trouble, and either make a commutator, by some preparation of mica and copper, which will not spark, or if the trouble lies deeper remedy it by remodelling the entire motor. This may seem to be a heroic measure, but the end will justify the means. I think, however, that usually the trouble is not in the commutator, nor with the motor, but in either the brushes or brush-holder, or both, and it is probable that with proper adjustment and with proper care and treatment we should find the trouble obviated and sand-papering of commutators unnecessary. When speaking of the treatment of brushes, I refer to a treatment of oil or something similar.

The writer has personal knowlege of a large road where common brushes were used without any treatment or care except to replace them as needed, and it seemed as if the man who used the most brushes was given the credit of taking the best care of his motor. The average life of brushes on this road and the above conditions with the commutator sand-papered every day was six days. Subsequently the sand-papering was stopped entirely, and the brushes were removed every six days and properly treated in oil. The life of brushes under this treatment was increased from six days to from 40 to 60 days. The trouble with commutators, which before had been great, was reduced to a minimum; in fact, almost entirely averted. It is possible that under some heavy conditions the practice of sand-papering must be kept up, but it must be accomplished in a different manner, and, instead of indiscriminate sand-paper, it must be applied sparingly.

Not later than every fourth day every controller and switch should come under the notice of the man who has charge of these parts. The main point is to clean thoroughly, using a little vaseline on the contacts. The parts that are worn should be touched up with a file, or should be sand-papered, and if badly worn should be replaced, so that at least every fourth day the controllers will be sent out in first-class condition. This man can also examine the car wiring, lamp fixtures, headlight, and all similar parts. The fourth man should have the care of the trolley poles and wheels. These should be carefully looked over each night and oiled if necessary. The man who attends to this part of the equipment will also have considerable time to devote to general inspection of the car bodies and trucks under the direction of the general inspector. Under the scrutiny of these two men should come all the details of the car body, such as grab handles, window catchers, curtain fixtures, and similar parts. These should be carefully attended to each day, insomuch as the reputation of the road will suffer in direct proportion as the attention to these small details is neglected.

After having touched upon the subject of the matter of inspection in the car-house, we have to deal with outside inspection—that is, inspection on the road by inspectors, motormen, and conductors. It may be a good plan to have outside inspection, and it is often advantageous if not carried too far, but I do not believe it is desirable to have a large force, for this reason: but very little of the time devoted to this line of inspection is really used in looking over the equipments, but must necessarily be consumed in getting from one car to another and in waiting for opportunities, and most of the trouble located by these inspectors is not of such a nature as to require immediate attention. If it were, the inspector could not make the necessary repairs without taking the car to the car-house. Troubles of a serious nature, such as would require immediate attention and taking the car out of service, should be easily detected by the motorman or conductor, and reported at once to the proper official. It may not be entirely irrelevant to speak here of the relation of motormen and conductors to the inspection of cars. It has been proven that it is usually a waste of time, and very little has been accomplished by attempting to instruct motormen and conductors in other than the simplest ideas of electrical problems; for while on some roads there may be a number of old motormen who have a fair idea of electrical equipments, and whom it would probably be safe to allow to locate existing trouble, it would be difficult to draw the line between the men competent in this direction and those wholly lacking in such knowledge.

Next comes the matter of testing. The service which we will obtain from our equipments depends largely upon the manner in which the repairs are made. If the repair work be rushed through with the idea of going over as many cars as possible in a short space of time and with little or no regard for the thoroughness of the work, we must expect the necessity for repairs to increase to an alarming extent. If, on the other hand, we make our repairs with the idea that work thoroughly done will have a tendency to greatly decrease the liability to breakdowns while the cars are in service, and correspondingly reduce the amount of work to be done in the repair shops, we shall naturally consider the best means, not only of doing the work, but of definitely determining its condition when finished. To do this properly we must resort to our testing, and we use the word "testing" in a broader sense than it usually signifies. For example, all material furnished, such as tape, mica, paper, etc., must be kept up to the standard, and to accomplish this everything used should be carefully examined, or, under our classification, tested. We must begin testing in the purchasing department. In the purchasing of supplies a great deal of trouble is often occasioned by changing the kind of material furnished. This is probably more noticeable in the case of small roads. Now, while there may be no great difference in the quality of goods furnished, or if any one of the many different kinds were used exclusively, it would give satisfaction, yet the very fact that many different kinds are used has a tendency to produce a lack of care in the details of the work which will almost invariably show in the general result. If, however, we have to allow only one kind of material in the repair shop, the question naturally arises as to how we can avoid being behind the times in the matter of different kinds of supplies, and also in the manner of their use. The answer is, we must have an experimental room, and there must be tested samples of all supplies and materials before being contracted for by the purchasing agent.

Having now provided for our testing department, and established its relation to the purchasing of supplies and to the employés of the repair shop, what machines and instruments shall we need in its equipment? A high and low reading direct-current voltmeter, one having a double scale reading from 1 to 750 and from 1 to 15; a direct-current ammeter reading from 1 to 100; a low-reading ammeter would be very convenient many times, but is not absolutely necessary; a 50,000-ohm magneto bell; an alternating-current voltmeter and some handy testing set will make an outfit of instruments with which we can do all the testing required.

If the alternating current is not within reach of the car-house we must procure a small dynamo. A very small machine, say 2 h.p., would be sufficient for all the needs of the testing department. If this machine is designed for about 100 volts it would be most convenient for our use. With a few small transformers wound for 2,000 volts primary and for either 50 or 100 volts secondary, we are prepared to furnish any voltage within a range of from 5,000 to 10,000 volts. The man who has this part of the work in charge can very easily and cheaply arrange the details of installation of the wiring, etc. He can also make some resistance coils and many other pieces of apparatus which will greatly facilitate the quick testing of whatever may be sent to this department.

What shall we test? First, everything that goes into the repair shop: By doing this we shall be sure of keeping all material up to the standard, which means an absolute guarantee against breakdowns caused by poor material. In this way we raise the standard of workmanship. Second, all supplies which go to the foreman of the car-houses: In connection with this matter we are of the opinion that in the testing-room should be decided the manner of treating brushes, the length of time they should be used before being removed from the motor, the manner in which they should then be cared for, their final disposition, the proper attention to be given the trolley poles, the length of time they ought to remain in service, their condition when removed, and many other similar questions should not be left to work out their own

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solution or be dependent upon the feelings or judgment of the various employés and workmen, but should be definitely determined and decided in our testing department. Many may be of the opinion that we are carrying system beyond necessary limits in thus definitely and positively arranging these details, but why should we allow several different men to use material in whatever manner they may individually see fit, to treat brushes as their fancy may dictate, to regulate the tension of trolley poles in accordance with their own feeling at the time rather than by any fixed standard, and various other matters which might be mentioned along these lines. Third, all finished material, such as armature coils, insulation for controllers, commutators, and brush-holders: We do not necessarily need to test every piece, but enough to satisfy ourselves that the general order of work is kept up to the standard. Fourth, all armatures, fields, commutators, and controllers as they are being made or repaired: One illustration will be sufficient to show how the testing may be carried on in this branch of work. An armature is wound and ready to be connected to the commutator. With a small wire we connect all of the top leads together, with the bottom leads each separate from the other. With a magneto or testing set we find the insulation of the complete armature is not right. First, we cut the small connecting wire on the top leads in several places, then by testing each of these parts we locate that portion of the armature which is bad; then, by removing the wire, we will test each coil separately until we find the weak one. Next, by the use of our transformers we obtain 3,000 or 4,000 volts, which we apply to this one coil. If it stands the test we may allow it to go through, and if not it can be replaced. If we should find that the trouble extended to a large portion of the armature and indicated moisture in the coils, we may by the use of this same transformer obtain 25 or 30 volts, and by connecting the armature to the commutator with the exception of one end of one coil, then connecting one side of the 25-volt circuit to this end, and the other side of the circuit to the commutator bar left vacant, we may apply the current for the purpose of drying the armature. With this arrangement the heat will be generated in the coils, and the armature will dry from the inside instead of from the outside.

ON THE INFLUENCE OF ALTITUDE ABOVE THE SEA ON THE ELEMENTS OF TERRESTRIAL MAGNETISM.*

BY DR. VAN RIJCKEVORSEL AND DR. W. VAN BEMMELEN.

The object of an investigation, which lasted from 1895-97, was to see if we could detect any influence of altitude above the sea on the magnetic elements. For various reasons, the Rigi was thought to be the mountain most suitable to our purpose, and in 1895 our observations were taken solely in order to discover if this mountain was really non-magnetic. We found that it was so. In 1896, complete series of observations were taken, both on the mountain and at its base, at a large number of stations. The discussion of these observations seemed to show a very slight decrease of the horizontal and a somewhat larger, though still very slight, increase of the vertical component. However, this result was very doubtful, because we found at the same time that the Rigi, though certainly non-magnetic as a mass, was covered all over with superficial centres of attraction, very weak, but still causing disturbances which seriously interfered with our results. We resolved, therefore, to try again in 1897. In that year we took dips only at 198 stations, one of us always observing near the base of the mountain, the other, absolutely simultaneously with him, on the top or on the slopes. Although this time also the small, but numerous, local disturbances were a decided drawback for the discussion, the following results were obtained:

1. We think it is proved, that if there be an influence of the height above the sea on terrestrial magnetism, it is so exceedingly small as to make it unfeasible to detect it with our present surveying instruments. Therefore it is decidedly unnecessary to take altitude into account in magnetic surveys.

2. If, nevertheless, it should ultimately be found that there is such an influence, however small, it is more likely that it would be an increase of the vertical force with altitude, than anything else.

* Abstract of a paper read before the Conference on Terrestrial Magnetism at Bristol.

A NEW ELECTRIC COMPANY.

We have this week been allowed to peruse the prospectus of a new company formed to take over the business of Dr. Hermann Aron, of meter fame. We understand that the company will issue its prospectus and invite applications next week. The following details may therefore be of use to our readers as giving a general idea of the undertaking.

Dr. Aron's meters were introduced in the early days of electric light distribution, and then shared, with other electric apparatus, the common defects of all pioneering apparatus. No one knew more about these defects than the inventor of the meter, and he has devoted years of careful attention to the designs of new types to overcome the faults. As a result, the latest types of meter are self-winding, self-compensating for all defects in the individual pendulums, and direct reading. The other errors due to temperature, etc., have also been eliminated.

That the new type of Aron clock meter is reliable, is proved by the fact that the Board of Trade electrical department, which is difficult to satisfy, has issued a certificate to that effect for the continuous-current types. Prof. Ayrton has also made a series of careful tests on behalf of the company, and reported as follows under the date of Aug. 5, 1898: "I have tested many Aron meters, and find that the recent improvements—viz. (1) driving the two pendulums with one clock; (2) automatically reversing the direction of the current every few minutes, as well as the connection between the counting mechanism and the pendulums; (3) and automatically winding up the clock—are of great value. The Aron meter, as now constructed, has all the well-recognised advantages of the clock type, while it is freed from its former drawbacks. I find it to be now the most accurate supply meter in the market."

The new company will have a capital of £250,000, and will take over all the works at Berlin and the branches of the firm in London, Vienna, and Paris. A London factory is to be established at Hammersmith. The above capital will be divided into £125,000 of 6 per cent. preference shares and £125,000 of ordinary shares. All the ordinary shares go to Dr. Aron, but after 10 per cent. has been paid on these, the preference shareholders participate in further profit. The certified profits for the last few years are given, and amounted to £18,550 in 1897, so that the preference shares, for which application will be invited, appear to be quite safe investments. About £45,000 will be reserved for working capital. The directorate is as follows: chairman—Sir J. Pender, Bart.; directors—G. B. Byng (of the General Electric Company), R. E. B. Crompton, R. W. Wallace, Q.C., Dr. Hermann Aron, and Dr. Julius Juttke. The new types of meters are rapidly finding favour in England, and it is worthy of note that they are not of the motor type, about which so much litigation is before us. When the makers of motor meters have done fighting each other they may find a stronger rival to compete with, which will have to be faced on competitive grounds only. We wish the new company every success.

Electric Lighting at Eastbourne.—The editor of the *Eastbourne Gazette* has cleared his conscience of laying down the lines on which the electric light agitation is to be conducted in that town. He says: "Meanwhile, though I should like to see the town electrically light-heated and trammed, I hope eager advocates of the scheme will refrain from overstating the case." We hope "light-headed" is not intended.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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MOTOR VEHICLES.

The idea which Mr. Shrapnell Smith had in reading a paper on this subject before the section of Municipal Engineers at the Sanitary Institute Congress, held at Birmingham last week, is to be commended. The author assumed the certainty of the introduction of this class of vehicles, and therein he is correct. He has been connected with the movement almost from its earliest initiation, and has had the advantage of taking part in and seeing the results of the Liverpool trials. So long as gentlemen put forward actual results obtained, so long is adverse criticism impotent. It is only when estimates are put forward, no matter how carefully framed, that differences of opinion may justly arise. Those who have followed closely the development of the motorcar both in England and in France seem to have come to the conclusion that oil motors stand pre-eminent as practical and economical machines at the present moment. They admit the bad points of the less recently constructed engines, especially in the trail of stink left behind, but they are emphatic that these bad points can without much difficulty be remedied. This may be so, though as yet we have seen no very good sign of perfection, yet we must again impress upon manufacturers the claims of electricity. Of course, we shall be told we are biassed in this direction. That may be so, though we should have some doubts upon the subject. An important part of Mr. Shrapnell Smith's paper was the comparison between the old dustcart so largely used by municipal authorities and the motorcart to take its place. The reasoning was to the effect that owing to questions of speed, etc., the motorcart would replace four dustcarts, and the estimated figures of comparative cost were based upon this assumption. We are afraid that we must take exception to the whole of this estimate. The difference in speed only partly comes in. The question of speed in house-to-house collection is of no consequence during the filling of the cart. It is only of consequence when going to get rid of its load and when returning to the point of collection. The time of filling is unaltered, sizes being the same, unless a larger staff of men be employed with each cart. If this is done, there will be extra work in filling, though there will be a saving of time during which the men are idle owing to the greater speed of going and returning. All these questions must be considered in the actual costs, and estimates that do not take them into account are undoubtedly imperfect. Further, another point which seems to escape the notice of the framers of estimates is that certain losses are continuous, at any rate in the steam motors as used at Chiswick and possibly in the oil motors also, which do not occur when electricity is used. If the engine is in the one case always running there are constant losses due to condensation, friction, etc., which, as we say, do not occur with electric motors. During the discussion on the paper a good deal of stress was laid on the question of starting and stopping upon inclines, but no speaker seemed to think that such questions could be solved by differential gearing. No doubt the whole question is in its initial

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stages, and therefore many of the facts bearing upon the problem are not thoroughly understood, yet we feel there is necessity to be continually harping upon the matter, and insisting that points like those we have referred to are not overlooked. The common use of cycles has undoubtedly caused greater attention to be paid to the better maintenance of roads, and we contend that the introduction of motor vehicles will similarly be largely assisted by the proper construction and maintenance of the roads. There is still one more point to be mentioned. Opponents to the introduction of electric lighting restricted their criticisms as much as possible to direct comparisons of costs. Users, on the other hand, have found, as they were told they would, many indirect advantages which go to counterbalance some of the items of cost, but the indirect advantages obtained by electric lighting pale into insignificance with those which come into play with the introduction of properly-constructed motor vehicles.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

THE MANCHESTER REGULATIONS.

SIR,—My attention has been called to a clerical error in our new regulations just issued. On p. 15, regulation No. 21, the minimum thickness of pure rubber required is stated to be 0·002in., whereas it should be 0·02in. I should be greatly obliged if you would be good enough to make this correction in order to avoid misconception.—Yours, etc.,

C. H. WORDINGHAM.

REVIEWS.

The Discharge of Electricity through Gases By J. J. THOMSON, D.Sc., F.R.S., Cavendish Professor of Experimental Physics, Cambridge. Published by A. Constable and Co. Price, 4s. 6d. net.

Clerk Maxwell once stated that in his opinion the nature of electricity would be ultimately brought to light by means of experiments with vacuum tubes. It is natural, therefore, that Maxwell's successor, Prof. J. J. Thomson, should have devoted much time to this fascinating branch of experimental physics. Röntgen's famous discovery has led to a widespread interest in connection with the phenomena attending the discharge of electricity through rarefied gases, at the same that it has called into existence a bewilderingly extensive and not always reliable outgrowth in the literature of this subject. Hence Prof. Thomson's little book is peculiarly acceptable, coming as it does from one of the pioneers in this branch of science, and embodying an account, not only of the author's experiments and conclusions, but those also of other experimenters, the whole being, perhaps, now for the first time connected into a coherent system, and brought into line with many puzzling results in widely different branches of physics.

The first chapter contains a clear and concise account of the phenomena attending the discharge of electricity through gases at ordinary pressures. It may be somewhat surprising, even to those who attempt to keep abreast as far as possible with recent scientific advances, to learn the rapid strides made in this department during the last few years. To take an instance, many will feel no little astonishment to learn that the atmospheric air is electrified negatively by the splashing of raindrops on the ground, or by the formation of spray at the foot of a waterfall, whilst the spray formed by the breaking of sea waves on a rocky coast electrifies positively the air in its neighbourhood.

In the second chapter photo-electric effects are dealt with. The present state of our knowledge in regard to the discharge of electrified bodies by ultra-violet light and by X-rays is fully described. Becquerel's uranium radiations are discussed, and the conclusion reached that their wave-length is not very much shorter than that corresponding to ordinary ultra-violet light.

The third chapter is devoted to a *résumé* of our present knowledge concerning cathode rays. Perhaps the most startling conclusion reached is that atoms may be dissociated into simpler elements. The value obtained for the ratio of the mass of one of the "corpuscle" whose movements constituted the cathode rays, to the charge carried by it, is found to be about one five-hundredth of the same ratio for an ordinary-charged atom. A similar result has been obtained by Zeeman as a result of his experiments on the doubling of the D lines when a sodium flame is burnt between the poles of a powerful magnet.

In conclusion, it may be said of this book that it will prove interesting, not only to scientific specialists, but to that large class of the general public who take an intelligent interest in scientific achievements.

NEW ELECTRIC PUMPING ARRANGEMENTS AT ARNISTON COLLIERY.

The directors of the Arniston Coal Company, Limited, on Friday last inaugurated a new and large electrical pumping installation which has just been concluded. A new lease of the collieries has recently been entered upon, and in connection with it arrangements were made to have the present pumping apparatus duplicated so as to remove all fears for the flooding of the mine should anything go wrong with this most essential part of the collieries' equipment. How necessary it is that the pumping machinery of the colliery should be full and efficient may be judged when it is stated that in the two mines which are practically linked together, the Emily and the Gore pits, it is necessary to lift five tons of water for every one ton of coal sent to the top. The new pumping apparatus is electrical, and the plant now fitted up at the Arniston Collieries by Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne, is the largest installation of electric pumping machinery in the United Kingdom. The power station is a large building at the head of the Emily pit, with pitch-pine floor, white enamelled walls, and open timber roof. The size and massiveness of the engines and dynamos at once impress one on entering the building. Two steam-engines, of the horizontal compound, long-stroke type, by Messrs. Robey and Co., Limited, Lincoln, are provided for driving the dynamos, each engine being fitted with cylinders of the following dimensions: diameter of high-pressure cylinder, 16¾in.; diameter of low-pressure cylinder, 26½in.; length of stroke, 36in.; approximate revolutions per minute, 84. Each engine is capable of giving 350 i.h.p. with 120lb. steam pressure when working condensing, and is fitted with Richardson and Rowland's automatic triple-expansion gear. The flywheels are each 15ft. diameter, and are grooved for nine cotton driving ropes, each rope being 1¾in. diameter. The engines are fitted with barring gear for starting, and also continuous lubricating gear throughout. The boilers, which are located outside, are of the Lancashire type. They are of steel throughout, and are constructed for a working pressure of 140lb. per square inch. Each boiler is 30ft. long by 8ft. in diameter, and complete with all modern improvements and mountings. There are two dynamos of the latest and most improved type, fitted with drum bar armatures, each dynamo being constructed to give the following output: total watts, 200,000; amperes, 363; volts, 550. Being designed for continuous running, they are of massive construction, and impress one with their size. Each dynamo is 14ft. long, 4ft. in width, 9ft. in height, and weighs about 20 tons They make about 400 revolutions a minute. The main switchboard, placed on one of the walls of the power station, is so designed that the current from one or other of the dynamos, or from both combined, can be used to meet any contingency caused by the breakdown of any part of the

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machinery. The heads of the Emily and Gore pits are about 1,000 yards apart. The shaft of the Emily is 156 fathoms (937ft.) in depth; that of the Gore pit 113 fathoms. Three hundred and thirty-three yards from the Emily pit bottom the road begins to rise until it reaches the foot of the Gore shaft. In the area between the two shafts they mine the great seam, the splint, and the kailblades seam. But from the foot of the Emily shaft a steep incline road has been driven to follow the parrot seam, which is the great stand-by of the Arniston Collieries. This, like the strata, has a sharp down dip of 1 in 2·66. It goes down to 500 fathoms (3,000ft.), and from this great depth the hutches are hauled up by means of a wire rope worked from the top of the Emily shaft. The Gore pit drains into the Emily, and the whole water at the 156 fathoms level collects at the bottom of the Emily shaft. At the bottom of the main dook road, as it is called, the water from the parrot workings of course accumulates. The pumps provided to keep the mine dry are as follows: one set of Scott and Mountain's improved mining pumps of the three-throw type, fitted with rams 11in. diameter by 18in. stroke, at the Gore pit bottom, to deliver 500 gallons per minute against a head of 678ft.; one set of pumps similar to the above at the Emily pit bottom, with rams 11in. diameter by 18in. stroke, to deliver 500 gallons per minute against a head of 256ft. through 3,175ft. of cast-iron pipe—both of the above pumps deliver through pipes 10in. diameter, tested by hydraulic pressure to 400lb. and 500lb. per square inch; three sets of pumps in the dook, each set being capable of delivering 100 gallons per minute against a head of 450ft.—these pumps deliver through 1,200ft. of cast-iron pipes 6in. diameter. In association with each pump at these different levels there is, of course, one or more electrical motors which transmit their pumps by driving belts. For driving the large high-lift pump, which delivers 500 gallons against 678ft. head, two 80-h.p. electric motors are provided, the speed being approximately 450 revolutions per minute. These motors are coupled together, and are constructed so that the armatures will be interchangeable with the single 80-h.p. motor for the low-lift pump. The second set of pumps are driven by a single motor of 80 h.p., which also runs at a speed of approximately 450 revolutions per minute. The three sets of 6 by 9 pumps are driven by electric motors, each capable of giving 25 effective horse-power when running at a speed of approximately 750 revolutions per minute. The current from the main switchboard is taken to a distributing board at the pit bottom by four cables, each about 400 yards in length. This cable is composed of 37 wires, No. 11 S.W.G., and is heavily insulated with vulcanised indiarubber, and armoured over all with steel tape. The object in having four cables is to enable the installation, under ordinary circumstances, to be divided into two circuits. If required, they can all be coupled together, or, in the event of any accident happening to any cable, the remaining cables being connected up, the pumps can still be run. The current from the distributing board at the pit bottom is conveyed to one 500-gallon pump by two lengths of cable, each 1,130 yards long, or a total of 2,260 yards, composed of 37 wire, No. 12 S.W.G., insulated with vulcanised indiarubber, and securely cleated to the uprights along the main road. Another branch is taken from the main distributing board to the four 100-gallon pumps. These cables are composed of 19 wires, No. 13 S.W.G. From the foot of the main dook, 500 fathoms deep, the water is raised in three lifts by the dook motors and pumps, and along the pipes described to the sump at the bottom of the Emily pit. From there it is pumped by the rising road, already mentioned, along which the pipes are laid to the foot of the Gore pit, where the two 80-h.p. motors and the 500-gallon pump send it at one lift up the Gore pit shaft. At the top of this shaft it is discharged into the Gore burn. Those of the company who were down the pits on Friday could not fail to recognise the patient and skilful labour necessary to carry down the electric cables into the depths of the mine and to excavate and fit up in the places narrated the powerful motors and pumping machinery. One thing which even the non-expert eye could see was the eminent adaptability of electrical plant to all mining purposes. This large installation, exclusive of the building of the power stations, has cost about £12,000. In the carrying out of the contract the Arniston Coal Company was represented by Mr. James Malcolm, general manager, in conjunction with Mr. A. A. Campbell-Swinton, consulting electrical engineer, of London; and Messrs. J. and G. H. Geddess, M.E., Edinburgh, as representing the mineral proprietor.

PROTECTIVE METALLIC COATINGS FOR IRON AND STEEL.

BY SHERARD COWPER-COLES, A.M.I.C.E., ETC.

This paper, which was read before the Society of Engineers last Monday, is too long to be produced in our columns. The author starts with the statement that to preserve iron and steel from oxidation it is necessary to exclude air and moisture, which is effectively done by a coating of zinc, cadmium, or copper under certain conditions. Before dealing with the different processes for applying these metals, the author examines the chief causes that tend to corrode iron and steel. He then reviews the hot galvanising process as regularly used before proceeding to describe the electrolytic process with which he has had experience. The details of these processes are given in our issue of Nov. 26, 1897, in which an abstract of a paper, entitled "Electro-zincing," read by the same author before the Liverpool Engineering Society, was given. In the present paper we notice that more information is given about the solutions to be used for depositing zinc, and hence have taken the ensuing paragraphs verbatim.

Various electrolytes have been suggested and experimented with from time to time. Elsner has experimented with ammonium chloride solutions; zinc lactates have also been tried. An electrolyte from which good bright deposits can be obtained is composed of 40oz. of zinc sulphate of 1·1770 specific gravity (= 19 per cent. of crystallised zinc sulphate) and 5oz. of ferrous sulphate to the gallon of water, the anodes being of lead.

Ferrous sulphate (protosulphate of iron $2FeSO_4 + 2H_2O$) when exposed to the air oxidises into ferric salts ($FeSo_4 + 3H_2O$), especially when free acid is present. Two atoms of iron in the ferric state require three molecules of sulphuric acid to dissolve them and form sulphate, whilst in the form of ferrous oxide only two molecules of the acid are required; the free acid is thus consumed. The electrolyte when in good working order has a reddish-brown colour. The yellowish tinge of a freshly prepared zinc sulphate solution, to which has been added ferrous sulphate, is due to hydrated ferric oxide in suspension; the solution retains the same colour after having been passed through a filter. A rusty brown precipitate of hydrated oxide is obtained on adding ammonia, and a deep-blue precipitate with red prussiate (potassic ferricyanide). Potassic ferricyanide gives no precipitate from ferrous solutions, but potassic ferrocyanide gives a bright prussian blue precipitate. The hydrogen set free at the cathode converts the yellow ferric sulphate into ferrous sulphate (green vitriol or copperas), and the oxygen set free at the anode tends to the formation of basic salts, some of the iron being converted into peroxide. A saturated solution of zinc sulphate at 10deg. C. (density – 1·422 – 89·6oz. of $ZnSO_47H_2O$ per gallon) has a specific resistance of 33·7; and about half saturated (density – 1·27 – 44·8oz. of $ZnSO_47H_2O$ per gallon) the specific resistance being only 28·5, which is about the minimum value.

Experiments have recently been made with depositing zinc from orthrophenol — sulphurous metaphenol—sulphurous acid and paraphenol—sulphurous acid.

Messrs. Siemens and Halske have recently taken out a patent in which they claim to overcome the formation of zinc sponge during electrolysis by the prevention of the supposed action of the zinc hydride (ZnH_2) and the nascent hydrogen in causing the production of zinc sponge by mixing with the neutral or slightly acid sulphate of zinc solutions free halogens, or such inorganic or organic halogen compounds (hypochlorous or hypolromous acids, or chlorhydrins of the gylcols), which under reduction give off their halogens to the nascent hydrogen.

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Dr. Kiliani, of Munich, who was the first to recognise the importance of E.M.F. in the separation of metals, found that during the electrolysis of a solution of zinc sulphate of 1·33 specific gravity = (76·0z. $ZnSO_4 + 7H_2O$), the anodes and cathodes consisting of zinc plates, the evolution of gas was greatest with a weak current and ceased when on one square centimetre of electrode surface three milligrammes of zinc were precipitated per minute—that is, 25·833 grains per square foot per hour. From a 10 per cent. solution the deposit was best with a current yielding from four milligrammes to 0·2 milligrammes per square centimetre per minute, or 3·46 to 1 78 grains per square foot per hour. From very diluted solutions the zinc was always obtained in a spongy condition, accompanied by evolution of hydrogen; with a strong current the deposit was very firm. With a weak current, and from a 1 per cent. solution, oxide of zinc was also precipitated even with an E.M.F. of 17 volts, when only 0·0755 milligramme of zinc was deposited per minute on one square centimetre of cathode surface (= ·62 grain per square foot per hour). The same authority found that 2·35 volts were necessary to decompose zinc sulphate.

Electrolytes made by adding caustic potash or soda to a suitable zinc salt have been found to be unworkable on a commercial scale, the zinc oxide formed on the surface of the anode being insoluble in caustic potash or soda.

A solution of cyanide of potassium and zinc cyanide is also impracticable, both on account of cost and the insolubility of the anode. The same remarks apply to a potassio-tartrate solution, patented in 1855 by Watts, and made by dissolving 200z. of cyanide of potassium in 20 gallons of water, to which he added 80z, by measure, of strong liquid ammonia. With this solution he filled large porous cells and put them upright in a vessel containing the bulk of the solution. He placed strips of copper in the porous cells and a large zinc anode in the outer vessel, and connected them up respectively with the negative and positive poles of a battery, and allowed the current to flow until zinc had been dissolved to the extent of 60z. in all, or 3oz. to each gallon of solution. To this solution he added 80z. of carbonate of potash by dissolving it in portions of the solution at a time and returning the dissolved salt to the bath.

A fair coat of zinc is obtained with difficulty from solutions of zinc chloride and from the fused salt. One of the great impediments to the reduction of zinc on a commercial scale has been the tendency of the zinc, after depositing in a sound state for a short time, to come down in one of the varieties of the spongy deposits. The following is an analysis of zinc sponge obtained from a zinc sulphate solution containing a small quantity of ferrous sulphate:

ANALYSIS OF SAMPLE OF ZINC SPONGE.

	Per cent.
Metallic zinc	2 90
Zinc oxide	63·50
Total zinc, expressed as ZnO	67·10
	Per cent.
Zinc oxide	63·53
Zinc	2·90
Sulphuric anhydride (SO_3)	10·05
Silica	1·05
Copper oxide	0 80
Lead oxide	0·07
Alumina	1·20
Ferric oxide	0 60
Lime	0·45
Chlorine and carbonic acid	traces
Moisture and organic matter	19·23 (by diff.)
	100·00 per cent.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

104. How does a high-tension continuous plant compare with a high-tension alternating one in capital cost, and in repairs and maintenance?—W. J. S.

105. With reference to Question No. 97, is the by-pass method of regulating feed pumps economical?—P. T.

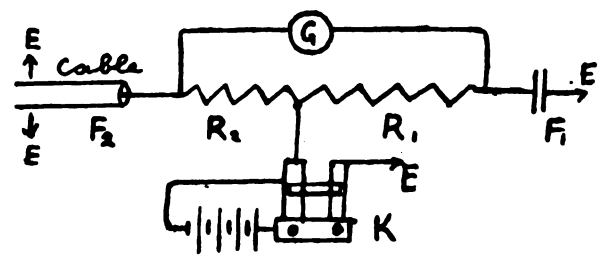
ANSWERS.

Question No. 98.—Describe, with sketches, the best method of testing the capacity of a cable when laid.

Best Answer to No. 98 (*awarded* 10*s.*).—The four practical methods that are used for testing the capacity of cables are: (1) direct comparison with a condenser—charge and discharge method; (2) bridge method—De Santy's; (3) Kelvin's method; (4) Gott's method.

Although originally invented in order to measure the capacity of submarine cables, the methods are equally applicable to measure, say, the capacity of the concentric mains used in alternating-current supply systems. For general purposes De Santy's method is the best, for, since it is a nil method, it is more accurate than the first method, and requires simpler apparatus. An ordinary Kelvin reflecting galvanometer, not necessarily very sensitive, a standard condenser, a 10,000-ohm resistance box, a 1,000-ohm coil, and a reversing key are all the apparatus that we require. When the first method is used, a sensitive ballistic galvanometer is a *sine quâ non*. In both Kelvin's and Gott's methods elaborate special apparatus is required, and, in addition, we have to determine first of all the insulation resistance of the cable, which is a very difficult test to make, as not only is a lengthy calculation necessary, but the insulation resistance is a variable quantity depending on the time that elapses before the reading is taken; some submarine electricians charging for 15 minutes, others for five minutes, and hence they get different results even when testing the same cable with the same apparatus. In De Santy's method, described below, the same answer is always got, as the element of time does not come into consideration.

De Santy's Method.—Make the connections as in the figure: C is the end of the cable; R_2, a 10,000-ohm coil;



R_1, a 10,000-ohm resistance box; G, a Kelvin galvanometer; F, the standard condenser (variable preferred), one terminal of which is connected to a water-pipe; K, a reversing switch. Tap down one side of the key, K, thus charging both the cable and the condenser, then tap down the other side, discharging both. In general there will be large throws of the light spot, but by adjusting the resistance, R_1, these can be got rid of, so that there is no deflection for a quick charge and discharge. When this is the case

$$F_2 = F_1 \times \frac{R_1}{R_2},$$

where F_2 and F_1 are the capacities of the cable and the standard condenser respectively. This is a very accurate method, and is the method usually adopted in laboratories for comparing the capacity of two condensers.

N.B.—If the cable is coiled in a tank, *both* ends of the cable must be connected on to the terminal of R_2, otherwise an error will be introduced owing to electromagnetic induction. Similarly, if a concentric main be coiled on a drum, we must be careful to connect both ends of the inner conductor to R_2, and both ends of the outer conductor to earth, or, better, directly on to the terminal of F_1.—J. C. R.

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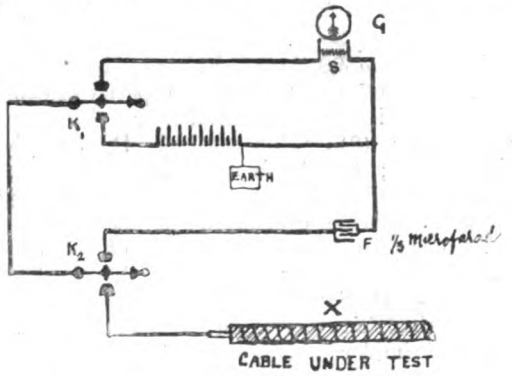
Answer to No. 98 (*awarded* 5*s.*).—The measurement of the capacity of a cable when laid is easily performed by comparing the capacity with that of a standard condenser. The condenser almost universally used in such tests is that known as the one-third microfarad. The method of making the connections is very similar to the one for insulation testing. Below is a diagram showing these connections. The galvanometer, G, is of the Thomson type, of high resistance, and provided with a set of shunts for multiplying the galvanometer deflections by 10, 100, or 1,000. Two similar keys, K_1 and K_2, for charging either the condenser or the cable are required.



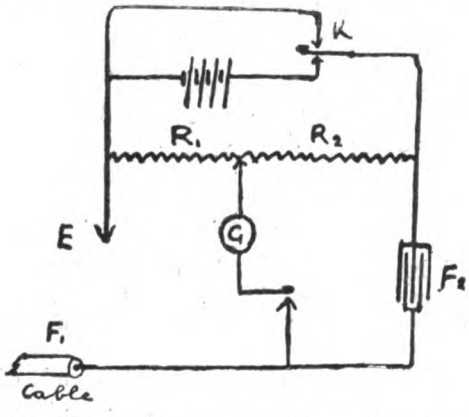
These are also used for discharging either, through the galvanometer. The method of taking a test is as follows: Switch K_2 on the upper contact (in the diagram) and put K_1 down on the lower contact. This operation charges the condenser. Now move K_1 to the upper contact. This discharges the condenser through the galvanometer. Let the deflection be D_1 and the shunt S_1. Now change K_2 on to the lower contact or cable side, and repeat the same test as before. Call this deflection D_2, with a shunt of, say, S_2 ohms on the galvanometer. Let X be the capacity of the cable under test, and F that of the standard condenser—*i.e.*, one-third microfarad. It is very simple to show then that—

$$X = F \frac{D_2 \times (G + S_2)\, S_1}{D_1 \times (G + S_1)\, S_2},$$

X being the capacity of the cable in microfarads.

It is better, for the sake of accuracy, to have a reversing key in the battery circuit in order to nullify any residual charge in the cable.—S. J. M.

Answer to No. 98 (*awarded* 5*s.*).—When a cable is laid either in the soil or in water, and one end is insulated, we have practically a condenser with the wire for one coating, the insulation as the dielectric, and the earth as the other coating, and with a ballistic galvanometer it may be compared with another condenser of known capacity. The simplest method of doing this is to charge the condenser of known capacity and discharge it through a galvanometer, and note the throw of the needle; then with the same E.M.F. charge the cable and discharge through the galvanometer.



The capacities will be in proportion to the swings produced. This is sometimes modified by the use of shunts and varying the number of charging cells. The best method is that of Gott's, for which is required ballistic galvanometer, standard condenser, a large adjustable resistance, Morse key, and a simple key or push. The sketch shows how they are connected up, and then to make the test R_1 and R_2 are first adjusted as nearly as is known in the proportion of F_1 to F_2. K is then depressed and clamped down; this causes the cable and condenser to become charged, and as they are connected in series they will each have an equal quantity. After five seconds, key, *k*, is depressed, and if the resistances, R_1 and R_2, are properly balanced there will be no deflection on the galvanometer, because the P.D. of the cable will be equal to that at the ends of R_1, and that of condenser equal to P.D. at the ends of R_2, so that the charge in each still remains practically the same. It is a similar method to measuring resistances by the Wheatsone bridge. If a deflection is observed, K is unclamped, and the key, *k*, is raised. It will be seen that K puts the cable to earth, short-circuiting it, and the condenser is also short-circuited for a few seconds by means of its plug. R_1 and R_2 are now readjusted, and the foregoing operations again gone through. Then we have

$$F_1 : F_2 :: R_1 : R_2, \quad \text{or} \quad F_1 = \frac{R_1}{R_2} F_2.$$

The best conditions for making the tests are obtained when F_1 and F_2 are as nearly as possible equal, and R_1, R_2 should be made as high as possible. The battery need not be insulated, and a slide resistance of 10,000 ohms, adjustable to an ohm, or two resistance boxes may be used. I prefer the latter, with one fixed and the other variable.

Example.—I made $R_1 = 100{,}000$ fixed;
$R_2 = 132{,}200$ adjusted;
standard ·3 microfarad condenser.
Then capacity of cable was ·227 microfarad.—J. GILHAM.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE I.

(Concluded from page 437.)

The force which we have hitherto considered as acting at the rim of the wheel now appears as a force acting at the centre of the wheel parallel to the rail, tending to push the whole motor along the rail.

Fig. 5 is a view of one of the locomotives used on the City and South London Railway. The armature of the motor is concentric with the axles of the driving wheels; these correspond to our wooden pulley, and roll on the rail. The torque produced by the action of the magnets on the current in the armature tends to make this wheel roll along the rail.

Let us see how we can apply our equations to find out the amount of the pull obtained by using two such motors in a locomotive of this kind. First of all we must observe that the torque produced is equal to the product of the horizontal force, T, acting at the centre of the wheel, called the drawbar pull, multiplied by the radius of the wheel—that is to say, T multiplied by half the diameter of the driving wheel is the *t* that we have used in our equations. In this case the wheels are 27in. in diameter, so that all we have to do is to know what is the

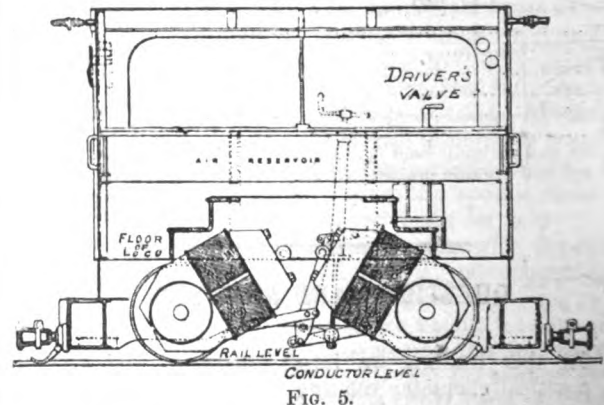


FIG. 5.

value of the induction factor of these motors for any given current and the mechanical efficiency, and we can at once tell what amount of drawbar pull or horizontal effort available for hauling purposes we can get with two of those motors. If we

* Cantor lectures, delivered before the Society of Arts.

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refer to the induction curve of these motors, which I have shown you in Fig. 2, we shall see that for 150 amperes in the motor the value of the induction factor is 63. If we put these values in the equation $t = 1{\cdot}41\ C\ M$, remembering that $t = T\ \frac{d}{2}$, where d is 27in., we shall find that T is 980lb. Now this is the total pull produced by each of these motors with 150 amperes, so that we have to deduct what is lost in overcoming friction. We put that in the way of a certain percentage of mechanical efficiency. Let us suppose the mechanical efficiency is 95 per cent., we should have then 936lb. per motor of horizontal effort available for useful purposes, or a total of 1,872lb. for the whole locomotive. You see then that when we have the induction curve of the motor and the diameter of the driving wheel, we can tell exactly how much horizontal pull we can get from the locomotive for any given current.

The case that we have just considered is the simplest of all, since no gearing is used, but in the majority of cases the armature of the motor is not mounted directly upon the main driving axle of the locomotive, but is connected to it by means of gearing—that is to say, a spur wheel is placed on the main driving axle—and on the shaft of the motor is keyed a small wheel, the pinion meshing into the spur wheel. We then have three wheels—the spur wheel, the pinion, and the driving wheel. The only alteration that has to be made in our equations is that the amount of torque that

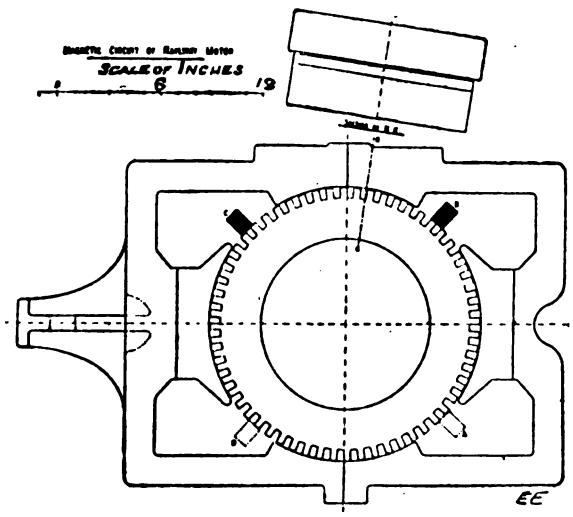

Fig. 7.

we get with a given current in the motor is greater than what we should get if that motor was put directly on the main driving axle, in the proportion of the number of teeth in the spur wheel to the number of teeth in the pinion. If we call v the velocity ratio of the gearing—that is, the ratio of the speed of the motor to that of the driving axle, which, of course, is the same thing as the ratio of the number of teeth in the two wheels—then we have simply to multiply by v to get the draw-bar pull obtained by a given current with a given induction factor. Of course the introduction of gearing would reduce the speed of the locomotive in the proportion of v to 1, so that the rate of working would be unaltered.

The only further change is that when we come to deal with gearing we cannot get such a high percentage of mechanical efficiency, and instead of taking, as we have, 95 per cent. of mechanical efficiency, we shall have to be content with something like 85 per cent. Almost all the street railway equipments that are now being used are geared equipments, but some of the largest railway locomotives are made without gearing. The locomotives now being built for the Central London Railway are to be provided with a gearless equipment. I am sorry to find that they are being made in the United States by an American firm. There is not the least reason why they should not be made in Great Britain, and I hope that the next large electric railway will be engineered by a British firm.

I propose now to show you some views of standard geared equipments. Here is a standard geared equipment made by the Westinghouse Company, who have kindly furnished me with these photographs of their latest types of geared motors. Fig. 6 is a view of a 150-h.p. railway motor. It shows the complete motor as it is turned out from the works ready to be put on to the car. I shall not describe at any length how it is put on to the car. There are plenty of sources from which anyone interested in that subject can find out how this is done. I propose to take this motor into two pieces in order that you may clearly understand what there is inside, and how the force produced by the torque on the armature is converted into draw-bar pull.

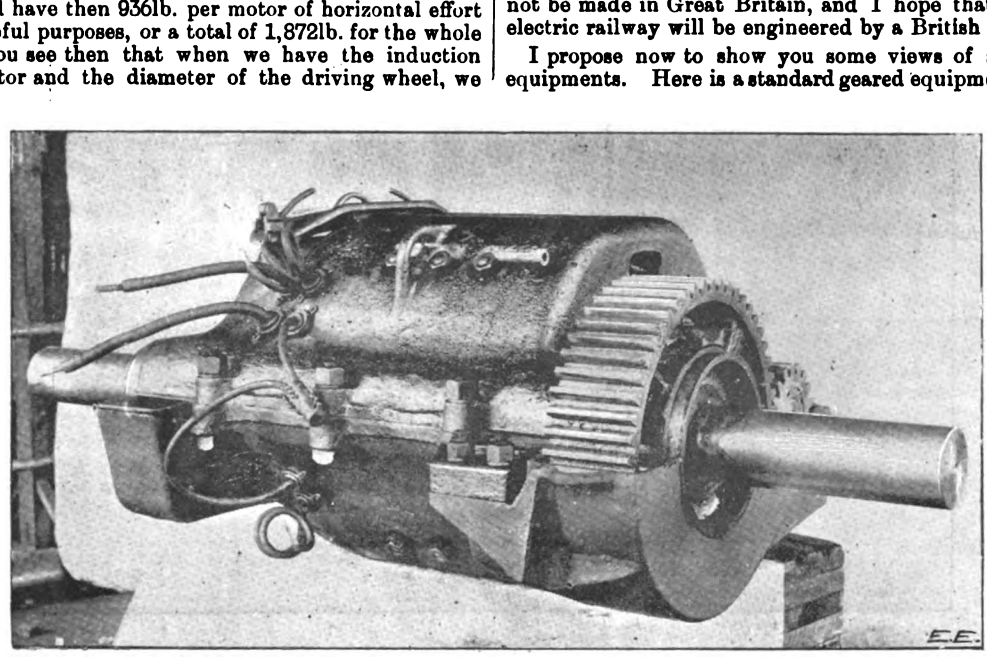

Fig. 6.

Before we open up this motor I want to give you a typical diagram of the magnetic circuit of one of these railway motors. In Fig. 7 you have a section taken at right angles to the shaft of the armature. This is a four-pole railway motor with a slotted armature. There are four magnets in this case. Of course, there are two distinct magnetic circuits. All the equations that we have hitherto discussed are applicable to such a machine as this. We have simply to know the number of conductors on the surface of the armature, and the value of M, and we can find the torque produced by any current in that machine. I propose to divide the machine in two; that is to say, to remove the whole of the top and disclose the armature lying inside.

In Fig. 8 the top magnets have been removed, showing the inside with the bearings ready for the main shaft.

In Fig. 9 we see two motors mounted on what is called a truck. The main driving wheels are each actuated by one motor. This truck is used with a second truck, either with or without motors, so that the locomotive may have two or four motors. Each truck is provided with a pivoted bearing, so that a long car can be used with one of these trucks at each end.

In conclusion, I will calculate what effect we could get, supposing that this truck is equipped with two motors like the G.E. 800 motor, the induction curves of which you have already seen. In those motors, when the current was 40 amperes, the value of M was 59, and allowing 84 per cent. of mechanical efficiency, we get a torque of 2,780 inch-pounds. We have now to consider what is the value of the velocity ratio. A common ratio used in street railway practice is to have 67 teeth in the spur-wheel and 14 in the pinion. That would give us a velocity ratio of 4·78.

Having settled the velocity ratio, all that we want to know is the diameter of the driving wheel. For street railway practice, 33in. is very commonly used. If, then, we take a driving wheel of 33in. in diameter, we get a horizontal pull of 800lb. available for useful purposes—that is to say, after deducting friction and all internal losses, a current of 40 amperes in one of these motors would give us a horizontal pull of 800lb. This is the origin of the name "G.E. 800." Two of such motors would give us a pull of 1,600lb., and if the complete locomotive

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contained four of these motors, we should get a total effective pull of 3,200lb.

LECTURE II.

In the last lecture we treated of the motor in a state of rest. To-night I propose to discuss the question of the motor in a state of motion. For this purpose I shall make use of the same motor as before to illustrate experimentally some of the points I want to bring to your attention. The first thing that I want to remind you of—I suppose there are a few here who are not aware of the fact—is that a motor in action is at the same time, in one sense, a generator. In order to explain this more fully I will make an experiment. I have started this motor in the usual way, and these instruments are recording as before; the ammeter, *a*, giving the current in the armature, and the voltmeter, *v*, the tension at the brushes. The connections are made as shown in Fig. 10. The magnet circuit is permanently connected to the line.

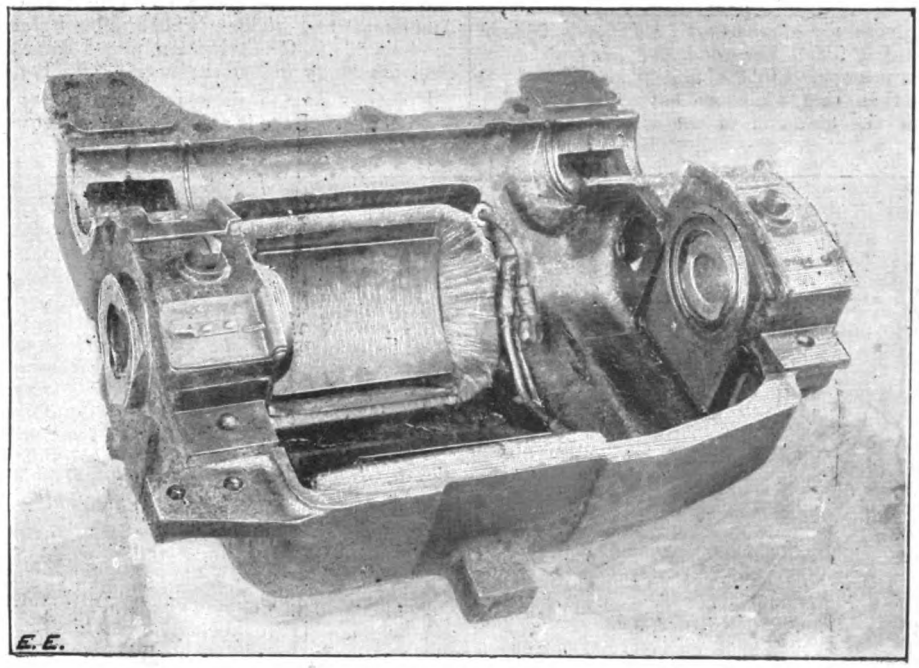

FIG. 8.

In the first place I want to show you that the tension at the brushes is the same as that of the line, both in sign and in amount. To do this, I have simply to lift one of the brushes off the commutator, as at *b* in the figure, by doing which I virtually cut out the armature altogether, and you see that the voltmeter reading does not alter. Take no notice of what the ammeter is doing, observe only that when I raise the brush off the commutator, the voltmeter reading does not alter—that is to say, the voltmeter reading gives you the number of volts on the line to which the motor is connected.

I now have to show you that the motor itself is inducing a tension of the same sign, with respect to the voltmeter, as that of the line. To do this I shall for an instant break the circuit from the line at a point shown by *f* in the figure, and leave the voltmeter still connected to the brushes of the motor. You see that the deflection of the voltmeter is hardly altered at all. To show that this is not due to the inertia of the volt-

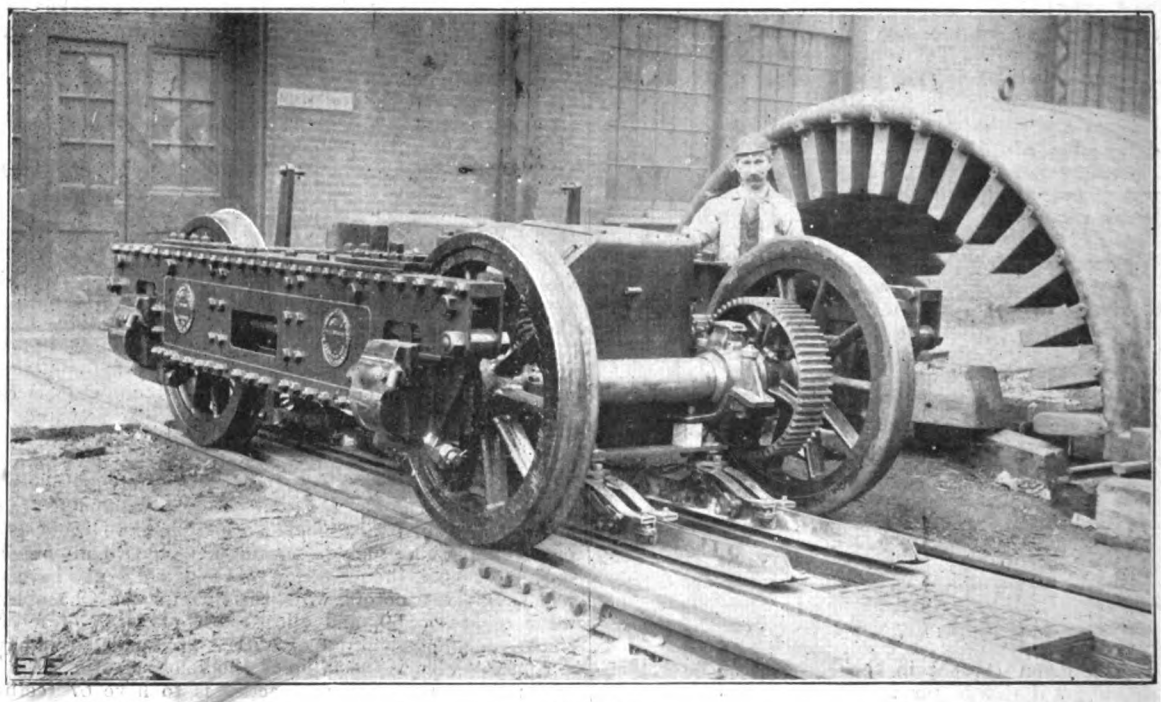

FIG. 9.

meter needle, I will break the circuit as at *d*. You see how very quickly the voltmeter needle drops. This proves that the reading we observed when we broke the circuit at *f* was due to the tension induced by the motor itself acting as a generator. When I disconnect the motor from the line there will be an indication on the voltmeter as long as the motor is moving. Of course, directly the circuit is broken at *f* the motor begins to run slower, but there is still a reading on the voltmeter, and in

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order to prove to you that the reading you have there is being induced by the motor, I will lift the brush off the commutator, and you see the needle drops at once. As long as there is any motion we get a tension induced and an indication on the voltmeter. I would ask you then to remember that as long as the motor is moving it is inducing a tension of the same sign with respect to the voltmeter as that of the line. This result is of great importance, because it follows that in the armature itself, the tension of the line, and the tension induced by the motion of the motor, are opposed to one another. I do not like the term "counter E.M.F.," but prefer to use the expression "induced tension," and to say that the tension induced by the motion is opposed to that of the line in the motor armature.

Now this question arises: "If a motor is moving at a certain rate, how many volts will be induced by the motion at terminals of the motor?" The answer is very simple. If you remember, last week I introduced you to what I called the induction factor. If n represents the number of revolutions per second of a motor, to get the induced tension at the terminals of the brushes you have simply to multiply n by M, the induction factor, and you get the induced tension in volts at the terminals of the motor. Suppose this armature to be running at 1,200 revolutions a minute—that is, at 20 revolutions a second. We found last week that the induction factor of this motor was about 6; hence the induced tension at the brushes would be six times 20—that is, 120 volts. If then you know what the induction factor is, you know that when it is running at any given speed you have simply to multiply the revolutions per second by the induction factor, and that at once gives you the induced tension in volts at the terminals of the motor. And generally, if you have a motor running under any conditions whatever at a known speed, the motor will be inducing a certain number of volts, which number is given by the product $M n$.

Wherever we have a current passing, the strength of that current must always be determined by Ohm's law. This law holds equally well in the case of a motor when it is running as it does in the case of any other conducting circuit. The only difference in the case of the motor is that the tension which is sending the current through the armature is the difference between that of the line and the induced tension. This motor is now running at 1,040 per minute, and the induction factor is now 6·1. When the motor is running at that speed with that induction factor, the tension induced is exactly 106 volts. The

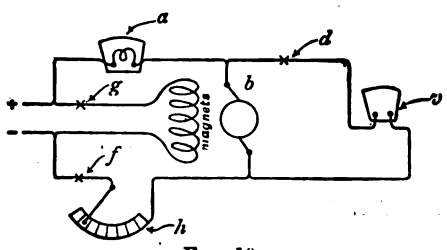

FIG. 10.

tension of the line you see to be 107 volts. Hence the effective volts which is causing the current to pass into the motor is one volt. You now only want to know the resistance of the motor; that is, about one ohm, according to a rough measurement that I made before the lecture, so that you get the current to be one ampere. The motor is now running at full speed, and you see that the ammeter reads almost exactly one ampere.

I may remark, in passing, that we have here a useful method of finding the induction factor of a motor. I gave you last week a method by which we found the induction factor by determining the amount of torque for a given current. This is a much better way. You have simply to run the motor at a measured speed, n, observe E, the volts on the line, and C, the current in amperes, and knowing the resistance, R, we have this simple equation:

$$M = \frac{E - C R}{n}$$

The induction curve of the G.E. 800 motor which I showed you last lecture was obtained by the use of this equation. This is the most convenient way of finding the induction curve of a motor—namely, to run it at different speeds, observe the tension, the current, and the speed, and then deduce the induction factor.

Let us now consider the conditions under which this motor is running. You notice, in the first place, that it is running at what we call a uniform rate. Now, what do we mean by that expression? We mean that there is a balance between the forces acting on the moving part of the motor—that is, the armature. These forces may be divided into two classes: first, those tending to assist the motion; and, secondly, those tending to retard the motion. When these two sets of forces are equal we get uniform motion. If they are not equal, for instance, if the forces retarding the motion are greater than those assisting the motion, then the motion will be retarded, and continue to be retarded until the motor finally stops. If, on the other hand, the difference is the other way, and the assisting forces are greater than the retarding forces, then the motor will go quicker and quicker, and it will continue to do so as long as that difference remains.

In the case before us, what are the actual forces acting upon this motor? The assisting force is the current of one ampere passing through the conductors of the armature, and we saw last week how to find exactly how much force that current produces. You have simply to multiply the current by 1·4 times the induction factor and you get the measure of the assisting force. Now, the retarding forces are those of the friction of bearings and brushes, hysteresis, etc. In this case it is easy to find out exactly what the amount of the retarding force is. Since the current is one ampere and the induction factor 6·1, the retarding torque is 8·6 inch-pounds on the motor shaft—that is to say, when this motor is running uniformly at about 1,000 revolutions per minute, there is a perfect balance between the assisting force due to the current and the resisting force due to the friction, etc.

In order to illustrate this more fully, I will describe briefly what happens when the load is changed. Of course, we know that any increase in the load on the motor will have two results: it will reduce the speed, and it will increase the current. What is going on in the motor during the interval of change of speed and current? When the motion was uniform we had a perfect balance between the assisting and the resisting force. When I put more load on I increase the retarding force. Of course, I need not tell you what happens when the retarding force is increased. The balance is upset, and there is a resultant force tending to stop the motion. The motor runs a little slower, and the induced tension gets less.

Now, $C = \frac{E - M n}{R}$. Hence, if n gets less C must increase, so that the result of increasing the load is to increase the current. Hence the motor will run slower until the current has increased to such an amount that there is again a balance between the retarding force, due to the load, and the assisting force, due to the current. We shall then again arrive at a condition of uniform motion, and this will continue until there is some further change in the load.

A similar process takes place if the load is reduced. It would be a difficult thing to reduce the load on this motor, because it has already as light a load as it can have—namely, that due to the friction of the bearings and brushes, and to hysteresis.

Here I want to explain that when I use the expression "load" I mean that which tends to retard the motion. You may express it in any way you like, either as inch-pounds of torque on the shaft or as the force at the rim of the pulley. But when I use the word "load" I mean the force that tends to retard the motion of the motor. Now, in this case the load is simply that due to friction, hysteresis, etc. When I put a brake on the load is increased by the amount of the friction of the brake. We have already seen that for uniform motion we must have a perfect balance between the assisting and the retarding forces. Now, the resisting forces are measured by what I have called the load; the assisting forces are measured—other things being the same—by the amount of current passing through the armature. It follows that for uniform motion the load determines the current. This is a deduction of very great practical importance. At first sight it may seem quite obvious that the only thing that determines the amount of current in the motor is the amount of retarding force on the shaft of motor. When, however, we come to consider the motor under different conditions, we shall find that it is not quite so obvious. I shall refer to some of these conditions later on, but for the present I simply want to emphasise the fact that when the speed is uniform, the current passing through the motor is determined by retarding torque on the shaft of the motor.

We know that n, the speed in revolutions per second, is equal to $\frac{E}{M} - \frac{C R}{M}$. This is simply stating equation C $= \frac{E - M n}{R}$ in another form, and giving us an expression for the speed of the motor. We find that the speed of the motor is made up of two parts: one which depends upon E, the tension of the line, and the other upon C, which, in its turn, depends upon the load. Now let us see what this means. In the first place we see that for a shunt-wound motor in which the induction factor is constant, when the load is nothing the current is nothing, and the speed has a certain definite value—namely, the line volts divided by the induction factor. Directly we put a load on the motor the speed begins to fall off by an amount depending upon C—that is, upon the load. We need not confine our attention to the case of motors in which the induction factor is constant. The most important class of motors for railway work is that of the series-wound motor, in which the induction factor is not constant, but varies with the current in the motor.

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I will illustrate this by some curves of the G. E. 800 motor that we were looking at last week. Here (Fig. 11) is a diagram illustrating the way in which the speed of this motor, which is series-wound, depends upon the tension of the line and upon the load. I have already shown you the induction curves of this motor in Fig. 3. The tension of the line in volts is set off vertically, and the speed of the car horizontally. These curves are drawn for an ordinary street railway equipment in which the maximum tension is 500 volts.

By putting the motors in series, we have practically reduced the tension on the motor terminals from 500 to 250; consequently we see at once that the effect of putting the motors in series will be to bring us over on to the 250-volt line, and the speed will at once fall to about three miles an hour. This would be a very serious diminution in street railways. Few street railway services would admit of such a reduction in the speed. We have, of course, as a set-off against this disadvantage the fact that the current is reduced 50 per cent. by connecting the

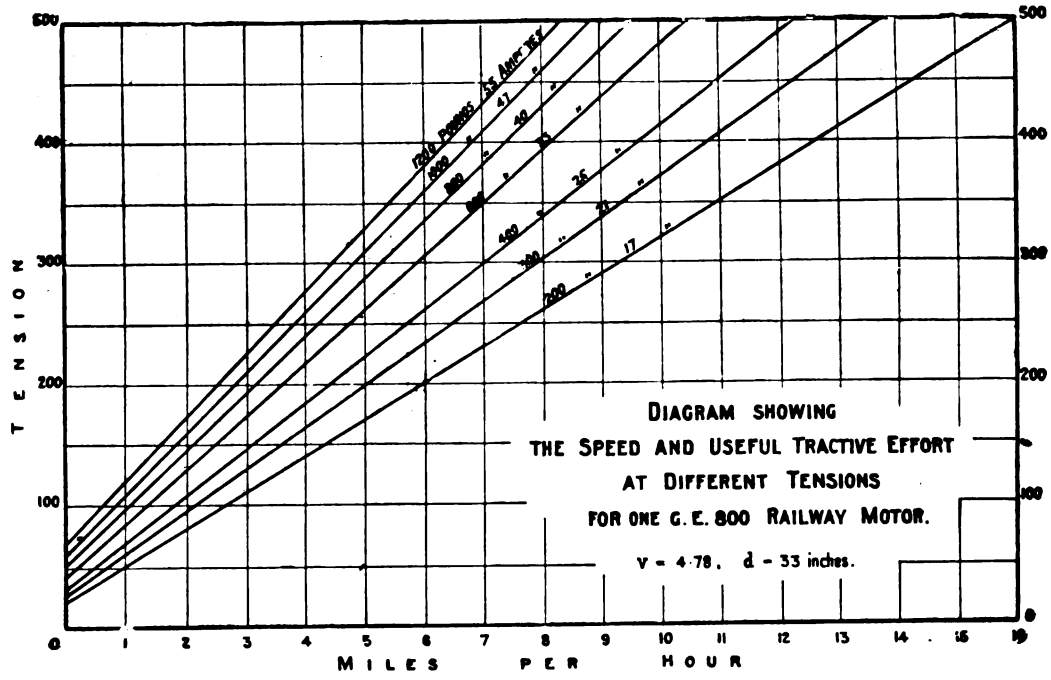

FIG. 11.

Let us take the case where the load on the motor is 800lb. Here is a curve which represents a load of 800lb. on the motor, *i.e.*, the motor is exerting a horizontal pull of that amount. As long as the load is constant, any increase or decrease in the tension of the line affects the speed of the car, as shown by this curve—that is to say, looking once more at the equation for the speed, we have the load constant, and therefore the current constant, and the only thing we are varying is the tension of the line. If the tension of the line were to vary, say, from 500 volts down to something under 50, the load meanwhile remaining constant, the speed of the car would vary as shown by the diagram. For instance, you see that for 500 volts the speed of the car is a little over nine miles an hour. If the tension drops to 200, the speed of the car falls to three miles an hour. As long as the load on the motor remains constant, the current remains constant, so that this diagram gives the variations of speed consequent upon vibrations in the tension of the line.

Let us now see what is the variation of the speed with the load—that is to say, let us keep E constant and alter C. Suppose we have a car equipped with two of these motors, and suppose that the tension of the line is 500 volts, suppose also that the car is loaded in such a way that in order to move the car a draw-bar pull of 800lb. per motor has to be exerted. We should then find the car moving at the rate of a little over nine miles an hour. Suppose now that the car encountered a grade of, say, 3½ per cent. If we assume that the car weighs 10 tons, there would be an increase of 50 per cent. in the load—that is to say, in order to move the car up the grade we should require not only the 800lb. for friction, etc., but we should require 400lb. more for the grade, so that the load per motor would be 1,200. We see from the diagram that we should have to come on to this curve, and the speed would fall from 9·4 to something like 8 miles an hour. The tension on the terminals of each motor in this case is of course 500 volts if the motors were in parallel, and each motor would be taking 40 amperes in the first case and 55 in the second, so that the current taken from the line would be 80 amperes in the first case and 110 amperes in the second. Now we will suppose that 110 amperes is too great a current to be taken. Let us see what would happen if, when we come to ascend this grade, instead of putting the motors two in parallel we put them two in series. The fact of putting them two in series does not alter the current per motor in the least, because the load per motor is just what it was before, and the current is, therefore, 55 amperes per hour; but since they are now both in series, the current for one motor also passes through the other, so that the current from the line is exactly halved—that is to say, 55 amperes.

motors in series. In most cases it is found necessary to run the motors in parallel when ascending grades, even at the expense of taking a very large current from the line.

(To be continued.)

LEICESTER TRAMWAYS.

PROPOSED PURCHASE AND CONVERSION TO ELECTRIC TRACTION.

A special meeting of the Leicester Town Council will be held on Monday afternoon next, when the Tramways Committee will submit a provisional agreement for the purchase of the tramways undertaking, and recommend the same for confirmation. In their report the committee state that they have carefully considered the question referred to them by the Council on March 16 last "as to the advisability of purchasing the tramways in the borough, either by agreement or compulsorily, and as to whether (if purchased) the Corporation themselves should work the tramways or lease them to other persons, and as to the most desirable method of traction to be adopted." Feeling that in a matter of such importance it was desirable that they should have expert advice and assistance, the committee consulted Mr. H. Graham Harris, of the firm of Sir Frederick Bramwell and Harris, who has had a large experience in the purchase and sale of tramway undertakings, as to the advisability of purchasing the tramways, and the amount which the Corporation ought to pay for the undertaking. The committee also instructed Sir John Rolleston to make a valuation of the freehold land and buildings of the company. The report proceeds: It may be here mentioned that the share capital of the company is £100,000 in £10 shares fully paid up, and the loan capital is £24,000 raised by debentures; and, in addition to this, the company have borrowed a large sum from their bankers. During the past seven years the company have paid an annual dividend of £5 per cent. on the share capital, and have also, since 1879, expended a large sum on the renewal of lines, the purchase of freehold property, etc. After a full inspection of the lines and property of the tramways company, Mr. Harris strongly advised that the undertaking should be purchased by agreement at once, if it could be obtained on reasonable terms. The committee fully concurred in that opinion, and with a view to a provisional agreement they instructed their chairman, with Mr. H. Graham Harris and the town clerk, to seek an

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interview with the chairman of the tramways company. After considerable negotiation terms of purchase were arrived at, subject to the approval of the directors and shareholders of the company and the Council, and the following heads of agreement were signed by the chairman of the tramways company and the chairman of your committee :

Heads of agreement, subject to approval by the directors and shareholders of the tramway company and by the committee and Council of the Corporation.

1. The company to sell and the Corporation to buy the tramway and omnibus undertaking as now carried on by the company, including all lands (and including any property held in trust), stock, etc., except the leasehold farm at New Parks and stock thereon, the book debts, and cash in hand as on June 30. The price to be paid by the Corporation to be £129,500, and the Corporation to take over the liability to pay off the company's debentures amounting to £24,000. The purchase to be completed on March 31, 1899, and on payment the company to be wound up.

2. The sale and purchase to be held as taking effect from June 30, 1898, and from that day until the day on which the transfer to the Corporation of the property hereby agreed to be sold shall actually be completed, the directors of the company shall be considered to be carrying on the business of the company as trustees for the Corporation.

3. The Corporation as and from June 30, 1898, to be entitled to all profits derived from the carrying on of the business, and shall pay and discharge all liabilities incurred after that date of the company in relation to the said business. The company to pay and discharge all liabilities incurred before the said June 30, 1898, except as aforesaid, and that so far as it shall be necessary for the purpose of this section, all profits, debts, and other liabilities of the company, shall be apportioned as from the said June 30, 1898. In case of dispute such apportionment shall be made by Mr. Arthur B. Wykes, of Leicester.

4. Until the transfer of the property, hereby agreed to be sold to the Corporation, shall have been actually completed, the directors (other than those who are members of the Corporation) to be entitled to receive from the Corporation the same remuneration as they now receive from the company. The company to pay all compensation necessary to the directors. The directors not to promote or be directly or indirectly interested in opposition tramways or 'buses in Leicester.

5. As from June 30, 1898, until the transfer of the property shall have been actually completed, the shareholders shall be entitled to receive 5 per cent. per annum, free of income tax, on their share capital of £100,000.

6. The Corporation shall take over the present staff of the company.

7. The Corporation to pay the company's costs, not exceeding £500.

8. This agreement to be subject to the consent of the Board of Trade being obtained thereto, pursuant to Section 44 of the Tramways Act, 1870, and in case such consent shall not be obtained within 12 months from the date hereof, this agreement and everything herein contained to be void.

9. This agreement to be also subject to the Corporation obtaining within 12 months the sanction of the central authority to enable them to raise a loan for the above-mentioned purchase money.

10. The company to give notice (six months' notice) to pay off debentures on this agreement being approved by the Corporation.

Dated July 26, 1898.

H. Simpson Gee
(Chairman of the Leicester Tramway Company).

Chas. Bennion
(Chairman of Tramways Committee).

The amount the shareholders will receive is calculated to be about £11. 15s. for each £10 share. The written report of Mr. H. Graham Harris is submitted herewith ; and it may be stated that the company's balance-sheets have been independently examined by the borough accountant, who advises your committee that the annual surplus on revenue account during the past 5½ years, after defraying working expenses and some considerable charges for permanent-way expenditure, would be more than sufficient to meet the yearly charge for interest and sinking fund for a loan of the purchase money provisionally agreed upon. Your committee recommend the Council to approve the above terms of agreement with the company, having regard to all the circumstances, and more especially to the fact that the property of the tramways company in Leicester is (outside the tramway lines themselves) of considerable value, and that no compulsory purchase of the undertaking can be completed by the Corporation for about four years yet to come, and not then without the expense and trouble of an arbitration ; and also on the grounds that your committee consider it is very important that the full control of the streets should be in the hands of the Corporation. Your committee have also considered as to whether the Corporation should, in case they purchase the undertaking, work or lease the lines, and have no hesitation in unanimously recommending that the Corporation shall themselves work the undertaking. The committee think this course will be very much to the advantage of the borough if, as as they hope will be the case, they can so work the undertakings as to accelerate and cheapen the service, and by so doing increase the facilities for persons of the working classes to live in the suburbs of the town. As to the most desirable method of traction to be adopted, your committee have not at present very fully considered this question, but it may be said they are favourably inclined towards the opinion expressed in Mr. Harris's report, that electric traction is the most desirable form of tramway traction ; the committee would, however, at this stage advise that the final decision on the question be left over until the tramways have been actually acquired, and the Corporation have had some experience in working them. Your committee recommend that the Council should confirm the provisional agreement to purchase the undertaking of the company, and if this recommendation be adopted your committee will, at a subsequent meeting of the Council, to be convened in accordance with the requirements of the Tramways Act, 1870, submit a formal resolution to purchase the undertaking.

Mr. Harris's Report.

In the course of his report, addressed to the town clerk, Mr. Harris says : On June 7, 8, and 9 last I visited Leicester with an assistant, and there, in company with yourself, the borough engineer, the electrical engineer, and the tramway company's manager, made a complete and detailed inspection of the whole of the property of the tramway company, including the depôts. I also rode over the whole length of the tramway, and had the roads opened in many places, so as to inspect the condition of the lines, and I generally made myself intimately acquainted with the tramway works throughout. I have before and since the above date carefully read the various Acts of Parliament of the company and of your Corporation affecting the matter, have read and considered your report to the special committee, dated April 14 last, and have examined the printed reports and statements of accounts of the company for the period commencing from Jan. 1, 1888. I have also carefully read and considered the valuation of Sir John Rolleston of the tramway depôts and buildings. I do not think it necessary to give herein even a brief history of the undertaking, as this is so thoroughly and fully dealt with in your report above referred to. On examining this, I find that your Corporation, "under Section 82 of the Local Act of 1877, and the provisional order of 1884, as read with the Tramways Act of 1870, will be in a position to give notice to the tramway company for compulsory purchase of their undertaking within a period of six months after July 28, 1901"; or, in other words, your legal powers to compulsorily acquire the undertaking of the Leicester Tramway Company may, if you choose, be exercised in January, 1902, practically four years hence. I further find that your Corporation inserted in the Leicester Corporation Act of 1897 clauses giving them the necessary powers to work the undertaking of the tramway company in the interests of the ratepayers, when this undertaking has been acquired by them, and to work it either by animal or mechanical power.

Description of Tramway Undertaking.—The tramways of Leicester are throughout their length mostly single-line tramways, with turn-outs or passing places. They are of the ordinary gauge of 4ft. 8½in., and are worked by horses. There is an omnibus service, in addition to the tramways, worked by the company and forming part of their undertaking. The total length of single tramway line open, including the lengths of double line, the "turn-outs," and the passing places, is about 12 miles. I append hereto a plan map showing the various lines as they exist, showing also the extension lines authorised by the company's Acts and orders, the tramway depôts, and, in red, the three existing destructor stations of the Corporation, and the proposed two further stations. The three depôts of the tramway company are situated respectively at Belgrave-gate and Humberstone-gate (and here the company owns some six shops)—at Grape-street, Causeway-lane, and Countess-street, and at Stanton-place, which is situated at the extreme end of the Belgrave-road route. The valuation of Sir John Rolleston (of which you have furnished me a copy) for the land, buildings, etc., at the three tramway depôts, exclusive, however, of any machinery, etc., that there may be at these places amounts to the sum of £59,766. 17s. 6d. This sum, however, the company (through Mr. Gee, the chairman) contend is too low ; he says it should be increased by some 20 to 25 per cent. As to the value of this land, I can express no useful opinion, for I have not the necessary local knowledge which would justify me in doing so. The lines of the company are practically five in number, all connecting at the centre of the town, and branching one along Belgrave-road, another along Humberstone-gate, another along Church-gate, the fourth along Granby-street and London-road, and the fifth down Welford and Aylestone-road. On examining the plan it will be seen

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that these roads divide up the town of Leicester fairly well, and that the tramway service, if efficiently conducted upon them, should satisfactorily meet the demands of the suburbs for connection with the town. It may be that additional lines, cross-connecting the existing lines somewhere towards the centre of their length, would be of advantage, but these cross-connections need not be taken into consideration just at present. In addition to the tramcars themselves, of which, according to the last report of the company, there are 46 in all (37 two-horse cars and 9 one-horse cars), there are for the omnibus service 32 omnibuses and 7 brakes. The number of horses varies with the season of the year, but averages between 320 and 360, while the number of passengers carried during the year ending Dec. 31 last was, according to the company's report, 9,366,467, while the gross receipts were £40,317. 14s. 11d., or 11·71d. per car mile. The average receipts for the three years 1895, 1896, and 1896 being £39,420. 1s. 3d.

Note.—It will be as well here to point out that it appears from all the foregoing the Corporation's present position is the following: First, that they are unable to purchase the undertaking of the Leicester Tramways Company compulsorily, under the purchase clause of the Tramway Act of 1870, for some 3½ or four years yet to come—*i.e.*, until, say, January, 1902. Second, that a large portion of the tramway company's undertaking consists of land and buildings situated in the heart of the town, of an omnibus service with its depôts (combined as a matter of fact with the depôts for tramcars), of stables (the horses are used both for tramways and omnibuses), and of machinery for treating the horses' food, etc. (common also to tramways and omnibuses), and unless there is some act of agreement, of which I am not cognisant, the Corporation could not at any time compulsorily purchase the omnibus service, and the tramway company might retain this for themselves, and work it in opposition to the tram service. Of course, it is undoubted that the tram service, if properly improved and mechanically worked, could successfully compete with the omnibuses, but until the tramway service is "properly improved," the omnibuses might be successfully worked in opposition. Third, that before the purchase could be completed it is certain there would be a long and expensive arbitration, the costs of which would have to be added to the purchase price. I think it just as well to call particular attention to this phase of the matter at this point, as it has great bearing on all I have to say in the remainder of the report.

Condition of Lines, Works, Buildings, Horses, etc.—The result of my investigations into the condition of the lines, works, buildings, horses, etc., of the tramway company may be generally summed up by saying that these appear in all respects perfectly efficient, satisfactory, and sufficient for the purposes of the undertaking, and that they have been fairly well maintained throughout. While this is true generally of the undertaking so long as it is to be worked by horse traction, it must be quite understood that the present lines are generally unfit for mechanical traction. This point, however, is dealt with later on in the report.

Half-Yearly Accounts of the Company.—As already stated, I have carefully read and considered the company's accounts from the year 1888, and I note that the value of the assets has steadily increased, and that while the dividend for 1888 and 1889 and the first half of 1890 was nil, for the past five years or more 5 per cent. has been paid. Dealing with the accounts of the year 1897—the last complete year—the company appear to have expended in all, up to Christmas last, the sum of £133,000 or thereabouts, and there was a debit balance of about £9,000, and £24,000 of mortgage debentures, these bearing interest at the rate of 4 per cent. per annum. The debentures, I am told, are repayable at any time on giving six months' notice. The share capital of the company is £100,000, and the gross receipts for this year, 1897, are, as already stated, over £40,000. I have been informed that some few shares have changed hands since Christmas last at the rate of £11. 15s. per £10 share. My examination of the company's accounts shows that the dividend which has been paid is hardly any fair measure of the prosperity of the company, for a large sum has in each year been put to a reserve fund, being invested in some way in the business of the company, mostly in the lands and buildings at the depôts, which, as already shown, are of very considerable value, and represent a large portion of the assets of the company. In the year 1897 (the year under consideration), as much as £1,500 was transferred to horse renewal account and £1,500 to reserve fund, while there was a special renewal of the lines in Gallowtree-gate, Steney-gate, Woodgate, and Horsefair-street, the cost of which, £1,542. 11s. 4d., was borne out of revenue, so that if the undertaking had been "starved" during 1897, a sum of more than £9,500 would have been available for dividend. This sum of £9,500 is equal to 9½ per cent. on the share capital, instead of the 5 per cent. which was paid. In addition to all this, £2,600 was spent out of revenue on general repairs and renewals to permanent way, rolling-stock, harness, etc.

Purchase Price.—The foregoing being a brief *résumé* of the facts in connection with the company itself, the question now arises as to the course which should be adopted by the Corporation and the sum which it would be advisable for them to pay to acquire the undertaking of the company. Probably the best way in which to approach the solution of this question is, first, to consider the price at which it would pay the Corporation to acquire the undertaking, even supposing the present mode of working by horses is retained. The result of the negotiations between yourself, the chairman of the Corporation Committee, the representatives of the tramway company, and myself, has been that for a lump sum of, say, £154,000, the company will agree to hand over their undertaking to the Corporation as it stands, complete, including the omnibus service, with the exception of a small farm, as and from June 30 last, and for the purposes of this calculation I will assume that the total cost to the Corporation rises to the sum of £155,000, so as to allow a margin to cover legal expenses, etc. The present price of Corporation stock may be taken at £105 for each £100 of stock. The stock bears interest at the rate of 3 per cent. per annum. Assuming that the Corporation obtains powers to borrow the sum of £155,000 for the purchase of the tramways undertaking, and that the period for the repayment of the loan is fixed at 30 years, and assuming that this is repaid out by means of "interest" and "sinking fund," but upon the basis of an "annuity," then the annual charge the Corporation would have to bear for interest and repayment of loan for this amount in 30 years would equal a sum of, say, £7,479, and this is assuming also that the stock is issued at the 5 per cent. premium at which it may be said to stand. If issued at par the annual sum required would be, say, £7,872. As stated above, the accounts of the company for the last year show that the maximum amount available for dividend for this year would have exceeded £9,500. So that, even without any increase in the receipts (and these are steadily increasing under the management of the company), the Corporation would still have a yearly credit balance, after paying interest and the sum necessary for the repayment of the loan, of some £1,500 to £2,000, a sufficient margin to justify the acquirement of the undertaking at the price suggested. In addition to this, the advantages would be obtained which the Corporation deem so desirable; that is to say, they would have control of their own streets, and would have the tramway undertaking in their own hands. These advantages are such as to, if possible, increase the justification for the purchase. So much, therefore, for the question of purchase, even if the undertaking is to continue to be worked by horses.

Note.—It must be remembered that in the case of a corporation the capital sum borrowed by them has to be paid off by annual instalments and within a fixed period. These annual instalments really represent contributions to what would be called a reserve fund by an ordinary trader. As regards the period for the repayment of the loan, the Liverpool Corporation were by their Act granted a period of 42 years for the repayment of the money necessary for the purchase of the electric light undertaking—a period of 30 years for the repayment of the money necessary to purchase the tramway undertaking—and a period of 25 years for the money necessary to change over the tramway working from horse to electric traction.

The Use of Electricity.—But it is almost certain that a Corporation such as Leicester, already owning as it does the electric light, gas, and water undertakings, would desire to employ upon its own tramways the latest, most modern, and most successful form of traction, and this is, undoubtedly, traction by electricity. I have said on more than one occasion in similar reports to this, that the ideal tramway line should be, not only from the point of view of the proprietors of the lines, etc., but also from the point of view of the convenience of the public, constructed and worked in the following manner: The lines should be of the most substantial character, so as to be unaffected, either in gauge or in any other way, by the heaviest traffic which may traverse them. The cars should pass any given point with the least possible interval between them. This interval should be definite and unvarying. The maximum speed should only exceed the average by the least possible amount. This average speed should not be less than, say, eight miles an hour. Passengers should be able to get on or off the cars at any point. The carrying capacity should be capable of being readily doubled in emergency, or when occasion may require, and last, but not least, the cars should be under perfect control. In addition to these "traffic conditions," as they may be called, the cars in themselves should be cleanly and not foul-smelling, well lighted, cool in summer, and warm in winter. It is found that the above "traffic conditions" are most nearly fulfilled when the lightest possible mechanically-propelled cars are used, these cars being provided only with inside seats, additional cars unprovided with motive power (technically known as "trailers") being added on to be drawn by the ordinary motorcars when the traffic is great. The time occupied by the passengers in getting to or from their seats, if these are on top, during which time it is almost always necessary that the car should be at rest, is, in practice, so great that, in order to obtain a reasonably rapid average speed, the maximum—*i.e.*, that between the stoppages—has to be exces-

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sive. For the above reasons, in almost all modern tramway undertakings the number of cars is relatively large, and top seats have been abolished, special open-sided cars being provided for summer use, or the ordinary cars or the "trailers" built so that the whole of their windows can be readily removed when desired. But for mechanical traction, where the tractive effort has to be transmitted through the wheels to the rails themselves, instead of being absorbed on the roadway between the rails, as in the case of horse traction, the tramway lines as they exist in Leicester are not sufficiently rigid and strong, except for some short lengths. The track has been laid on several different systems and at many different times, and is in parts entirely unfit for mechanical traction. Appended hereto will be found a description of the routes throughout. From this it appears that it will be necessary to replace the greater portion of the existing lines with new and more rigid rails and track. It would also be necessary to equip the lines generally with new cars, and to provide the necessary machinery for working these. I have made a rough estimate of the cost of transposing the whole of the lines into lines proper for electric traction, of equipping these, providing the necessary number of cars, say 60—an increase of 30 per cent. over the number at present in use—etc., and a copy of this estimate is to be found in the appendix. From this it will be seen that it will cost to relay the existing length of line, and to equip it for electric traction, a further sum of £110,000.

Total Cost.—The two sums, £155,000 for the purchase of the undertaking, and the £110,000 for the equipping of the new works—together £265,000—make the total sum which the Corporation must expend to acquire the existing tramway undertaking, and to equip this for electric traction on the most modern and approved system. Assuming that the sum of £155,000 is borrowed for a period of 30 years, and the sum of £110,000 for a period of 25 years (as in the case of the Liverpool purchase of the tramways) the annual charges to be borne by the Corporation for the whole £265,000, if issued at par and borrowed for such periods, would be a total of, say, £14,158 for 25 years and £7,872 for the remaining five years. It has already been stated that the gross receipts of the tramway company during the year 1897 were in excess of £40,000. Of this, about one-fourth—say some £10,000—may be attributed to the omnibus service, and to other sources of income, rent of shops, etc. Of this one-fourth, about £4,000 may probably be considered as gross profit. As regards the balance of three-fourths of the gross receipts of the company—*i.e.*, £30,000—this may be attributed to the tramway portion of the undertaking. Experience has shown that in working a tramway undertaking electrically, the working costs, including every item, may, in a town like Leicester, be assumed to be, say, 40 per cent. of the gross receipts. Allowing, however, that the working expenses in Leicester reach as much as 60 per cent. of the gross receipts, and that the balance of 40 per cent. of the £30,000—*i.e.*, say, £12,000—is the amount of the net profit to be derived from the working of the tramways themselves, then this £12,000, added to the £4,000 of the omnibus service, making a total of £16,000 of profit per annum, a sum which is nearly £2,000 per annum in excess of that which the Corporation would have to provide for the first 25 years to meet the interest and repayment of loan under the above-stated conditions. It will be seen, therefore, that even without any increase in the receipts due to the much more efficient service provided by electric traction (and this increase would probably mean an immediate addition of 20 per cent. to the gross receipts), or to any other increase due to any other cause, there would be a margin of profit to the Corporation, justifying them in purchasing the undertaking and in changing the mode of working from horse to electric traction. The cost of working the tramways electrically, which is assumed in the above calculation—*i.e.*, 50 per cent. of the gross receipts—is in excess of that which will be found to be the fact in Leicester, more especially if the suggestions as to the utilisation as far as possible for tramway working of the waste heat to be obtained from the various existing and new dust destructor stations are adopted. At the request of the borough engineer, I have carefully inspected these stations, have seen that they are so arranged as to be in satisfactory positions as regards the tramlines, and I am sure that economy would result from employing, for tramway purposes, the present waste heat from the destructors. This will not be sufficient to work the whole service, but enough will be obtained to justify its employment. It will be noted that throughout this report no credit has in any way been taken for the large amount of valuable land and property which the Corporation would acquire with the tramway undertaking, nor is any deduction made from the estimated cost for this, or for the value of the large stud of horses, etc., which would be rendered unnecessary when electric traction was adopted. These items have purposely been left out of the calculations, as I have thought it desirable to show that, even under the worst possible conditions, such as those set out herein, the purchase of the tramway company's undertaking by the Corporation at the price given would be financially justifiable.—*Leicester Daily Post.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brussels.—The Government Railways will shortly advertise for tenders for 18 lots of material for lighting purposes.

Braila.—The term for tenders for an electric lighting installation for the Corporation has been extended to Oct. 13.

Ghent (Belgium).—The Corporation are advertising for tenders for public and private electric lighting on Oct. 27 and 29 respectively.

Paris.—The Post and Telegraph Department, rue de Grenelle, 103, will accept tenders on Oct. 13, at 11 p.m., for 78 miles of paper-insulated electric cables.

London, N.W.—Tenders are invited by the St. Pancras Vestry for the supply of Welsh and other steam coal for use at the Regent's Park and the King's-road electricity stations for eight months. Tenders by 13th inst.

London, W.—Tenders are invited by the Hammersmith Vestry for the supply of about 1,000 tons of such best Welsh smokeless steam coal as may be required up to March 25, 1899, at the electric lighting works. Tenders by 12th inst.

South Shields.—The Corporation are inviting tenders for the supply and erection of (1) vertical triple-expansion engine, 800 to 1,000 i.h.p., with surface condenser; (2) alternator, iron-clad or inductor type, 400 or 500 kw. Tenders by Oct. 19.

Knowle.—Tenders are invited for the supply and fixing of two engines and dynamos, equal to an output of 24,000 watts each, etc., for the County Lunatic Asylum, Knowle, near Fareham. Tenders by Nov. 10. Further particulars appear in our advertising columns.

Madrid.—The Post and Telegraph Department invite tenders for 40,000 insulators for telegraph posts. Offers must reach the above department at Madrid or the office of the Civil Government, either at Barcelona, Cordoba, or Leon by Oct. 12. The maximum price is 1 peseta 7 c. per piece. 10 per cent. deposit is required, 5 per cent. to accompany tender.

London, W.—Tenders are invited by the Great Western Railway Company for the supply of the following, among other stores: indiarubber goods, telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, and incandescent electric lamps. Samples and patterns may be seen at Swindon from 12th to 21st inst. on application at the office of the Stores Superintendent, Swindon, where specifications and forms of tender may be obtained. Tenders by 24th inst.

Bangor.—Tenders are invited by the Corporation for erection of buildings, chimney shaft, etc., for its electric lighting station. Plans and specification may be inspected at the offices of Mr. John Gill, A.M.I.C.E., borough surveyor, and at the offices of Mr. F. Hastings Medhurst, B Sc., M.I.E.E., the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., from the latter of whom the bill of quantities can be obtained on payment of a deposit of £5. 5s., which will be returned on receipt of a bona fide tender. Tenders by Oct. 15.

Leigh (Lancs.).—Tenders are invited by the Urban District Council for the supply and erection of the following plant: (Section 1) steam dynamos, steam and exhaust pipes; (2) main switchboard; (3) accumulators; (4) mains, etc.; (5) meters; (6) overhead crane; (7) water softener. Tenderers are at liberty to tender for any section or sections, but not for part of a section. Plans may be seen and copies of the specifications, forms of tender, and further particulars may be obtained at the office of the engineer, Mr. John Foster, Leigh, Lancashire, on the deposit of £3. 3s., which will be returned on the receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Machinery, etc.," to be sent to Mr. P. Thomas, clerk, Town Hall, Leigh, by 12 noon on Oct. 14.

Hull.—Tenders are invited by the Electric Lighting Committee for the supply and erection of certain plant in connection with their electric lighting works. Forms of tender and specifications for the following are now ready: (Contract 4) high and low tension mains, casings, trenchwork, etc.; (5) switchboards, continuous-current rotary transformers, motor-generator, etc.; (6) centrifugal pump, condenser (ejector type), steam-pipes, etc. Specifications for any one of the above three contracts may be obtained from Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Cheques or postal orders to be made payable to Thos. Geo. Milner, city treasurer. Tenders, endorsed respectively "Tender for Mains," "Tender for Transformers," "Tender for Steam-Pipes," to be delivered to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on Oct. 27.

RESULTS OF TENDERS.

Stockton.—The Town Council have accepted the tender of the Brush Electrical Engineering Company for the proposed electric light installation.

London, S.W.—The following tenders have been received by the Fulham Vestry for the construction of dust destructor and steam-raising plant: Messrs. Beaman and Deas, Limited, £16,520; and the Horsfall Furnace Syndicate, Limited, £16,760.

Leeds.—The City Council have accepted the following tenders in connection with the electric tramway extensions: Messrs. James Russell and Sons, for poles and brackets, £5,058; and the British Thomson-Houston Company, Limited, for trolley wire and attachments, £4,248.

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BUSINESS NOTES.

Petersfield.—The Rural District Council are about to apply to the Board of Trade for an electric lighting provisional order.

St. George's (Hanover-square).—Extensions of mains have been granted under the usual conditions to the Westminster Supply Company.

Keighley.—At the last Council meeting a proposal to apply for a provisional order to enable the Corporation to supply electricity was confirmed.

Hereford.—The Electric Lighting Committee have entered upon an agreement for the purchase of property for £1,650 to be used as the electric light works.

Bradford.—The Corporation electric trams were stopped for five hours on Oct. 2 owing to the overheating of the bearing of a dynamo at the power station at Valley-road.

London Tramways Company.—The London County Council will next week consider a proposal of the Highways Committee to pay £86,000 for the undertakings of the above company.

Edinburgh.—During the past fortnight the number of applications received equalled 3,196 8-c.p. lamps. Since May 15 the number of applications has been at the rate of about 1,500 lamps per week.

Hampstead.—The Guardians have decided to take their supply of electric current for the lighting of the workhouse from the Hampstead Vestry, and not to pursue further the question of laying down an electric lighting plant of their own.

North Berwick.—It having been ascertained that the probable number of lights to be used at the outset, in the event of the introduction of the electric light into the burgh, would be only 794, the matter has been abandoned for the time being.

Drake and Gorham Electric Power and Traction Company, Limited.—This Company, to the promotion of which we have already referred, has been registered by Ashwell and Co., 79, Queen-street, E.C., with a capital of £250,000 in £1 shares.

Norwich.—The Town Council have decided to borrow £15,000, being the first instalment due to the Norwich Electric Tramways Company, Limited, in respect of new streets and street widenings under Section 30 of the Norwich Electric Tramways Act, 1897.

Stafford.—The free library and the reading and reference rooms are to be lighted electrically. The number of lamps in various parts of the town are to be increased. Compared with the corresponding month last year, there has been an increase in the sale of electricity.

Fire.—We are informed by Mr. G. Braulik, of 217 and 218, Upper Thames-street, that a fire broke out adjoining his premises at Graham Wharf, and that, though his goods were considerably damaged by water, no delay in the execution of orders will occur, as the warehouse and wharf is used for storage purposes only.

Acton.—Before engaging in a scheme of electric lighting estimated to cost between £30,000 and £40,000, the District Council have decided to obtain expert evidence bearing upon the best scheme to adopt, and also suggesting which of the two consulting engineers' plans is the more feasible and practicable for Acton.

Colwyn Bay.—The Local Government Board have written to the District Council with regard to a sum of £436 proposed to be borrowed for electric lighting coets, stating that it was not the practice of the Board to sanctioning the borrowing of money in respect of expenses incidental to a scheme which had not been matured and adopted.

Tottenham.—At a meeting of the District Council on the 5th inst. it was decided to apply to the Board of Trade for a provisional order to supply electricity within the district, and to oppose applications made for provisional orders by several companies. The working of the electric light in connection with a dust destructor is contemplated.

Eastern Telegraph Company, Limited.—The directors announce the payment on the 14th inst. of a dividend at the rate of 3½ per cent. per annum, less income tax, on the preference stock for the quarter ending Sept. 30, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ending June 30 last.

Appointments Vacant.—The Council of East Ham require the services of an electrical engineer.—The Corporation of Southampton require the services of a third assistant electrical engineer. A demonstrator is wanted to take charge of the laboratory classes at the City and Guilds Technical College, Finsbury. Particulars of these and other vacancies appear in our advertisement columns.

Bootle.—The Corporation hope to be in a position to supply electricity at the end of the present year, and have decided to charge 7d. per unit for the first hour at maximum demand and 3d. per unit afterwards. The payment for the wiring of consumers' premises will be spread over five years, if the intending consumers so desire, and no meter rent will be charged for the first year.

Shoreditch.—Owing to the rapid increase in the demand for electric current, and on the advice of the chief engineer, the Vestry have agreed that a 100-kw. transformer, complete with the necessary switch gear, be ordered from the Electric Construction Company at £881 on the terms and conditions of their tender; and that tenders be invited for two smaller transformers of 66 kw. capacity each.

Gloucester.—The City Council have resolved that an amended application be made to the Local Government Board to sanction the purchase of Mr. Browning's property and the Beanland estate, or the portions thereof not required for the proposed electricity and dust destructor works, as a means of investing corporate funds now awaiting investment, and proceeds to arise from the sale of corporate lands.

Partnership.—We understand that Mr. Reg. J. Wallis-Jones has entered into partnership with Mr. Montagu C. Dent, and that they have taken offices at 36, Great George-street, Westminster, for the purpose of carrying on the business of consulting electrical engineers. Mr. R. J. Wallis-Jones will continue to act as engineer to the Electric Welding Company, and will advise them on all technical matters.

Weston-super-Mare.—The Corporation have invited a number of companies to make them an offer to take over their provisional order for a limited time. The answers were to be in yesterday by 10 a.m. That did not leave intending tenderers much time to consider, and we hope that this suddenness of action is an indication that the Weston-super-Mare Corporation really do intend to do something now.

Fenton.—The Urban District Council have confirmed a resolution to the effect that it is desirable to apply for an order to authorise the Council to supply electricity for public or private purposes, and that a special meeting be convened on the 17th inst. to consider and decide upon the subject. A committee has been appointed to deal with the business, and Mr. Hammond appointed as adviser to the Council.

Sheffield.—The work in connection with laying the tramrails in Fargate in order to complete the communication between Pinstone-street and High-street was commenced last week. On the completion of the work in Fargate the rails from the bottom of High-street to Fitzalan-square will immediately be laid, and a connection made with the Haymarket branch, thus finishing the whole route between Nether Edge and Tinsley.

Cardiff.—On Monday last the Mayor of Cardiff and Alderman Carey, accompanied by the borough and electrical engineers, left Cardiff for Kidderminster, whence they will visit several of the larger towns in the North of England, where electric tramways are in working order. The deputation are going with the object of reporting to the committee who have charge of the proposed electric tramways upon the best systems now in use.

"Ediswan" Queen of Lamps.—Under the above title Messrs. Edison and Swan have brought out a new 16-c.p. lamp for ceiling panels, fixtures, etc. No shades are required for this lamp, which aims at a more perfect diffusion of light than that obtained with the ordinary bulbs. The top reflecting part of the bulb is made of opal glass, by which a very soft even light is obtained, altogether free of the "lines" or shadows peculiar to silvered bulbs.

Cygnet Stylo Pen.—We have received from Messrs. Mabie, Todd, and Bard, who are so well known as the makers of the Swan fountain pens, one of their Cygnet Stylo pens. This pen runs very easily, the ink flows freely, and it writes very much like a pencil. The price brings it within the reach of every student being only 3s., or with oxidised clip to keep it secure in pocket, 4s. It should prove a very useful pocket companion for students.

Tramway Trust.—A new tramway trust, called the Fédération des Tramways, is about to be floated. The capital is 7,000,000fr., and five tramway enterprises, three of which are in France and two in Belgium, are to be taken over. Amongst the founders of the trust are the Compagnie Belge des Chemins de fer Réunis, the Compagnie Russe-Française de Chemins de fer et de Tramways, and the Compagnie Générale de Railways à voie étroite.—*Financial News.*

Hammersmith.—At the last meeting of the Vestry a letter was read from Mr. J. Clifton Robinson, managing director of the London United Tramways, to the effect that the directors felt that the time was opportune to reopen negotiations with the London County Council, asking its assent to the introduction of the overhead trolley system of electric traction on their lines in Hammersmith. The subject was referred to the committee of the whole Vestry.

Ilford.—Some time ago Mr. Hawtayne was instructed to report on the introduction of the electric light into Ilford, and at a Council meeting held on the 28th ult. it was decided that electric traction should form part of the scheme, and Mr. Hawtayne was instructed to prepare the necessary plans and specifications without delay for nearly 17 miles of road. Anyone who has not been to Ilford for some time would be surprised at the marvellous growth of the district which renders a scheme of this sort necessary.

Lancaster.—The Electricity Committee have reconsidered the minutes of the Lighting Committee, requesting them to discontinue the rent for the street arc lamps, in order to place a larger sum of money at the disposal of the committee for street-lighting purposes. The present rent of each pillar, lamp, and cable is £3 10s. per annum. It has been resolved that no rent be charged for arc lamps, pillars, and cables, but that the Lighting Committee be held liable for the repairing and renewing of the same.

Chiswick.—At an adjourned meeting of the Urban District Council, the clerk reported that Messrs. Kincaid, Waller, and Manville, the engineers to the Aberystwyth and Chiswick Electric Supply Corporation, had written giving notice of their intention

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to commence laying mains in the High-road, from the east corner of Turnham Green to the boundary between Chiswick and the Hammersmith parish, in a month; also that they contemplate using the low-tension three-wire system. It was decided to inform the engineers that their notice was invalid.

Islington.—At an ordinary meeting of the Vestry to-day a report from the Electric Lighting Committee will be presented, stating that in consequence of the numerous complaints of nuisance in Victoria-road, near Liverpool-road, due to the insufficient lighting, and as the darkness will only be intensified by contrast when the arc lamps in Liverpool-road are lighted, it is of opinion that an additional arc lamp should be erected on the left-hand side of Victoria-road at an estimated cost of £100, and that it be kept alight all night, and recommending accordingly.

Poplar.—At the last meeting of the District Board the Electric Light Committee recommended that the offer of the trustees of the German Estate to sell to the Board, for the purpose of an electric station, the piece of vacant ground now in the occupation of the Board, and situated between Violet-road and Glaucus-street and adjoining the Board school site, for the sum of £3,000, the Board to forego a claim for paving, amounting to £104 12s. 5d., in respect of the land, and to pay all costs, including negotiation, etc., be accepted by the Board. The report was agreed to.

Leeds.—The City Council have confirmed the minutes of the Parliamentary Committee recommending the Council to promote a Bill in Parliament for powers to extend the tramways of the Corporation from the city boundary to the boundary of the city of Bradford, and the town clerk has been instructed to apply for the consent of the West Riding County Council, as the road authority, and the Urban District Councils of Pudsey, Farley, and Calverley to the proposed tramway extension. The Council have increased the salary of Mr. H. G Jeken, assistant electrical tramway engineer.

Stockton.—At a meeting of the Town Council on the 4th inst. the town clerk was instructed to inform the Brush Electrical Engineering Company that the sanction of the Local Government Board having been obtained for the loan required for the electric light installation their tender, as amended and approved by the engineer, was accepted, subject to a formal contract being signed, the position of the site being reserved for the decision of the Corporation. It is expected that the work of laying the new electric plant will soon be in hand, and that within 12 months the town will be lighted throughout by electricity.

Sunderland.—The borough engineer (Mr. R. S. Rounthwaite) and the electrical engineer (Mr. J. F. C. Snell) have reported that they are pushing forward the plans, and that everything in regard to the latter will be completed ready for the proposed application to Parliament for the necessary powers for the municipalisation of the tramways. The lease of the present company does not expire until August of next year, but the Council desire to commence operations with their new electrical system at an earlier date, and a deputation has been appointed to negotiate with the company with a view to the termination of the lease at an early date.

Isle of Thanet.—A representative of the *East Kent Times* has been informed by a gentleman prominently associated with the promotion of the Isle of Thanet electric tramway scheme that the plans are being prepared with all possible speed. This work, together with the placing of orders for the enormous quantity of plant and material, must of necessity take a considerable time before any actual breaking up of roads is commenced. It is expected that a start will be made either in October or November if the drawings are ready at that time. The promoters hope that the whole of the line will be completed and opened for traffic by the season of 1899.

Walthamstow.—Major-General Crozier, R.E., Local Government Board inspector, has held an enquiry into an application by the District Council for sanction to borrow £41,690 for electric lighting. The Inspector said he thought it was probable that another enquiry would have to be held, as notices calling attention to the enquiry had not been posted on the church and chapel doors in the district. He saw nothing in the scheme to object to except the proposal to wire private houses at a cost of £5,000. He could not recommend this to the Local Government Board, as a fresh tenant might decline the electric light, and the wires would have to be taken out at the expense of the ratepayers.

St. Pancras.—At the Vestry meeting on the 5th inst., the Electricity Committee's report stated that the total revenue for the half-year ended June 30 last was £17,408. 17s. 3d., an increase of £3,088. 2s. 5d. on that of the corresponding period of 1897, yielding a net profit of £1,166. 6s. 7d. The total profit for the past 18 months was £2,883. 13s. 9d. Owing to the expenditure on mains, and the reduction of the current to the consumer, the profit was £1,000 or £1,500 less than it would have been otherwise. It was stated that the object of the Vestry was not so much to make a profit out of the undertaking as to allow the parishioners to have the electric light at a price cheaper even than gas, and to supply the public lighting at cost price.

Skipton.—A largely attended meeting of ratepayers was held in the town hall last week for the purpose of taking into consideration the proposed compulsory purchase of the gasworks by the Urban District Council. The Chairman proposed a resolution to the effect that the ratepayers and owners should give their consent to an application by the Urban Council for compulsory powers of purchase. During the discussion it was said that the proposal was 40 years behind the time, seeing that the electric light was coming so much to the front. Also that Skipton could obtain plant and mains for electric light for £10,000, while they would probably have to pay £60,000 for the gasworks. The Chairman having called for a show of hands, the resolution was declared carried. A poll was demanded.

Blackpool.—We have already referred to the proposal of the Blackpool, St Annes, and Lytham Tramways Company to transfer their undertaking to another company. It was necessary to obtain the consent of the Blackpool Corporation to the lease of the Lytham-road line within the borough boundary being dealt with, and it is stated that an agreement has now been arrived at by which the new company undertake that any electric energy they may require at any time during the remainder of the lease, about 19 years, either for the line within the borough boundary, or for the whole of the line to Lytham, shall be supplied by the Blackpool Corporation at a price to be agreed upon by arbitration. The Corporation will of course, have to obtain parliamentary powers to supply electric energy out of the borough, should it be necessary.

Swansea.—At a special meeting of the Tramways and Electric Lighting Committee it was agreed to defer for the present the dust-destructor scheme owing to the difficulties in regard to the acquisition of the necessary land, and to request Mr. Manville to prepare amended plans and estimates of an electric lighting station only on the Corporation property on the Strand. The Mayor, referring to the difficulty of obtaining the site for the dust destructor, said that this part of the scheme was to cost £11,287, the estimate for a low tension electric lighting station only being £32,470. Major-General C. S. Hutchinson, R E., C.B., has been appointed to act as referee on behalf of the Board of Trade to settle the matters in difference between the tramways company and the Swansea Corporation, and will hold an enquiry to-morrow.

Eastbourne.—At the meeting of the Town Council on the 3rd inst. the scheme for utilising the refuse destructor for the supply of the electric light was discussed. A report was presented by Mr. Hawtayne, in which three schemes were given—scheme 1 being for a steam-raising plant combined with a remodelled destructor, scheme 2 for steam-raising plant without destructor, and scheme 3 for a similar undertaking worked by a destructor only. The committee's recommendation to the Council was that scheme 1 should be adopted, and it was stated that in respect of public lighting the scheme would yield a profit to the ratepayers of £1,500 a year, even after setting aside £750 a year as a special depreciation fund. It was decided to apply for a provisional order, and to offer to buy up the electric lighting company's undertaking on fair terms.

Cheltenham.—The Montpellier Gardens are to be illuminated by small coloured electric incandescent lamps in festoons along the boundary of the outside paths, the cost of which is estimated by the electrical engineer as follows: £850 for establishment and £1 per night for maintenance, calculated upon the basis of illuminating the gardens three nights a week for 26 weeks between the beginning of April and end of September. The electrical engineer's report states that the number of customers connected last month was 269, equivalent to about 16,140 8-c.p. lamps, and that the number of arcs in use was 121. He estimates the cost of lighting by 27 arcs various roads and streets at £2,215, and it has been resolved that application be made to the Local Government Board to sanction an additional loan of £2,500 to provide for the expenditure.

St James's.—The Parliamentary Bills and General Purposes Committee have considered the letter from the St. James's and Pall Mall Electric Light Company, Limited, with reference to the company's charges for the supply of electricity in the parish, and have reported to the Vestry that they have decided to defer the consideration of the company's suggestion—viz., that the views of the Vestry would be met by bringing the question, in a friendly way, before the Board of Trade, with a request that the Board should see a representative of the Vestry and the company, and advise generally until the latter have arranged their charges for the ensuing year. Extensions of mains have been granted under the usual conditions to the St. James's and Pall Mall and the London Electric Supply Corporation, Limited, by the London County Council

Llandudno.—The electric light is to be turned on on the 10th inst., and a committee has been appointed for the purpose of arranging a demonstration to be held in celebration of the event. The President of the Local Government Board is to be invited to attend. Mr. Preece has recommended the Council to make an arrangement to supply Craigside Hydro with current, the company being willing and desirous of taking same on favourable terms. Mr. Preece states that the cost of laying down a new main from the works would be about £800. It has been resolved that premises consuming more than 15,000 units in one year shall be supplied at a uniform charge of 4½d. per unit, and that, provided the Craigside Hydro accept the above terms, and also undertake to take current for a period of not less than 10 years, the Council will lay down a new main at the above cost.

Garston.—At the last meeting of the Urban District Council on the 4th inst., a letter was read from the Local Government Board stating that the Board had considered the report made by their inspector, Colonel Slacke, after the enquiry held by him with reference to the application made by the Urban District Council for sanction to borrow £25,000 for the purchase of land for the erection of a refuse destructor, and for the purpose of electric lighting and the expenses connected therewith. The Board consider that if the District Council adhere to their proposal to erect combined electric lighting and refuse destructor they should endeavour to obtain some site for the works which is further removed from the centre of a residential neighbourhood from that now in question. After a protracted discussion, the Council

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decided to ask for sanction to borrow the money to purchase the land for the extension of the yard.

Personal.—Mr. F. A. Wilkinson has been appointed inspector of works in the electricity and public lighting department of the St. Pancras Vestry.—Mr. George A. Zeden has resigned his appointment on the technical staff of the Brush Electrical Engineering Company in order to take up the position of managing engineer to Mr. W. C. C. Hawtayne, consulting engineer, of 20, Bucklersbury, E.C Out of his 10 years' service with the Brush Company, Mr. Zeden has spent six years in their estimating department in London, and before leaving on Friday last he was presented with a handsomely-fitted travelling bag by his colleagues at the head office.—We note that Mr. J. H Woodward, who was for many years head designer of all classes of electrical machinery at Messrs. Thomas Parker, Wolverhampton, has resigned that position.—Mr. Val. A. Fynn has resigned his position of chief electrician to Messrs. Easton, Anderson, and Goolden, Limited.

Southend.—A meeting of the Town Council will be held on the 26th inst. to decide whether application shall be made to the Light Railway Commissioners for an order authorising the Southend Corporation to construct a system of electric tramways, covering the principal streets of the borough, and including Prittlewell, Leigh, Southchurch, Westcliff, etc. The Town Council hold already an order for electric lighting, and appear to be in favour of the suggested tramways, and many of the members contemplate using the same plant for electric traction as for lighting. They are not unanimous upon the points whether the Council should themselves work the service when powers are obtained, or whether they should let the powers provisionally to some company. The scheme concerns 10 miles of tramway, and the total cost for buildings, rolling-stock, etc., would be about £80,000. The profit per year is estimated at £2,000 for the tramway, and £500 for supplying electricity to the pier, etc.

Devonport.—Communications have been passing between the town clerk of Devonport and the clerk of East Stonehouse District Council with respect to a proposal to transfer the Stonehouse electric lighting order to the Devonport Corporation. The clerk of the East Stonehouse District Council requested that terms might be submitted to him on which the Corporation would be prepared to supply the electric current in Stonehouse provided the transfer took place. This request was submitted to Prof. Kennedy, who stated that he saw no objection whatever to the suggestion that if the order of the Stonehouse authority were transferred to the Corporation a contract should be entered into to supply current in Stonehouse at identically the same rates as were charged in Devonport, and that in reality it would be to the interest of both parties. The negotiations with the Stonehouse District Council was referred to a sub committee, with the town clerk, to confer and report.—*Western Morning News.*

Newport.—A Local Government Board enquiry was held at the Town Hall, Newport, last week by Mr. Walter A. Ducat into an application on the part of the Newport Corporation for sanction to borrow £6,150 for the purpose of electric lighting. The town clerk, Mr. A. A. Newman, explained that the total expenditure to date on the electric lighting of the town was £74,665, and the present application would, if granted, bring the total up to £80,815. Of the amount now asked for, £5,000 was for sub-stations and transformers, and for low-tension distributing mains and high-tension mains and feeders, and £1,150 was for emergency plant. During the first year of the undertaking there was a gross profit of £224, but the payment in respect of the sinking fund and interest amounted to £1,634, leaving a net deficiency of £1,410. In the second year there was a gross profit of £864, but the payment of £1,828 to the sinking fund and interest made this into a net deficiency of £912; and the third year the gross profit was £1,716, payment to sinking fund and interest £2,150, and the net deficiency only £454. There had now been a large increase in the number of lights, which now reached a total of about 20,000. There was no opposition.

Removals.—We note that the registered offices of the Newcastle-upon-Tyne Electric Supply Company, Limited, have now been removed from Pandon Dene to 50, New Bridge-street, Newcastle-upon-Tyne.—We are informed that Messrs. Williamson and Joseph, Limited, have removed from their City address to the Northampton Works, Northampton-grove, Canonbury, in order to associate themselves more closely with their manufacturing department.—Mr. J. W. Barnard informs us that in order to meet the increased demand for E.P.S. small storage cells (Q and V type) he has acquired additional premises at 13, Brownlow-street, Holborn, W.C. These premises will be equipped as a warehouse and factory for repairs and for charging cells.—Owing to their premises being required for the widening of Parliament-street, Messrs. A. and W. Hopkins have removed to Clun House, Surrey-street, London, W.C.—Messrs. Mendham and Co. (late King, Mendham, and Co.), of Bristol, have removed their works from 10, Victoria-street to larger premises at 1 and 2, Quay Head and St. Stephen's-avenue.—Messrs. Wardrop and Whitaker, consulting engineers, have removed into new offices at 1, Army and Navy-mansions, Victoria-street, Westminster, S.W.

"Armalac."—We have received from Messrs. Laing, Wharton, and Down a sample tin of this American insulating compound. After opening the tin, no doubt remained as to one of its constituents, and this was not one which finds favour with teetotallers. The makers' description of armalac is as follows: Armalac is a very high-class compound derived from petroleum by special method of refining at the very high temperatures of 1,500deg., and under pressure. This varnish will stand with ease a temperature of 500deg. F. before melting. Lubricating oils, being also usually derived from petroleum, have absolutely no reaction on this varnish, such as takes place where the copal or shellac styles of varnish are used. The latter are apt to form chemical combinations with lubricating oils, thereby releasing resin acid, which is almost as dangerous to armatures as sulphuric or other free acids. Armalac does not dry hard, and it is on this point great stress is laid, since a permanent plasticity under all conditions is obtained. Therefore, in driving on coils or bars insulated with armalac, whether for field magnet or armature building, there is said to be no chance of the insulation crumbling and breaking away, as is often the case with the ordinary style of varnish.

Tunbridge Wells.—Mr. E. A. Sandford Fawcett, A.M.I.C.E., held a Local Government Board enquiry on the 3rd inst. into the application of the Corporation to secure another loan of £15,000 for electric light extension purposes. The Town Clerk stated that the electric lighting order under which the Council were acting was obtained in 1891. The total area of Tunbridge Wells borough was 3,740 acres. At the initial stage of the electric lighting scheme Mr. Preece had advised a tentative outlay of £13,000, which would meet the expenses of 4,000 incandescent and 35 arc lamps. There had been an increase of from 13,000 to 20,000 incandescent lamps. The gross revenue last year was £4,208, and this year £5,694. The gross profit to March 23, 1897, was 10 per cent. At the end of March, 1898, the number of consumers was 350, and the number of streets illuminated was now 57. The mileage of cable was 18 in 1897, and there were 30 miles at present. In view of this extension, it was now proposed to borrow another £15,000 for the work of extension in various additional streets of Tunbridge Wells and suburbs. The light was now a source of considerable municipal profit. From 1897 to 1898 the electric light profits had been £1,347. 17s. There was no opposition.

Stretford.—A public meeting of the ratepayers in the urban district was held on the 3rd inst. to consider the action of the District Council in deciding, by the casting vote of the chairman, to establish and work its own system of electric lighting, haulage, and power. There was a large attendance. A resolution expressing disapproval of the action of the District Council, and requesting the Council to accept the terms and conditions offered by the Manchester Corporation, was passed. It appears that these terms are very favourable—viz. (1) to supply the electric light to the ratepayers of Stretford at the same price as to the citizens of Manchester; (2) to find all the capital required—to take all the risk of the undertaking, and thus relieve the ratepayers of any loss; (3) to take the lease of the order for 12 years, the Council then to take over the undertaking, if they desire to do so, upon payment of the original cost, less depreciation, and without any charge for severance; (4) Manchester to pay all the cost of obtaining the order. It is stated that owing to the action of the Stretford Council the Trafford Park Estate is to be lighted by a private company. The directors of the estate cannot wait for Stretford, as it will probably be two years or more before Stretford's scheme and plant are ready, and they have arranged for Messrs. Glover, of Salford, to put down plant in the park and supply the park as well as their own works.

Aberdeen.—The Tramways Committee's report, adopted by the Town Council on the 3rd inst., included the following recommendation: (1) that application should be made for a provisional order in the ensuing session of Parliament for powers to reconstruct the tramway between Kittybrewster and Woodside and lay a double line of rails, and that authority should be given for the publication of the requisite advertisement, the service of notices, and the preparation of plans; (2) that the whole line between Union-street and Woodside should be equipped for electric traction—the mode of applying the same to be afterwards reported upon; and (3) that it be remitted to the committee with powers to take such further steps as may be necessary for obtaining the provisional order and carrying out the works thereby authorised. The expense of doubling the line from Kittybrewster to Woodside, and of providing and electrically equipping the same on the whole section (exclusive of cars), is estimated at £21,400. The committee at the same time resolved to recommend that the question of future extensions should be deferred, pending the result of the working of electric traction on this portion of the system. The following resolution has been proposed and lost by 18 votes to 13: "That the Council, while approving of the recommendations of the committee, resolve to include in the intended provisional order the construction of an electrical tramway from Castle-street to the Bathing Station *vid* Justice-street, Park-street, Constitution-street, and remit to the committee for consideration as to details."

Chelsea.—At the last meeting of the Vestry a letter was read from the Board of Trade stating, in reply to the Vestry's letter of July 25, which urged the Board to reconsider their decision with regard to the proposed application for a provisional order authorising the Vestry to supply electricity, that the decision in question was given after most careful consideration, and the Board regretted that they were unable to vary it; pointing out, with respect to the provisional orders granted to the Vestries of Bermondsey and St. Marylebone, that, although there was only one company in each of those parishes authorised to supply electricity, the Board felt considerable hesitation in granting the orders, and only did so with the view of giving Parliament an opportunity of deciding whether powers to compete with the existing companies should be granted; and that, in the case of St. Marylebone, where the existing company have exercised their powers to a considerable extent, Parliament has refused to confirm the order granted by the Board. The letter was referred to the Lighting Committee. A communication was received from the

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"Pluto" Hot-Water Syndicate, Limited, forwarding sketch of the "Pluto hot-water lamp," for supplying the public with hot water, coffee, etc.; applying for permission to erect lamps, which give an illumination of from 200 c.p. to 250 c.p., in Sloane-square, and other convenient sites in the parish; and stating that a "Pluto" lamp may be seen working at the south-east corner of Leicester-square. Referred to Works Committee for view.

Belfast.—The Council in committee have adopted the report of the Public Health Committee on the disposal of house refuse and the providing of refuse destructors. The committee recommended that 12 cells be erected at once; that steam boilers be fixed so as to obtain the maximum steam from the plant, and that this steam be supplied to the pumping engines of the outfall works, which use about 300 tons of coal per annum at present; that a small electric light plant be also provided to supply light to pumping station and destructor establishment, and save the present expenditure in oil light at the pumping station. In order to lose no time in carrying out these suggestions, they asked to be authorised to invite tenders from Messrs. Manlove, Alliott, and Co., Messrs. Goddard, Massey, and Warner, the Horsfall Syndicate, and the Beaman and Deas Syndicate for the necessary plant of not less than 12 cells, subject to certain conditions. This plant would probably involve a capital expenditure of £10,000. A paragraph in the report of the Electric Committee gave rise to a discussion, and was finally ordered to be omitted from the report. It was a resolution worded: "That the Corporation be recommended to promote a Bill in Parliament for the laying and working of electric tramways in the city of Belfast, especially in those streets not already provided with a tram service, with power to acquire rights over any existing tramways within the city, and for all other purposes necessary for the establishment of an electric tram service in the city." During the debate it was stated that it appeared the tramway company would not lay down any lines without a sort of proof positive that they would receive remuneration sufficient to justify the outlay. They would not take any risk whatever. If the view suggested were carried out it did not follow that they should go to Parliament for that one specific object, but for a number of other objects. The Glasgow Corporation, with characteristic zeal and determination, had compelled the Treasury, and those connected with it, the Post Office people, to establish a separate telephone system in Glasgow, and, following the lead, as one of the newspapers put it, of Glasgow, the Belfast Corporation might do something in the same direction.

London County Council.—At the last meeting of the Council, with regard to notices of the Charing Cross and Strand Electricity Supply Corporation of intention to lay high-tension mains, the following extra conditions were added: That the mains for Charing Cross-road and Shaftesbury-avenue be laid in the subways there, and that the company do pay rent in accordance with the scale laid down by the Council in respect of the user of such subways; that the positions to be occupied by the mains in the subways be subject to the approval of the Council's chief engineer; that the work of placing the mains be carried out, and any damage that may be done to the subways in the execution of the work be made good to his satisfaction and at the cost of the company. Similar extra conditions were made in the case of the Metropolitan Electric Supply Company. The application of the London Electric Supply Corporation to lay high-pressure mains was granted under the following extra conditions: That the high-tension mains be placed at least a foot lower than those of low-tension, or if the mains cannot be laid at that depth under the footway, they be laid in the carriageway; that separate boxes be used for the high and low tension mains respectively, or adequate precautions be adopted, to the satisfaction of the Council's chief engineer, to keep the mains apart in the boxes. Applications from the County of London and Brush Provincial Electric Lighting Company, the House-to-House Electric Supply Company, the Westminster Electric Supply Company, and the Vestry of St. Pancras were sanctioned under the usual conditions. With regard to the receipt of two notices from the Islington Vestry of intention to lay high and low tension mains in several streets, the Council replied that the Vestry was the undertaker under the order, and the Council had no power to approve or disapprove of the works. The South London Electric Supply Corporation having given notice of intention to lay mains, under the Lambeth Order, 1892, the Highways Committee reported that the order was originally granted to the Vestry, and subsequently transferred by agreement to the company, and contains no provision enabling the Council, as in the case of orders granted to companies direct, to approve or disapprove of works. The Blackheath and Greenwich District Electric Light Company has asked that the Council do accept four days' (instead of one month's) notice with reference to the laying of service lines from distributing mains already laid. This concession has been made to other companies, and the Council has therefore acceded to the request. The following loans have been completed: Hammersmith Vestry, £15,500 for electric lighting; Hampstead Vestry, £16,700 for electric lighting; Hampstead Vestry, £39,980 for electric light installation; Islington Vestry, £23,840 for electric light installation; Shoreditch Vestry, £11,340 for electric lighting.

West Ham.—The Town Council have received the following report from the electrical engineer: "The chairman and myself have visited Messrs. Ferranti's works at Hollinwood. We saw one engine of exactly similar type to our own under steam, and, as the whole of the parts of two of our plants are complete, the adjusting can now be done rapidly, and we have every reason to believe, from what we saw, that they will be able to carry out the progress mentioned in their letter to me of Sept. 11. I am sorry to say, though, that the works will not be in a forward position enough to justify an official opening at present. I may point out to you that in other towns the official opening was by no means always concurrent with the actual starting; in fact, at Leicester the official opening took place four months after they started supply. I do not anticipate having to wait as long as four months. The whole of the work is well in hand. The majority of the transformers are in position; those that failed under my tests I expect to receive in the course of a few days now. The arc lamps left America on Sept. 3, and the arc lamp transformers are almost complete. The cable is finished off in the lamp-posts, and the fixing of the transformers in these posts is only a small matter. The main switchboard is at the central station, and the first engine ought to be there soon The pumps, condenser, and pipe work are either finished or well in hand. At the time of accepting the contract for wiring the public buildings I told you the only point I could not fix definitely was the question of the lamp the contractors proposed to supply. I have since made tests of these lamps, and do not recommend your accepting them. I therefore propose to adopt the course I suggested at the time of accepting the contract in the event of those lamps not being satisfactory—*i.e.*, that the contractors supply Edison and Swan lamps, the Council paying the difference in price. With reference to the wages of the men to be employed at the central station, I propose to appoint two stokers at once, and a third very shortly. Other arrangements will be made when the pumping station is complete. In the engine-room I shall require three engine-drivers, working eight hours per day, seven days a week, and one fitter, preferably one who has worked in an electric light station. I shall be glad to know what wages you will authorise me to pay. In my original report to you two years ago I pointed out to you that I had made provision for the equivalent of 6,500 8-c.p. lamps connected to the mains in Romford-road and Woodgrange-road. I have the pleasure to inform you now that at the present time I have signed applications for the equivalent of 6,527 8-c.p. lamps from that district. This means very shortly we shall have to face an extension from the central station to Woodgrange-road *vid* Upton-lane. I am calling your attention thus early to this matter, as it takes a very considerable time after the Corporation have given their sanction to the scheme for the Local Government Board to give their sanction to the necessary expenditure. Also, it is extremely difficult at present to get immediate delivery of plant from the manufacturers. There is one other point. Apparently the question of working the tramways by electricity is approaching very rapidly, and near Upton-lane and Woodgrange-road appears to me (without having gone into details) the most likely spot for a tramway sub-station. Consequently, if we lay mains from the central station to Upton-lane, provision ought to be made for cables for tramway traction. It will take some considerable time to prepare a report on such a scheme, and the actual work here, on the extension for the light, ought to be in hand not later than the beginning of March, 1899. I propose to take a man on shortly capable of dealing with electric bells, fittings, meters, etc. Part of his wages will be borne by the various departments for whom the work is done, while all his time on the meters will be charged against our revenue."

PROVISIONAL PATENTS, 1898.

SEPTEMBER 26.

20295. A new or improved instrument for the direct measurement of magnetic hysteresis. William Peddie, 115, St. Vincent-street, Glasgow.

20313. An improved fitting for entirely concealing from view ceiling or other blocks (or other preparations for receiving roses) and roses for electric light pendants or fittings, without resource to screws or the like fastenings, in ceilings, walls, or other contiguous surfaces. Albert Edward Pullen and Cecil James Cooper, "Rawdon," Hinton-road, Bournemouth.

20353. An improved cell switch. Heinrich Julius Ferdinand Voigt and Jacob Adolf Haeffner, 6, Lord-street, Liverpool. (Complete specification.)

SEPTEMBER 27.

20393. Improvements in or connected with electrical motor-transformers. Arthur Bromley Holmes, 15, Water-street, Liverpool.

20394. Improvements connected with the controlling of electrical circuits. Arthur Bromley Holmes, 15, Water-street, Liverpool.

20398. Improvements in electrical switches. Alfred Watson, 24, Temple-row, Birmingham.

20418. Improvements relating to motors for electric railways. Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20440. Improvements in alternating-current measuring instruments. Harry Phillips Davis and Frank Conrad, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 7, 1898, being date of application in United States.)

20446. Improvements in connection with electric railways. George William Johnson, 47, Lincoln's-inn-fields, London. (Stilson Hutchins, United States.) (Complete specification.)

20458. Improvements in the generation, supply, and transmission of electricity. John Henry Barker, 18, Southampton-buildings, Chancery-lane, London.

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SEPTEMBER 28.

20469. Improvements in apparatus for lifting, lowering, supporting, and conveying the drums on which electric cables are coiled for purposes of carriage or transport. Thomas Orley, 18, St. Ann's-street, Manchester.

20496. Improvements in insulators for telegraph wires and the like. John Taylor and William Taylor, 37, Chancery-lane, London.

20523. Life-saving spring bolts as applied to railway trains by steam or electricity. Alfred J. Disney, 19, St. George's-square, Forest Gate, London.

20528. Improvements in standard cells for small electric currents. Siemens Bros. and Co., Limited, and Eugene Frederick August Obach, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20531. Electromagnetic mechanism for actuating engine valves. John McLaren and Henry McLaren, 47, Lincoln's-inn-fields, London. (Ernest W. Nayler, United States.)

20532. Improvements in or relating to electrically-propelled vehicles. Robert Winthrop Blackwell, 47, Lincoln's-inn-fields, London. (Complete specification.)

SEPTEMBER 29.

20610. Improvements in controlling and other switches. John Vaughan Sherrin, 77, Chancery-lane, London.

SEPTEMBER 30.

20621. Improvements in or relating to automatic electric switches. Charles Turnbull, jun., and Gerard Septimus Peck, 11, Pavilion-square, Scarborough.

20625. Improvements in means appertaining to the electric haulage of vehicles. William Thomas Smith and John William Astley, 17, Hanover-street, Keighley.

20661. Improvements in and connected with distribution, connection, or terminal boards for telephonic systems. Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

20672. Improvements in or relating to arc lamps. T. Söderlund, 322, High Holborn, London.

20677. Apparatus for starting electric motors. George Bullock, 40, Chancery-lane, London. (Complete specification.)

20685. An improved sliding and self-locking coupling for electrical communication apparatus between parts of railway trains. Richard Robert Harper and James Coote Garnham, 166, Fleet-street, London.

OCTOBER 1.

20689. Improvements in electric magnets or magnetic fields. Charles M. Johnson, 22, Laurence Pountney-lane, Cannon-street, London.

20734. Improvements in or relating to telephones and microphones. Richard Hammerstein, 111, Hatton-garden, London.

20753. Improvements in alternating-current motors. Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

20759. Improvements in the construction and working of electric arc lamps. La Société les fils d'Adolphe Mougin, Clun House, Surrey-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 2, 1898, being date of application in France.)

SPECIFICATIONS PUBLISHED.

1897.

20732. Electric signalling apparatus for railways. Gascoyne.

20834. Arc lamps. Andrews.

23192. Dynamo-electric machine and motor. Finlay.

23489. Electric storage cells. Elieson.

23514 Electric tramways or railways. McKenny and Porte.

23705. Electric motor engines. Callow.

25519. Electrodes. Hargreaves.

25859. Manufacture of electrical vacuum tubes. Glew.

26332. Jointing of electrical cables. Menier. (Date applied for under International Convention, May 11, 1897.)

27398. Means for indicating the duration of conversations in public telephones. Ewald and Friedlaender.

29180. Electrical accumulator. Brandt.

1898.

3207. Guide for the carbon holder of an electric arc lamp. Bergmann.

6637. Electrolytic production of metallic alloys and apparatus therefor. Acker.

10269. Alternating-current induction motors. The British Thomson-Houston Company, Limited. (Steinmetz.)

13012. Caps for enclosed electric arc lamps. The British Thomson-Houston Company, Limited. (Harthan.)

15041. Circuit breakers. The British Thomson-Houston Company, Limited. (Hewlett.)

15203. Arrangements for exciting the magnets of dynamo machines. Déri.

15246. Automatic break or interrupter apparatus for electric currents. Kinraide.

16714. Systems of electrical distribution. The British Thomson-Houston Company, Limited. (Steinmetz.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Oct. 1	4,160	4,040	+ 120	—	—
Blackpool and Fleetwood Tramroad	,, 1	683	—	—	11,470	—
Bristol Tramways and Carriage Co.	Sept. 28	2,958	2,712	+ 246	—	—
City and South London Railway	Oct. 2	955	926	+ 29	13,269	12,621
Dover Tramways	,, 1	209	146	+ 63	6,417	—
Dublin U.T., elec. cars	Sept. 30	422	320	+ 102	7,522	5,292†
Dublin S.D. Electric Tramways	,, 30	870	585	+ 285	14,444	10,239
Halifax Corporation Tramways	,, 21	295	—	—	3,432	—
Liverpool Overhead Railway	Oct. 2	1,597	1,350	+ 247	—	—
South Staffordshire Tramways	Sept. 30	666	743	- 77	24,612*	24,833*

* Receipts since Jan. 1. † Horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price, Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	14½-15½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9⅞-10⅛
—— 4½ per cent. Cum. Pref.	10	10⅞-11⅛
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16⅜-17⅜
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	10-10⅛
——	6	6-6⅛
—— Pref. Half-Shares	1	1⅛-1⅜
—— " "	5	4½-5
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6-6⅛
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24½-25½
—— 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	2⅜-2½
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	13-14
—— " " No. 30,000-40,000	6	10½-11½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅝-2
—— 5 per cent. Debentures	—	90-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5⅛-5⅜
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅞-1
Elmore's Wire Company	2	1⅞-2
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22½-23½
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	14-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	116-120
National Telephone, Ordinary	5	5⅜-5⅝
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oriental, Limited, 1879	1	1⅛-1⅜
—— New	4½	6¾-7
Oriental Telephone and Electric Company	1	⅜-½
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160 xd
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105 xd
South London Electric Supply, Ordinary	3	2⅞-3⅛
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	13	39-43
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	117-122
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

Society of Engineers.—An extremely interesting visit was made by a party of the members of this society on Tuesday last to the Post Office station of the Central London Railway works.

The Sanitary Institute.—On Monday next, Oct. 17, Sir Douglas Galton, K.C.B., F.R.S., will give a lecture at this institute. The lecture will serve as an introduction to a course of lectures and practical demonstrations in sanitary science.

Telephone Royalties.—The American Bell Telephone Company have advised all their licensees that they will hereafter waive the commission that these licensees have been accustomed to pay on all long-distance telephone and telegraph business.

Extensions of Owens College.—The foundation stone of the new physical laboratory which is being built at Owens College, Manchester, was laid recently by Mr. Henry Simon, who has founded a German professorship in the college, and contributed liberally to the general funds. The laboratory has been designed by Prof. Schuster.

Institution of Civil Engineers. — The opening meeting of the session will be held on Tuesday, Nov. 1, at 8 p.m., when the president, Mr. W. H. Preece, C.B., F.R.S., will deliver his presidential address, and will subsequently distribute the awards made by the council to the authors of papers dealt with during the past year.

Electricity.—Mr. A. Colson, the able engineer who directs the electricity and gas department of the Leicester Corporation, is this year president of the local literary and philosophical society. His presidential address, delivered on Monday last, was on electricity, and traced the gradual increase of the knowledge of the properties of electricity during the last 2,000 years. The known facts were ably expressed, and the lecture ended by a good description of the Leicester electricity works.

Cairo to the Cape.—The "all British" telegraph from the Cape to Cairo is progressing favourably. Mr. Mohun's party, which is to construct the line from Lake Tanganyika to Stanley Falls on the Upper Congo, is, it is announced, almost ready to start. Mr. Cavendish is already at work carrying the line northward through the extreme northern territory of the Chartered Company, and it is expected that his line will "connect" with Mr. Mohun's during the next two years. Working from the north, the wire has already reached Omdurman.

Measuring Line Losses.—Mr. F. Lecomte describes in *L'Electricien* a method of accurately ascertaining the fall of potential in a line or circuit in which there is frequent alteration in pressure. This method consists in having two voltmeters, one at each end of the line. The circuit is then interrupted at the generator end. The voltage is read at that end at the time of break, and the observer at the further end of the line takes the interruption as a signal to record the reading on his voltmeter. The method is simple, but the necessary interruption is the faulty part of the idea.

Electric Pumps.—During the last 13 years, says the *Daily Mail*, the Yarmouth Town Council has pumped some 1,000,000,000 gallons of salt water out of the North Sea. This is used for private baths, street-watering, flushing drains, and extinguishing fires. On Tuesday last the Town Council decided to spend £3,000 in laying down further pumps capable of raising 25,000 gallons per hour, so that the available supply will be doubled, or 200,000,000 gallons per annum. The new pumps will be electrically driven from power supplied from the Corporation's generating station.

The Anderson Closed-Conduit Traction System. This system, which is on trial at Leeds, was referred to in our last issue. Since writing the note in question we have learned that the contacts are operated mechanically. There is in reality a closed conduit containing a series of bell-crank levers and conducting wire. The levers are so arranged with respect to each other that only one contact can project at any one time. The projecting contact is knocked down by the collector on the car just as it breaks contact. This downward motion causes the stud in front to rise. The electrical connections are made by switches actuated by the movement of the plungers and lever.

Finance in Germany.—We note from an article appearing in the *Financial News* that during the first six months of 1898 178 new companies were formed in Germany, with a total capital of just over £12,000,000. In the classified list of the objects for which these companies were formed, we see that banking is first in order of capital, and railways come next. Third on the list are electrical enterprises, in which some £1,550,000 have been invested during the six months. It must be remembered, however, that banks in Germany do more to directly promote economical enterprise than in England, and that of the 2½ millions raised for new works, some is sure to be used for electrical undertakings.

The Electric Light in the Bengal Mills.—Almost all the jute mills, says *Indian Engineering*, are now lighted with electric light, and the special inspector reports that, with two or three exceptions, mills that had previously opposed its introduction have since been compelled to give way by the necessity of competing with their neighbours and retaining their hands, who otherwise would be attracted by the slightly higher wages they could earn by longer work elsewhere. In the report for the year 1896 the opinion of Mr. Walsh was quoted to the effect that working for the longer hours made possible by the use of artificial light was in reality a doubtful advantage, in view of the discontent caused among the operatives, the deterioration in the work done, and the higher wages to be paid for overtime. The facts now reported would appear to conflict with the view then expressed.

Proposed Memorial to Prof. James Clerk Maxwell.—It is proposed to place in Corsock Parish Church a suitable memorial to the memory of the late Prof. James Clerk Maxwell. There is already in the church a memorial to the memory of his revered father, John Clerk Maxwell, by whose influence and exertions the church was originally built. This church is chosen for the memorial as the professor's connection with it through life was very close. He was ordained an elder in it, and acted as such up to the time of his death, and otherwise interested himself in its behalf. The matter has been brought under the notice of Lord Kelvin, and he has sent £1. 1s. as half-guinea subscriptions from himself and Lady Kelvin, and adds that the object has their warm sympathy. Subscriptions, fixed at half a guinea, are asked for by the Rev. George Sturrock, and should be sent to the Manse, Corsock, by Dalbeattie, N. B. The memorial appears to be chiefly of local import, and we are glad to note that many local subscriptions have been received.

Telephones in New South Wales.—The telephone exchanges in this colony are all under the Government. The charges are low, and the number of instruments and length of lines are increasing by leaps and bounds. For instance, while in 1895 593 miles were constructed at a

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cost of £6,680, we find at the end of 1896 a further construction of 1,772 miles of line at a cost of £16,053. As the network is so bound up with the telegraph service, the actual length of miles of telephone line is not obtainable. The last figures published are those in the *New South Wales Register* for 1896 and previous years by the Government statist, Mr. T. A. Coghland, F.S.S., from which we quote. We find that the annual telephone revenue increased from £7,212 in 1891 to £31,955 in 1896. During that period 4,084 miles of line were constructed at a cost of over £52,000. There were 5,105 telephones in use in the system, half of that number being in Sydney and suburbs. Public telephone offices, at which a small charge is made for the use of the instrument, numbered 14 in that district, but there are also telephone stations at the various telegraph offices (856) in the country districts.

Labour Methods.—The conditions accepted by labour organisations in the United States differ radically from those enforced by the same organisations in England. The English labour unions start on the basis of the equality of all, and their members, whether good or bad workmen, receive equal salaries. This is a premium on laziness and indifferent work, as nothing is to be gained by incessant effort. In America, a strike in the works of the Bullock Electric Manufacturing Company has just ended in favour of the masters, and the cause of the strike is illustrated by the following extracts of a letter from that company to the *Electrical Review* of New York. It seems that the strike was against the introduction of the piece-work or premium system in the factory. The system employed is practically a premium system, and men are paid by the piece, but piece-work prices are so arranged that the average workman can earn as much, if not more, than his day wages. If any man regularly falls below the amount of work done by the average man, the assumption is drawn that he is not as good a workman as the average, or that he is careless or lazy, and his regular daily wages are lowered or his services are dispensed with altogether. The machinists objected to this system, and struck on account of it, yet they have been forced to give way, in spite of support from labour unions. In fact, the American employer pays a man his true worth as a producer, and gives as well increased remuneration if by a large output the shop charges can be reduced. This fact should be borne in mind by those who fear competition from America. The labour unions' systems are the real cause for fear.

Royal Society.—On Monday, Oct. 10, the president and council of the Royal Society were "At Home" from 8.30 to 11 p.m. to meet the delegates to the conference on an international catalogue of scientific literature. As the rooms of the Royal Society are still in the hands of the plumbers, the extensive sanitary improvements commenced in the summer being yet uncompleted, the guests were received in the rooms of the Royal Society of Antiquaries. The gathering was well attended, most of the English and foreign scientific societies being represented. It is unquestionably becoming a matter of vital importance to inaugurate a systematic scheme for cataloguing the extensive literature connected with scientific advances. Further, a mere catalogue would seem hardly to meet the requirements of the case. What is required would appear to be a system, not only of cataloguing, but of abstracting scientific papers. Mr. H. Elder, one of the secretaries of the Physical Society, wishes an amalgamation of the various scientific societies to be formed, so as to publish their joint abstracts in a single volume. The Institution of Electrical Engineers has already combined with the Physical Society in this connection, but it is questionable whether a greater further extension that would include, for instance, the Institution of Civil Engineers and the Chemical Society would be welcomed in a single publication. Whilst wishing to avoid all unkindly criticism of "Science Abstracts," we cannot but wish that it could be found possible to keep these more up to date; if they are to fully serve the purposes for which they were designed, it would appear necessary that they should not be as much as four or five months in the rear of the progress of science.

Cross-Country Electric Lines.—Our New York namesake is giving a series of descriptions of the electric cross-country railroads round Ohio. As an example of what these are like, we would refer to the lines of the Akron, Bedford, and Cleveland Railroad Company. The total distance from Square to Square in the two cities is 36 miles, and the cars are run on a half-hour headway, requiring two hours and ten minutes to make the trip. The schedule speed, outside of the cities, is 25 miles per hour, but on the level sections and on long down grades the speed frequently reaches 40, and even 50 miles per hour. The fare for the round trip, including a transfer in each city, is 4s. 10d.; for one way, 2s. 8d. The tracks are laid along one side of the highway. The more recently constructed portions of the track are of 70lb. tee-rail, heavily bonded with a large contact, laid on large ties 6in. by 9in. by 8ft., and spaced 2ft. centres, this being the adopted standard. Turn-outs, with suitable spring switches, are provided at such intervals as to allow for a half-hour headway. Derailing switches are provided at steam railway crossings. These switches are of the Porter type. In normal position the switch is open, leading into blind tracks, and before the car can pass it is necessary for the conductor to go forward, cross the steam track and work the operating lever which is attached to one of the side poles. The rolling-stock consists of 21 double-truck cars, an electric snow-plough, and a number of flat gravel cars. It requires 10 cars to cover the line with the headway as noted above. The cars are 41ft. long over all, and 8ft. 5in. wide. They are vestibuled and run one way only, loops being provided at each terminal for turning. These cars are equipped with a G. E. four-motor equipment. About 500,000 passengers are carried per annum.

Street-Lighting in Adelaide.—We have perused with great interest the report in the *Journal of Gas Lighting* on the struggle between the electric lighting and gas undertaking in Adelaide for the street-lighting contract. The Town Council wishes to know which system makes most progress in England. Our esteemed contemporary remarks that "it is obviously impossible to answer such a query conclusively unless its scope is clearly defined. Naturally, where local authorities have electricity supply undertakings of their own, they commonly like to do the street-lighting in their chosen area in order to start with a 'nest egg' of trade. This gives a big spurt to the electric light, for the time being. It is, however, a line of business that does not, in the long run, pay either electric lighting local authorities or companies. The progress that has been made the last three or four years in the application of incandescent gas lighting to street lamps is far and away beyond the contemporaneous extension of public electric lighting in the United Kingdom. Town after town is giving in its adherence to the incandescent gas lamp for public lighting; and when it is remembered that these lamps are applicable wherever gas is to be had, while electric lamps are of necessity restricted to the central compulsory areas of a statutory electricity supply, the failure of the latter to keep pace with the extension of the former is easily understood." This ingenuous special pleading is rather futile in the face

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of the progress street-lighting by arc lamps has made. The plea that electric street-lighting is often carried out at a loss conveys no reflection on the electric undertakings. Street-lighting by gas is also often given at a loss, and this has been specially the case with incandescent gas lamps, both in England and on the Continent. In fact, the charges for street-lighting are most difficult to compare, as the cost per candle power is seldom, if ever, the dominant feature in settling the price.

Association of Birmingham Students of the Institution of Civil Engineers.—The syllabus of this association has just been issued, and contains, among the arrangements projected for next session, an excellent list of papers. Dr. Bostock Hill is to read a paper on "Some Observations on Sewage and Modern Methods of Treatment"; Prof. H. F. Burstall will give a paper on "The Experimental Study of Heat-Engines"; other papers will deal with sewerage, water supply, electrical engineering, and other subjects. The session opens on Thursday, Oct. 27, when the president, Mr. J. C. Vaudrey, M.I.C.E, will deliver his inaugural address. Opportunities for social gatherings are not neglected by this progressive association. As a rule the members dine together before the meetings, and light refreshments are served at the close. The annual dinner, which usually draws together all the leading engineers within the radius which the association covers, is fixed for Feb. 2, at the Grand Hotel; Mr. Preece, president of the Institution of Civil Engineers, has accepted an invitation to be present. Several successful visits have been made to works of interest during the past summer, and only recently the members visited the Birmingham waterworks now in the course of construction at Rhayadr, as the guests of Mr. Jas. Mansergh, the eminent engineer of the works. The meetings and all other advantages of the association are free to all students of the Institution of Civil Engineers residing within 50 miles of Birmingham, while the corporate members of the institution in the district are considered honorary members. The secretarial duties in connection with the association are in the hands of Mr. Henry C. Adams, Stud.Inst.C.E., M.S.I., etc., of the city surveyor's office, Birmingham, this being the fifth year in succession that he has been elected to occupy a position which, on account of the increasing prosperity of the association, is by no means a sinecure.

A Legal Description.—The *Electrical Review* of New York gives the following extract of a statement of a case for damages brought against the Wichita Electric Railway Company. The man on whose behalf the claim was made had fallen in a car. The claim reads: "That the said defendants permitted said rails of said street railway system, and particularly upon Douglas-avenue in said city, to alternately contract and expand, rust, wear out, separate and spread out of line, so that a car passing over the same at either the minimum or maximum rate of speed, as provided in their franchise, frequently jumps the said rails and glides peacefully over the asphalte pavement of said Douglas-avenue in said city, which action of said cars is a standing menace to the citizens of said city, and particularly to strangers who are not familiar with the antics of said defendants' cars, and same is dangerous to comfort, life and limb, as is well known to defendants; that said rails are antiquated and have become so worn, spread and separated, and were so negligently maintained, that said aforesaid cars jump, rebound, jerk, and jolt, producing a peculiar sea sick feeling, so that passengers compelled to use them keep their seats with difficulty, compelling many to stand to avoid serious injury to their anatomy, so that prudent physicians have advised their patients to cease riding upon or in said so-called passenger conveyances. . . . That the wheels attached to said cars are variously abbreviated in that the same are flanged and flat in spots, causing noise resembling a threshing machine working on No. 4 wheat, against the peace and dignity of the inhabitants of Wichita, whereby and wherefore said cars cannot be stopped until the flat portion strikes the said aforesaid decrepit rail, ground, or pavement, as the case may be, thereby making it difficult for said car to again proceed upon its journey without the assistance of the aforesaid motorneer and the unfortunate passengers. That said cars were so negligently kept that same have become racked and warped, causing some to be convexed, both horizontal and vertical, the spherical surface thereof showing apertures through which a person on one side of the car can see a 13in. shell on the opposite side of the street, compelling the liberal use of tarpaulin and umbrellas to keep out the elements from said aforesaid conveyances some time hereinbefore designated as cars."

Electric Door Openers.—Our New York namesake illustrates and describes an electric door opener devised by Mr. H. Rowntree, of Chicago. In this electric door-operating device the work is done by a double solenoid of peculiar shape at the top of the door. The two solenoid coils operate on the same core. The right-hand coil is the one which acts to open the door and the left-hand coil acts to close it. When the operator on the car wishes to open the door he presses a foot button, and a mechanical device on the car trips the solenoid switch. The solenoid then promptly draws the door open. When the elevator man releases the button or when the car leaves a floor the switch is tripped the other way, the left-hand coil of the solenoid is brought into play and the door is drawn shut. Just as the door is closed the switch controlling the left-hand solenoid coil is automatically opened, so that there is no consumption of energy when the device is not in use. The two solenoid coils are wound tapering; that is, they are about two-fifths larger in the middle than at the outer ends. This shape has been found by actual experiment to give the proper variations in pull over the range of the solenoid. Thus, with the door open, the pull on the iron core is 80lb., which is the maximum, and is needed to promptly overcome the inertia of the door. When the door is half closed this pull falls to 30lb., which is all that is needed with the door in motion. When the door is almost closed, the iron core of the solenoid gets so near to an iron plate at the end of the coil that the pull is increased to 50lb., due to the improved magnetic circuit. This increased pull is just what is wanted to insure the door being shut tight. The pull of the solenoid core is transmitted by a link to a pivoted lever which acts on the door. The actual travel of the door is then about three times that of the core. Such is the construction and operation of a device that is in its practical working fully equal to the usual pneumatic device, but, as said before, it is to be regretted that the first cost of the air device is less at present. The electric device has no piston packing to get cold and retard action, as sometimes happens with air devices, and 110-volt circuits are sometimes more convenient than compressed-air pipes. Perhaps these advantages, together with some unforeseen cheapening of the cost of construction of the electric door operator will eventually bring it into more common use.

The London County Council and Overhead Traction.—The agenda of the London County Council for last Tuesday contained the following report of the Highways Committee on the application of Mr. J. Clifton Robinson to be allowed to erect a few miles of trolley wires in West London. After rehearsing the facts of the offer

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the report says: "We are still of the opinion we have previously expressed that the overhead trolley system of electrical traction is unsuitable for the more crowded of the London thoroughfares; but we think that, as the company is desirous of making an experiment, and has offered to make concessions which will probably be of considerable benefit to the Council should the experiment ultimately prove successful, and has further expressed its willingness to adopt any other system which may be proved superior after further experience shall have been gained, the Council might in the circumstances give consent to the application being made by the company for authority to use the overhead trolley system of electrical traction, but so far only as regards that part of the company's tramways as is between the Askey Arms and the Uxbridge-road railway station. This consent, if given, will enable the company to apply to the Board of Trade to be allowed an opportunity for a full and satisfactory trial of the experiment upon a road quite at the outskirts of the county; and we consider that the Council should, for the present at any rate, not go further than this, and that, before giving consent to the use of the overhead system on the two routes (*b*) and (*c*) above indicated, the Council should ascertain whether the system proves successful in the Uxbridge road, and is not a source of inconvenience. We recommend that Mr. J. C. Robinson, managing director and engineer of the London United Tramways, Limited, be informed, in reply to his letter, dated Sept. 27, 1898, that the Council will consent, on the terms stated in that letter, to an application being made to the Board of Trade by the company for authority to use the overhead trolley system of electrical traction on the portion of the company's tramways between the Askew Arms and the Uxbridge-road railway station, a distance of 1 mile 3 furlongs and 3 chains; but that this consent will only be given on the company giving a written undertaking that the underground conduit system of electrial traction, or, failing that, horse traction, shall be used on the other tramways referred to in the letter—namely: (1) from the Uxbridge-road railway station by Goldhawk-road to Young's-corner; and (2) from Young's-corner to Hammersmith-broadway." So far so good, but then the report was withdrawn, and we await with interest the issue of the next agenda to see if the withdrawal was only due to want of time.

The Potentialities of the Telephone.—The influence of the telephone in London has not tended to a decrease in profanity, and at times the troubles of the telephone have been the indirect cause of insanity. Our readers will remember the sad case a few months ago of the arrest of a harmless lunatic who was endeavouring to get telephonic communication out of a sewer ventilator. Our contemporary, the *Electrical Engineer* of New York, however, publishes some facts which show how different the country telephones may be to that in the towns. The soul-stirring language of the text leads us to hope for better things, even in London, but also reminds us of certain passages in "Martin Chuzzlewitt." The editorial is headed "The Isolation of the Farm," and reads as follows: "Statistics go to show that a large proportion of the insanity in this country is due to the isolation of farm life, just as no small portion is ascribed to the isolation of servants engaged in domestic employ, sitting in their lonely, bare kitchens. The farmer, however, is emerging from his loneliness, and may presently be longing for it again. The trolley and the telephone have found him out, or, rather, have found him at home. He is becoming a new creature. The future is the farmer's. He has hitched his wagon to a star and his ear to the thunder, and what he now misses of the world's movement is not worth having. It is sometimes argued that so far electricity has done nothing in the domain of agriculture, whereas the truth is that, even at this early period of development, it has affected few branches of industry more profoundly. Anyhow, the telephone now hangs in every farmer's hall, and, like the horn of the hunter, can be heard on every rural hill. We printed last week a characteristic statement from one of our readers who has lately been engaged in converting part of Ohio into a whispering gallery. He is not alone, however, in this enterprise. Reports of the same nature come from all over the land. Michigan is a typical example, and since one of the farmers near Grand Rapids put in an instrument and got first quotations from market, his compeers all through the State have been inspired with a noble rage to patronise this improvement. We opine that their wives and daughters care less for quotations than for gossip and other humanities, and that these telephones meet many wants that are not filled by the price of bread alone. Hereafter solitary confinement on a farm ceases to be the penalty of rural life, and thus is presented another reason for expecting to see the redundant city roll back upon the country its myriads of workers, whose chief object in coming to town has been to get society."

Institution of Mechanical Engineers.—An ordinary general meeting of this institution will be held on Wednesday evening, 26th inst., and Thursday evening, 27th inst., at the Institution of Civil Engineers, Great George-street, Westminster. The chair will be taken by the president, Samuel W. Johnson, Esq., at half-past seven p.m. on each evening. At this meeting the nomination of officers for election at the next annual general meeting will take place. The following papers will be read and discussed, as far as time permits: "Electric Installations for Lighting and Power on the Midland Railway, with Notes on Power Absorbed by Shafting and Belting," by Mr. W. E. Langdon, superintendent of the electrical department, Derby; "Results of Recent Practical Experience with Express Locomotive Engines," by Mr. Walter M. Smith, member, of Gateshead; "Mechanical Testing of Materials at the Locomotive Works of the Midland Railway, Derby," by Mr. W. Gadsby Peet, member, of Derby. The following is the syllabus of Mr. Langdon's paper: Generating station at Derby, including engine-room plant, output, and lamps in use—Analysis and details of cost of working 11 separate installations on Midland Railway—Particulars of direct high-tension plants (2,200 volts) at Leeds and Kentish Town—Power required to drive lathes, drilling machines, shafting, etc., in the workshops of the electrical department; detailed results. In Mr. Walter M. Smith's paper on the "Results of Recent Practical Experience with Express Locomotive Engines," details are given of the preparatory work for trials on North-Eastern Railway, between Newcastle and Tweedmouth—Coal used—Particulars of train—Instructions to drivers—Time records, gradients, and curves of line—Particulars of five express engines employed, and observations made during their five round trips—Indicator diagrams, and estimates of horse-power developed at various points on each trip—Estimates of train resistances. The paper is accompanied by a number of tables, a complete dynamometer diagram from Newcastle to Tweedmouth; together with speed, gradient, curve, and other diagrams, showing conditions under which the trials were made. Mr. W. Gadsby Peet discusses the general question of mechanical testing for commercial purposes, and also in detail a Whitworth 50-ton hydraulic testing machine; experiments to ascertain errors due to friction of cup-

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leathers, etc—Statical friction between lubricated metallic surfaces—Methods of holding test-pieces—Hand pump, power pump, and oil accumulator for applying pressure—Tests of copper and bronze alloys at various temperatures—Deeley torsion machine; autographic apparatus with Crosby indicator—Description of specimens, including fractures of boiler plates, crank and straight axles, some showing internal flaws.

The Best Rails for Tramways.—Mr. A. J. Moxham read a paper on the construction of tramway rails from a scientific standpoint before the recent meeting of the New York State Street Railroad Association at Manhattan Beach. He described experiments which lasted for three years, made to try what is the best steel for the purpose. The first endeavour was to take, broadly, a "soft" steel and a "hard" steel for the rails to be tested, securing the difference by carbon alone, leaving all other ingredients as nearly as possible the same. Additional rails were added afterwards, of a steel both hard and ductile. The conclusions, therefore, are based upon what may be described as soft steel, hard steel, and steel both hard and ductile. The rails (some 33 in all) were laid in the South Eighth-street tracks of the Nassau Electric Railroad of Brooklyn. They were laid continuously, so that the same car was obliged to pass over every rail, and therefore each rail is subject to the same wear, and the wear on the head only was considered. Every rail was measured at two points, taken about 10ft. from each end, in order to eliminate the special wear at the joints. Each rail had two cast-iron boxes bolted to the outside, at the points to be measured, to permit access for purposes of measurement without disturbing the road-bed. There were 17 rails of low carbon—viz., averaging 0·28—14 rails containing high carbon—viz., 0·59—and two were West End rails. The least wear shown was in the West End rail, the hard rail follows a good second, while the greatest wear is shown in the soft rail. The average monthly wear amounted to 0·0007in. for the West End rail, 0·0012 for the hard rail, and 0·0017 for the soft rail. The result of the experiments are conclusive on this point. The only difference in composition between the steel of the so-called hard steel and of the West-End rail lays in the proportion of phosphorus and manganese. The West End rail contained less phosphorus and more manganese. This can only be obtained by increased cost in production. When considering whether the cost is warranted, the author points out that a street rail can be used until at least ½in. is worn away from the head. On this basis, and taking the average wear of the different rails as shown in the test, it would take 25 years to wear away ½in. with the soft rail; 35 years to wear away ½in. with the hard rail; 60 years to wear away ½in. with the West End rail; and this is the case of a road which represents not average but excessive wear, the rails in question having borne the wear of heavily-loaded cars running on an average of 30 per hour for 20 hours per day during the time of the experiments, or a two-minute headway. This means during the busy part of the day less than one-half minute headway, and during the night hours a wider interval. Taking the ordinary line, its average headway is less than this, consequently the theoretical wear would be greater. All who are interested in electric roads are aware of the fact that they do not get anything like this wear, and this being the case we have got to look to something else besides quality of steel. This something is the joints, which give out long before the centre of the rail is affected. The conclusions the author gives are as follows: (1) That for street railway use a hard rail will give the best results; (2) that the most economical way to secure this hardness is by increase of carbon, accepting the manufacturers' standard specifications for the other ingredients; (3) that the next step should be towards an improvement of the joints; (4) after making the joints perfect, what we have termed the "West End rail" would certainly justify its extra cost. Still, he adds that until perfect joints are got there is no need to worry about the quality of steel. Anything in the shape of steel—the very cheapest that can be bought—will last longer than the joints will permit the rails to be kept in the track.

The Regulation of Dynamos.—The *American Electrician* points out that when the rheostat on a shunt dynamo is adjusted to effect a change of voltage, the operator cannot fail to note that the response is very sluggish, so much so, indeed, that it is very easy to manipulate the rheostat handle so rapidly that the voltmeter cannot follow it. Although most designers are certainly aware of this, it is surprising to note that at stated periods a device appears which has for its object the regulation of voltage and for its principle of voltage-controlled device, which in turn controls the field rheostat. If the action of a field magnet is so sluggish that it will not quickly follow changes in rheostat resistance made by hand, how can it be expected to follow the infinitely more rapid variations which sudden changes of load will create in a sensitive automatic device? In making an automatic regulator to keep the voltage steady under sudden changes of load, the variation of the field strength must not enter as a factor. There have been cases where regulators have been produced using two field magnets in the linkage of regulating factors between change of voltage and readjustment thereof. This was done by the device of separately exciting the exciter field and controlling the current in that circuit. The idea of this seems to be that the controlling device would be smaller, its parts would have less inertia, and it would therefore be more sensitive. The designer seemed to be totally oblivious to the fact that, however sensitive the regulator was made, the interposition of a field magnet in the regulating system destroyed its utility, and the insertion of two such sluggish members, the one dependent on the other, is practically fatal. Extreme accuracy of potential regulation is not obtainable in this way, and unfortunately there is little else of a practical nature that can be offered in its stead. Absolute regulation, while always desirable, can be dispensed with in commercial work. An expedient which may answer in some cases is to vary the speed, to which function the voltage almost instantly responds, as every gas-engine manufacturer can testify. Of the many ways of doing this, the method of shifting a belt on two conical drums by a magnetically controlled shifter may be suggested. In such a case the generating armature must be of small flywheel capacity. There is, however, a more practical application which may be used on engine-driven dynamos—namely, that of controlling the speed of the engine electrically. The cut-off of the engine can be varied by potential magnets instead of centrifugal or inertia governors. This device is by no means a new one. It has been tried in numbers of instances, and always with marked success. The difficulty which seems to have stood in the way of its commercial exploitation is the fact that engines and dynamos are separately manufactured, and the steam engineer has no faith in anything but a centrifugal or inertia governor. If some maker was to incorporate enough electrical engineering talent into his draughting department, and produce an engine that would regulate for constant current or constant potential, as required or ordered, he would certainly create a stir among plant designers who have had troubles of their own, especially in the case of alternate-current machinery.

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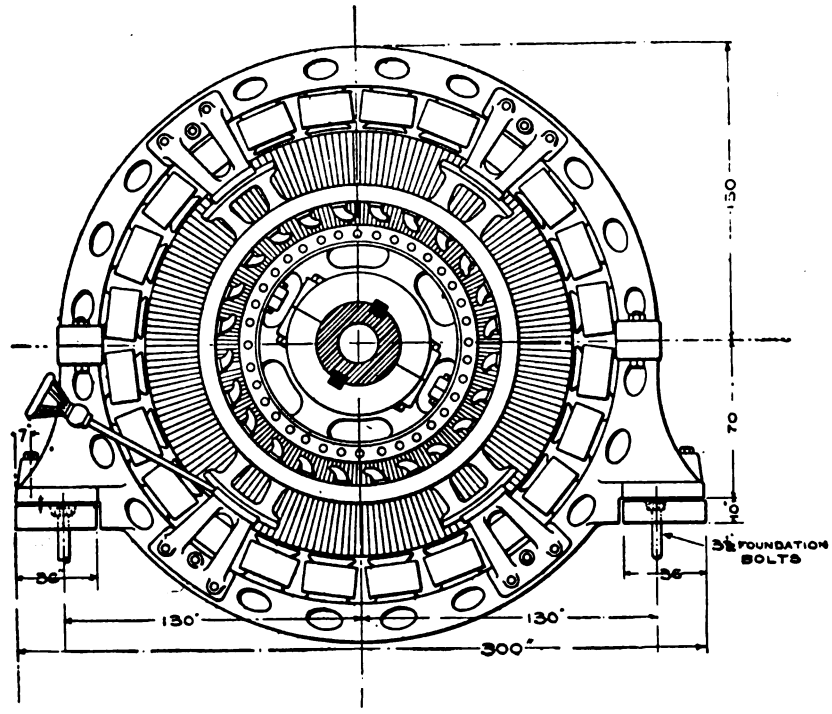
THE LARGEST DYNAMO IN THE WORLD.*

The rapid development of electric power for various purposes has made a demand for larger and larger units in the generating stations where this power is produced. A few years ago generators of 100 kw. to 200 kw. capacity were considered enormous machines. There soon appeared, however, direct-driven generators of 750 kw., to be used in large railway plants in such cities as Chicago, Boston, St. Louis, and Brooklyn. At the World's Fair, in 1893, the first 1,500-kw. generator made its appearance in the Intramural Railway Station. This machine was then considered a monster. This unit was soon adopted for many of the large street railway stations, notably in Chicago and Boston, and finally machines of 1,600 kw. were placed in the Kent-avenue station in Brooklyn. Still later Louisville, Ky., purchased a 2,200-kw. generator. The Metropolitan Street Railway Company, of New York, has recently placed an order for a number of 2,500-kw. alternating machines, and but a few months ago the Boston Elevated Railway Company, which succeeded the West End Street Railway Company, of that city, gave to the Walker Company, of Cleveland, the order for a 3,000-kw. machine.

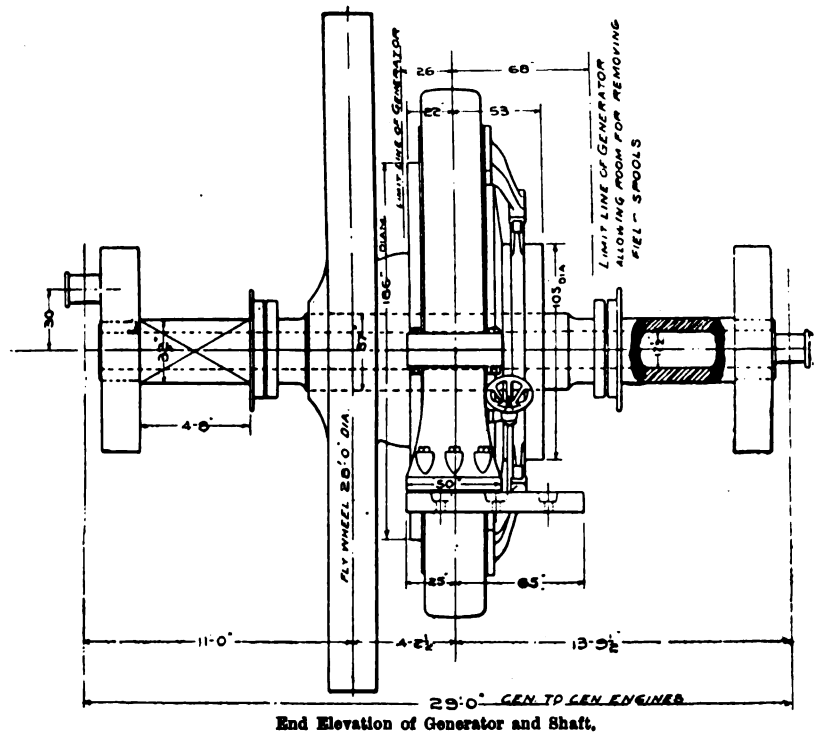
All of these large machines are made to run at the very slow speed of from 75 to 80 revolutions per minute. The alternating-current machines built for the Cataract Construction Company at Niagara Falls have an output of 5,000 h.p. each, while that ordered by the Boston Elevated Railway Company has an output of but 4,000 h.p. Nevertheless, the 4,000-h.p. machine being built by the Walker Company is much larger than the alternators in use in the Niagara Falls power house, because the speed of the Boston machine is 75 revolutions per minute, while that of the Niagara machines is about 300 revolutions per minute.

If the Boston machine were run at the speed of the Niagara machines its output would be something over three times that of the latter, or about 16,000 h.p.

As the construction of this 4,000-h.p. generator marks



Side Elevation of Generator.



End Elevation of Generator and Shaft.

* From the *American Electrician*.

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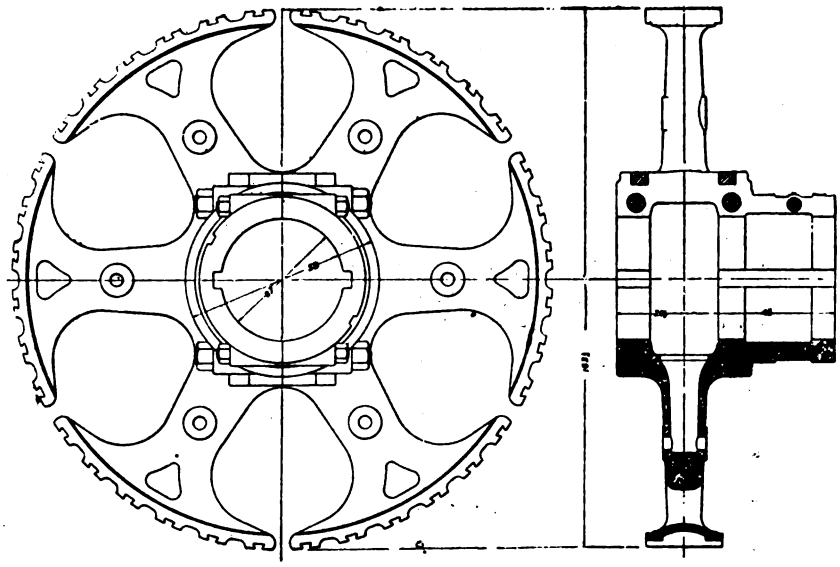
an era in the development of dynamo-electric machines, it may be interesting to electrical engineers, and those using electrical apparatus, to know its dimensions and general design. We therefore devote some space to its illustration and description.

The total weight of the complete machine is 250,000lb. The frame is made of cast steel and is circular in form, the diameter over all being 21ft. 7in. The weight of the frame alone, without the field-magnet cores for magnet spools, is 50,000lb. To the inside of the magnetic ring or frame are bolted 24 laminated steel magnet cores or pole-pieces, the total weight of which is 30,000lb. The inside diameter of the bore of these pole-pieces, completed, is 15ft. 6in.



Side and End Elevation of Armature Spider.

The magnet cores are each provided with spools wound with shunt and series coils in the usual way. The pole-shoes arranged to hold the magnet spools in place and each core is bolted by four 3in. bolts to the inner surface of the magnet frame. The magnet frame is divided in halves, on a horizontal plane, and is mounted upon the foundation plates in such a manner that the whole frame may be made to slide lengthwise of the engine shaft far enough to uncover the armature windings, or to allow the individual magnet cores or field spools to be removed without separating the magnet frame.

The armature spider of this machine is made in halves, like the hub of a flywheel, to be bolted together upon the shaft of the engine after it reaches its destination. If it had been made in one piece, no railway car could be found large enough to ship it from Cleveland to Boston. The armature hub weighs, complete, 40,000lb. and has an outside diameter before the laminations are in place of 13ft. After the engine is upon its foundations in Boston this armature spider will be mounted upon the engine shaft, which is itself 37in. in diameter. The laminations which form the armature core, the total weight of which is 30,000lb., will then be built upon the periphery of the armature spider. The slotting in the armature laminations will register accurately, and provide, when completed, 594 slots. The insulation and windings will then be fitted into the slots and connected with the commutator.

The commutator itself is made up of 1,188 bars, and is 105in. in diameter. It is divided into halves for the purpose of shipment and ease of handling, and will be placed upon an extension of the armature hub after the latter is secured to the engine shaft.

The flywheel of the engine will be bolted directly to the armature hub near its periphery, in order that the regulating force of the wheel shall not be transmitted wholly through the shaft of the engine. This will relieve the armature shaft and its keys from strain to which they would otherwise be subjected.

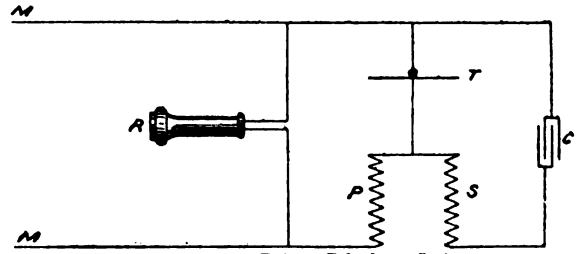
The machine has been most carefully designed, and an unusually large factor of safety provided for every part subjected to electrical or mechanical strain. Because of this the machine will be able to take twice its normal load for short periods of time without injury, and to carry a 50 per cent. overload for several hours.

The greatest care has been taken to secure from the generator a higher percentage of efficiency than has thus far been attained in units of large size.

COMMON BATTERY SYSTEM FOR CHICAGO TELEPHONE EXCHANGE.*

The common battery system of telephone exchange operation as developed by the Bell companies is now, without doubt, perfected to an extent where it will probably be only a matter of months and years until this system is installed to operate all the larger and many of the smaller Bell exchanges. The removal of all batteries, magneto-generators, and troublesome appliances from the subscriber's instruments, and the supplying of all the electrical work from a common battery at the exchange is certainly an object that is worth spending considerable money in re-equipment to attain. The Bell common battery system has been standardised to a large extent, so that engineering difficulties are nearly weeded out.

The Chicago Telephone Company is putting in a new exchange station on the second floor of the Title and Trust Building, 100, Washington-street, and in this installation, which is to be known as "Central," the common battery system will be used. It is understood that the "Express" telephones of this company's exchange will be changed on to this new common battery system and new telephones in the heart of the city will be put on it also. The standard adopted by the Bell companies for common battery work is a 24-volt bank of storage cells charged by motor-generators. From this 23-volt circuit the miniature signal lamps are operated and transmitters supplied.



Common Battery Return Telephone System.

As the arrangement of circuits for the transmitter in the Bell common battery system may not be familiar to some of our readers, we show a diagram of the circuits in the accompanying engraving. M M are the main wires from the central office, R is the receiver bridged across the mains, T is the transmitter, S and P are the primary and secondary coils of a transmitter coil connected in

* From the *Electrical Engineer* (New York).

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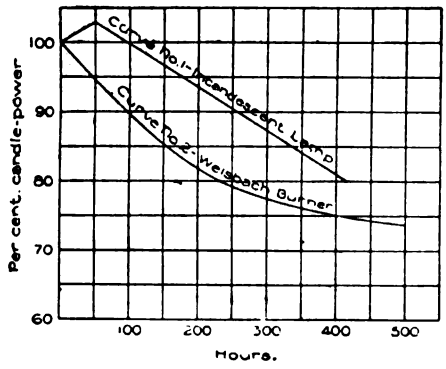
as indicated, and C is a condenser. S and P are so connected relatively to each other that the charge and discharge of the condenser with the voice currents tends to magnify the vibrations in the main transmitter circuit leading to the central office. Thus, when the resistance of the transmitter decreases, the increased flow of current through the primary tends to make a current flow through the secondary to charge the condenser, and this in turn increases the current in the primary, and consequently in the main line wires. Then, when the resistance of the transmitter increases, the primary, acting on the secondary, tends to help the condenser discharge through the transmitter, and oppose the voltage from the central office, thereby cutting down the current in the line wire. Thus both the rises and falls in the transmitter circuit current are magnified by this beautiful and ingenious arrangement, and the working of transmitters from a central-office current supply is made practicable under all conditions arising in ordinary practice.

DETERIORATION OF THE CANDLE-POWER OF WELSBACH MANTLES.

Gas companies have very generally claimed that the mantles used with Welsbach burners maintain their candle-power practically constant until the mantles are destroyed. Recent investigations, however, show that the drop in candle-power in Welsbach mantles is as rapid or even more rapid than that of the filaments of incandescent lamps. The accompanying curves, which, with the information, are given on the authority of the General Electric Company, show the average results of a series of tests made on incandescent lamps of its manufacture and Welsbach burners.



Candle-Power Time Curves of Electric and Gas Lamps.

Curve 1 shows that a good 32-c.p. incandescent lamp burns 415 hours before its candle-power drops to 80 per cent. of the initial value. Curve 2 shows that a Welsbach burner suffers the same fall in only 230 hours. In other words, the depreciation of the Welsbach mantle is so much greater than that of the electrically illuminated filament that the Welsbach burner drops to 80 per cent. of its initial candle-power 185 hours sooner than the incandescent lamp. Even if the drop of the electric filament is measured in terms of its maximum, as some engineers claim it should be, the comparison is but little changed, since 80 per cent. of the maximum is reached only after 350 hours' burning.

Economy dictates the substitution of a new incandescent lamp when the candle-power has dropped by at most 20 per cent. of the initial, but taking into account the high first cost of Welsbach mantles and the low cost of operation, a mantle would undoubtedly be continued in use until this candle-power had dropped much lower. In this case the customer would be obliged to consume the same amount of gas, and thus be at the same expense, although the light obtained would be much diminished in power. For example, if a Welsbach mantle having an initial candle-power of 32 were burned for 500 hours its candle-power, according to the curve, would drop about 27 per cent. leaving approximately 23·4 candles.

In 1897 tests were made in Berlin in which two English and three German mantles were tested. The standard of light used was the Heffner amyl-acetate lamp, in connection with a Lummer-Brodhun photometer, the gas being measured by an Elster experimental gas-meter. Much care was taken to secure uniform and reliable results, the room being thoroughly ventilated and draughts at the same time avoided, as it has been found that the light is materially affected if there is not an ample supply of fresh air. The horizontal candle-power was measured in three directions, 120deg. apart, and the mean taken as the correct reading, the measurements being taken every 24 hours. The final table, which contains practically all the important results, is as follows:

Make of mantle.	Candle-power. New.	Candle-power. 100 hours.	Candle-power. 500 hours.	Percentage fall in 100 hours.	Percentage fall in 500 hours.
English mantle, No. 1	36	33·4	14	7·2	61·2
,, ,, No. 2	52·9	49	29 7	7·4	43 8
German ,, No. 1	70·3	49·7	28·2	29·3	59 9
,, ,, No. 2	53·5	40 3	33 3	24·7	37·7
,, ,, No. 3	62 6	57·1	47·5	8·8	24·1

An important feature in connection with incandescent gas-burners is the proportion of the size of the mantle to the Bunsen flame. In many cases the mantle is much too large for the burner, and in consequence does not become properly incandescent all over; it also shrinks and warps out of shape to a much greater extent than when smaller. The tests also showed that the light absorbed by mica chimneys was about 10 per cent. more than by glass chimneys.

Mr. E. A. Medley, who made the report of these tests, sums up as follows: "The mantles give a wonderfully good light when new, but the extreme rapidity with which the light falls off and the consequent shortness of their efficient life, even when treated with every consideration due to their somewhat delicate constitutions, make them far from an ideal illuminant. With the possible exception of the German mantle No. 3, a great deal of improvement is necessary before, for domestic lighting at any rate, they can be considered satisfactory."

The deterioration in candle-power of Welsbach mantles should be thoroughly considered in connection with the heat given out, consumption of oxygen and contamination of the air, inconvenience of ignition, danger from fire, and other disadvantages which are common to any gas system, and station managers may find from the facts given cogent arguments in favour of eliminating these disadvantages by discarding the Welsbach burner for the more convenient and more satisfactory electric lamp.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

106. When is it financially profitable to add condensing plant to non-condensing engines?—J. F. M.

107. In an installation where you want to raise the voltage of part of the output of a 100-volt shunt-wound dynamo for charging cells, is, say, a 40-volt shunt-wound dynamo the best method of doing so? If so, is there not some likelihood of booster reversing should the voltage of cells be very low when starting to charge same?—H. P.

ANSWERS.

Question No. 100.—Write a short essay (not more than 2,000 words) on the practical advantages of electricity for lighting purposes.

Best Essay (awarded £1).—The fact that electricity has many advantages over other illuminants, while its disadvantages are comparatively insignificant, is beginning to be grasped by a larger number of the general public every

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day, and a few more years will see the new light all but universal. The reason why it is not used more extensively at present is probably owing to the lighting companies, who do not, as a rule, go the best way to work to attract customers, as the ordinary householder or shopkeeper knows nothing about Board of Trade units, watts, candle-power, etc.; all that he wants to know is how much a year it will cost him to light his premises by electricity as against the annual cost of lighting them with the gas or oil which he is using, and whether electricity is safe and can be relied on.

If lighting companies and corporations were to send to the owner or tenant of every building within the area of their supply a little pamphlet showing clearly the difference, if any, between the price of a Board of Trade unit as supplied by them and an equivalent quantity of gas at the average price charged in that particular locality, showing what a Board of Trade unit meant and the number of each size of lamps which would be lighted by one, also the number of lamps which would be equal to a given number of each size of gas-burners in general use, the approximate total cost of wiring different sizes and descriptions of houses, shops, hotels, etc., number and cost of new lamps required per year, and all other necessary particulars, stated in the most simple way possible, a far greater number of persons would use the light than do at present. In this matter of attracting customers the Americans are a good way ahead of us.

Perhaps the greatest practical advantage which electricity possesses over the other illuminants in general use is that it reduces the risk of fire to a minimum, which can be seen by comparing it with the three great sources of artificial light—coal gas, paraffin oil, and wax or other candles. The great danger from gas is that, when mixed with a certain proportion of air, it will explode on a light being brought into contact with it, the violence of the explosion depending on the quantity of explosive mixture present and the size of the space in which it is confined. There are still many people ignorant or foolish enough to blow a gas-jet out and leave the cock on, and a still greater number who will try to find a leak of gas with a lighted match or candle. Several deaths are caused by this every year, besides a great amount of injury to person and property. Then curtains are often blown against gas-jets and set on fire, and there are generally one or two cases every year of large gas-mains getting alight, in which case an enormous amount of damage may be done in a very short time.

Paraffin oil is used for lighting by the majority of the poorer classes in towns, by richer people who prefer it to gas, and almost exclusively in counting-houses. When heated slightly this oil gives off an inflammable vapour, which if heated to a certain temperature and mixed with air in a confined space will explode, the temperature at which this takes place depending on the quality of the oil, the cheaper oils flashing at a lower temperature than the better qualities. Many deaths are caused every year by the explosion of paraffin lamps, and although the danger may be lessened by using well-made lamps and the best oil, there is always the chance of a lamp upsetting and causing a fire.

The objection to the use of candles on the score of fire is that people will put them close to their beds to see to read and then they go to sleep, and the candle sets fire to the bedclothes.

Now, with electricity at the pressure which is taken into buildings for lighting purposes, which never exceeds 250 volts, there is absolutely no danger of explosion, and if the house is wired properly—that is, with well-insulated wires drawn into metal pipes—the risk of fire from leakage of current is quite negligible; and if the joints and connections are well made and insulated, and the fuses placed in metal or porcelain boxes, where they can be easily got at, there is no danger to be apprehended from them. It is impossible for the lamps themselves to set anything on fire, as the instant they are broken they go out, and the rush of air into the vacuum is sufficient to blow out any lingering spark.

Another great advantage of electricity is that it is not necessary to go to the lamps to light them; the current can be switched on miles away if required, which is very convenient in many cases—for instance, when streets are lighted by electric lamps, they can all be lighted up within a few minutes of one another from the lighting station without requiring the services of lamplighters. Some people object to the electric light because it cannot be turned down, but this seems to be a foolish objection, as people only turn gas and lamps down to save the trouble of lighting them again; and there is no trouble whatever in lighting electric lamps, no matches are required, and the lamps need not be touched. Then for bedrooms, switches can be placed at the head of the bed so that it is not necessary to get out of bed to light the room, and they can be placed outside banks and business premises so that the police can light the place up in the night to see if all is right; in fact, there is no end to the conveniences of being able to light a lamp from a distance.

Electric light has a great advantage over all other lights on the score of health, as other lights consume the oxygen of the air, which is essential to human life, and give off poisonous carbonic acid gas, and therefore the more ordinary lights there are in a room the less healthy it is; but electric lights being enclosed in hermetically sealed globes from which the air has been extracted cannot take any oxygen from the air, and for the same reason cannot give off carbonic acid to it. The light is very clean also, as there are no unburnt products of combustion given off to the atmosphere, as is the case with other lights, and as there are fewer heat rays given off from electric light than from other lights, rooms lighted electrically are much cooler than if illuminated by other means, which is a very great boon to persons compelled to work long hours in artificially lighted places. Of course electric arc lamps, being open, consume oxygen the same as any other light, but as arc lamps are generally only used for lighting streets and open spaces, or for very large buildings, such as railway stations, this does not matter so much.

Many people complain that electric light injures their eyesight, and there is a good deal of truth in this. The complaint is made chiefly by clerks and others who sit for several hours a day in the winter with an electric lamp in a plain glass globe dangling just in front of their eyes, and it would be strange if they were *not* affected, but if the lamps are hung near the ceiling, so that the eyes do not rest on them naturally, or if ground or frosted glass globes are used there is no danger to eyesight.

Another advantage which electric lamps possess over lights having an open flame is the ease with which they lend themselves to decorative effects. The electric light can be taken into any corner, the lamps may be fixed in the corners of rooms, hidden among curtains or in artificial flowers on dinner tables, or they may be put under water to illuminate fountains, etc.; while for the decoration of shop windows they are invaluable, as electric lamps can be safely placed among the goods in the window, and very pretty effects can be arranged, as electric lamps, unlike other lights, will burn equally well in any position, and the flexibility of the connecting wires allows of great play in the manner of fixing. Then for illuminations and advertisement or other signs electricity may be used to great advantage, as the light can be switched on from the lower part of the building, or from some other building, or an attachment may be made to a clock, so that the light is switched on for a certain number of minutes at regular intervals. For churches, halls, theatres, and other large buildings better effects can be got with electric light than with any other kind, besides the advantages of less risk of fire and greater coolness.

Electric light is a great boon to the photographer, as it enables him to take photographs in the evenings or on dull days which are almost equal to the best ones taken by natural light, owing to the fact that in composition electric light is nearer to sunlight than any other light. This makes the light useful in many other ways, as it will show coloured articles or materials in their proper hue, which other lights do not. This property also makes it very useful to the chemist in analysis.

One of the minor advantages of electric light is that, being enclosed in airtight globes, it will not blow out, and it can therefore be used in draughty passages, or in places

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where the wind can penetrate. Arc lamps, although open, are much better than gas in this respect. In many places it is useful to have a light, but impracticable to send a man to light it every day, or when it goes out, such places as clock towers, the tops of buildings, buoys at the mouths of rivers, ships' masts, etc., and electric light is suitable for all these cases, as it can be switched on from any point and will not blow out.

The electric arc lamp is of the greatest importance at sea, as when used in the form of a searchlight it enables those on board ship to see another ship at night several miles away, which may prevent a collision, and which would be of the utmost importance in time of war. This light is also used with great advantage in lighthouses, and for signal lights on vessels.

With all these advantages it seems strange that electricity is not used more extensively for lighting purposes than it is, but the fact that at present it costs more than other illuminants in the great majority of towns retards its use; while another cause of its not being used so largely is that most people object to go to the expense and trouble of having their houses wired, but when all new houses are wired for electric light, as pipes are now put in for gas, and when the cost of electricity has been lowered, owing to larger demand and improved and more economical plant, the use of this light will become almost universal, to the great betterment of the conditions of living in civilised countries.—R. S.

Second Essay (awarded 5s.).—The advantages of the electric light may be enumerated as follows: It is clean, healthy, comparatively cool, safe, compact, and is very suitable for decorative purposes. Considering it under the first three advantages mentioned, it can easily be pointed out wherein these lie. Compared with gas or oil, the electric light is much cleaner, healthier, and cooler than either of these two lights. No smoke or poisonous fumes are given off by electric lamps, neither do they consume oxygen; therefore, rooms lighted electrically do not get dirty so soon as if lighted by gas or oil, consequently the paint, paper, and other decorations do not require renewing as soon as they otherwise would. This in itself is a great saving, especially in a large house, where the expense of redecorating and painting is large. Also, from a health point of view, the advantage of having a light which neither gives off poisonous fumes nor consumes the oxygen in the air of a room or building cannot be estimated. Compare two large rooms lighted, one with 100 25-c.p. electric lamps and the other with the equivalent in gas. After burning for two or three hours (unless very good ventilation is provided) the room wherein the gas lights are burning will be almost stifling, while the other will be practically as cool as when the lamps were lighted. It is well known that a gas-light or oil lamp gives off a large quantity of heat when burning. While this is at times an advantage in a room which is otherwise heated, or in a room which requires a good light but no heat, the electric lamp is far superior to either of these. In a well-made incandescent lamp the heat given off is so small that it is hardly noticeable, and where a large number of lights are burning, instead of having a room insufferably hot towards the close of the evening, it remains at a moderate temperature. In a sickroom or bedroom, when a light is required to burn all night long, the electric light is cooler and healthier than any other light, and these advantages cannot be over-estimated. I will now consider the other advantages mentioned.

Safety.—A well designed and executed installation reduces the danger of fire to a minimum. This, whether in factory, workshop, store, business, or private house, is a very practical advantage. No match or light of any kind is required to light an electric lamp, therefore danger of fire by dropping a match before it is extinguished is entirely done away with. The switch for putting on the lights can be put by the door, and as soon as it is open the lights can be switched on. There is also complete immunity from danger by explosion. The average man, when he smells an escape of gas, usually takes a candle or match to find it. Occasionally he does so, and he can consider himself very fortunate if he lives to remember it, to say nothing of damage to the surrounding property by the explosion and fire which usually accompanies it. Cases of oil-lamp explosions and fatal injuries resulting therefrom are very common. Therefore the fact that the electric light is free from these may right be considered a very great practical advantage. Again, the incandescent lamp, being hermetically sealed, enables the light to be used where an ordinary light could not possibly be used. In a coal mine, when it is known that gas has accumulated in some of the workings, the electric lamp can be used with perfect safety. It may be said that an ordinary safety lamp could be used also, but the light is generally so feeble that an electric lamp is far superior to it; also, there is no possibility of a workman opening it for any purpose. On more than one occasion men have been known to open their safety lamps with disastrous results. Also, where the ventilation of the mine is bad, due to atmospheric or other causes, candles and ordinary lamps will not burn. Here, again, the fact that an electric lamp is not dependent on the air gives it a great advantage over any other light. It can also be used with perfect safety in gunpowder or other explosive factories, subject to extra precautions being taken with the switches and fuses, care being taken to have them placed in some part of the building where there is no danger of sparks when making or breaking the circuit catching the explosive material. All switches and fuses, however, can be fixed far away from any dangerous position, and they can also be enclosed in fireproof cases, so that no danger whatever need be anticipated from any of these sources. Therefore, the electric light may be considered to offer more safety from fire than any other light.

Compactness.—The incandescent lamp is very neat and compact, and so are the necessary fittings. They need only take up a small amount of room, and yet give a big light. This is a great advantage, especially in shop windows and places where a maximum amount of light is required with a minimum expenditure of room.

The electric lamp can be used for decorative purposes with far more effect than any other lamp. Whether at a private or business house, the ease with which it can be used for decorations of any and every description gives it far greater advantages than any other kind of lamp in the market, and, no matter whether for indoor or outdoor purposes, the result is the same, with this addition, that whereas with gas or candle decorations out of doors a heavy shower of rain completely spoils everything, it has practically no effect on the electric lamp. Whether it is windy, wet, or not, the electric light shines as brightly and steadily as though it were in a room completely sheltered from it all. This is one of the greatest advantages of the electric light. Being completely enclosed by a glass globe, and hermetically sealed, it makes no difference to the light whether the weather is fine or stormy, and what would render gas or oil lamps useless has no effect whatever on an incandescent electric lamp.

Then another great point of the electric lamp is the perfect safety with which it can be introduced into shop windows. No matter how delicate the contents of the window may be, it can be fixed here, there, and everywhere without any danger. This can be seen by looking in any large hosier's or milliner's shops in towns where the electric light is installed. The lamps are hung in the midst of laces and curtains, hats, etc., showing everything up to the best advantage in a manner which could not be approached by gas or oil lamps. The effect is varied by introducing different-coloured globes, and is generally most artistic. Needless to say, this form of decoration is in great favour and demand with shopkeepers, and many who are not favoured with a central supply are fixing installations of their own, or have had one already fixed, with most satisfactory results. Apart from these, the superiority and efficiency of the electric light compared with other lights will be worthy of consideration. The gas usually obtainable is flickering, and a very sickly yellow light. This can readily be seen and noticed when walking down a street where the electric light and gas is burning. The difference between the two is astonishing. On the one hand, a bright, clear, steady light, and on the other a yellow flickering flame. And if a 16-c.p. electric lamp and 16-c.p. gas-jet are burning side by side, the gas-jet seems quite dark—about

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5 c.p. or 8 c.p., instead of 16. Of course, the question of cost needs consideration as well, but it is generally estimated that gas at 3s. per 1,000 cubic feet is dearer than electric light at 5d. per Board of Trade unit. At this rate, eight lamps, each 16 c.p., could burn two hours for 5d. Up to the present, only the incandescent lamp has been considered, but I now come to electric arc lighting, which is more useful for some places than the incandescent.

For lighting large areas, such as streets, warehouses, docks, etc., the arc lamp has many advantages over the incandescent. The fittings, etc., are more expensive at first on this system, but the light is cheaper. With a well-made arc lamp, a consumption of 1,000 watts gives an estimated light of 2,000 c.p., or ·5 watt per candle-power. This is much smaller than in an incandescent, in which from three to four watts per candle-power are consumed, depending upon the efficiency of the lamp. This is one of the great advantages of arc lamps where a large light is required. They give a brilliant light, and fairly steady. It is chiefly used where a very large light is required, and they are made to give 500 c.p. and upwards. The advantages they possess over any other light for lighting large areas are manifold. Their brilliant, piercing light renders them peculiarly adapted for searchlights and lighthouses, and they are replacing all other types on board ships. They burn equally as well indoors or outdoors, therefore they possess the advantages of the incandescent over gas or oil in this respect. They require a certain amount of attention to keep the working parts clean, and the carbons require renewing every 10 or 15 hours, varying with the make of the lamp. This applies only to the ordinary arc lamp. With the enclosed arc lamps now being made, the carbons do not require renewing so often, 100 to 200 hours, according to maker, being the life of the carbons in these types of arc lamp.

As before stated, the energy consumed in an ordinary arc lamp is approximately ·5 watt per candle-power. At the rate of 5d. per Board of Trade unit this works out at 2,000 c.p. per hour for 5d., and where a private installation is fixed it does not always reach this figure. A reduction is generally allowed when burning longer than two hours by supply companies, and this again reduces the cost to people having it from a supply company. This is doubtless much cheaper than gas or incandescent lighting, so far as cost is concerned and where a large light is required. From the foregoing remarks it will be seen that electric light has many practical advantages over other lights, both with regard to the light itself, safety, healthiness, and cost to consumer.—HARRY ROBERTS.

Third Essay (awarded 5s.).—Electric lighting is at present lighting either by the arc or by incandescent lamps, vacuum-tube lighting not having yet entered the commercial stage. The advantages of the arc light over any other form of illuminant are even more strongly marked than those of the incandescent lamp. In no other way has it been found possible to obtain such intense illumination at one point as has been attained by the electric arc as used in lighthouses, a current of about 200 amperes giving in a suitably constructed lantern a reflected light of many million candle-power. To obtain a similar amount of illumination by means of oil or gas would require a very complicated arrangement of burners, each of which would have to be supplied with sufficient air for proper combustion, and the pipes conveying the gas would be of very material size, whereas the electric power necessary is conveyed by a cable less than 1in. in diameter. In the more familiar field of street-lighting by electricity the arc lamp is almost equally advantageous. It is ornamental in appearance, and can be switched on or off from the works without the aid of a lamplighter. The colour of the light is greatly in its favour, as is also the fact that it requires no arrangements to supply air for combustion. In fact, arc lighting is improved by altogether excluding the atmosphere and burning the carbons in an atmosphere of inert gases. This method of lighting by enclosed arcs is making very rapid progress at the present day, and appears to give a steadier light than most types of open arcs. For special work the facility with which the carbons can be arranged vertically, horizontally, or at any intermediate angle to give the best effect, is an advantage which is not possessed by oil and only to a limited extent by gas lighting. For photographic work the arc gives us a light commercially accessible, and equalled only in actinic power by the rays from burning magnesium and a few other rare metals. In magic-lantern work the ease with which the light can be handled and the emission of the light from a comparatively small source are points of the very highest importance.

For interior lighting of large buildings we find the same advantages, the chief being the colour and the ease with which the light can be arranged to give the best effect by inverted arc lighting or otherwise. The colour of the arc light being very similar to that of daylight, enables objects to be seen and colours matched with almost the same accuracy as in daylight. To these advantages must be added the fact that the arc does not vitiate the atmosphere in anything like the same degree as gas, and last, but not least, it is, for an illumination of 1,000 candles and upwards, the cheapest light in the world to-day. This is especially the case in street-lighting, where the existence of a long and steady demand for the current is eminently favourable to the supply on the lowest terms. The heat generated by the arc, though great, is far less than that given out by gas or oil burners of the same candle-power—in fact, the light efficiency of the arc, about 9 per cent., is the highest of any known illuminant.

Turning now to electric lighting by incandescent lamps, we find a light of great steadiness, of pleasing colour, and of singular adaptability. It lends itself readily to the most artistic arrangement of the light, as well as the most efficient distribution of the same. The incandescent lamp can be placed where it is wanted, and is safe in close proximity to inflammable goods, where no other light would be admissible. What other source of illumination, for instance, can be put inside a patient's mouth, as is done every day in dental surgery? The fact that the light can be turned on or off in a moment from any desired position, not necessarily near the light, is an advantage that should not be overlooked; also the fact that the light does not in any way contaminate or exhaust the atmosphere gives it an immense superiority over gas for domestic lighting purposes. The destructive effects of the products of combustion of gas (and to a less extent of oil) upon ceilings and wall paper, picture frames, silver and gold ornaments, and plants being entirely eliminated. Electric lighting is extremely convenient in its application, as lamps of widely different candle-power can be commercially obtained for about 1s. each, and to change a lamp is the work of but 10 seconds. Thus, a 32-c.p. may be changed for a 50 and the latter supplanted by a 5-c.p. without any appreciable loss of efficiency provided the installation is properly wired in the first place. The risk of fire is immeasurably less in a properly equipped installation than with either oil or gas lighting, while electric explosions are happily almost unknown.

This article must not close without a reference to ship-lighting, a field in which electricity is now supreme. The advantages enumerated are here present, but their value is enhanced by the peculiar conditions which any system of lighting has to contend with on board ship. It is of the first importance that the light should be absolutely safe from the risk of fire; and in order to get a steady light it must not be affected by the motion of the vessel. Hitherto, specially-constructed oil lamps have fulfilled this condition fairly well, but the quality of the light can bear no comparison with that obtained by incandescent electric lighting, and the comfort of the latter system now dominant in all passenger boats can only be adequately realised by those who have crossed the ocean with no better illuminant than the old oil lantern. Finally, the incandescent electric light is even now in many places as cheap as, or cheaper than, gas, with the prospect of becoming still cheaper as the consumption increases.—E. MORGAN.

Question No. 101.—Discuss the advantages and disadvantages of carrying the exhaust steam-pipe up the inside of chimney. If an advantage, how high should the steam-pipe be carried?

Best Answer to No. 101 (*awarded* 10s.).—The practice of carrying the exhaust pipe up the interior of the chimney is one that is not often resorted to, and has comparatively few

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advantages. The chief of these are: If of the requisite length, it can be made to increase the draught to some extent, the greatest draught being obtained when it is most required—viz, when the boilers are steaming heaviest. It removes the trouble of a noisy exhaust, which is often very pronounced in some slow-speed engines, and in districts where this would constitute a nuisance it obviates the unsightliness of an external exhaust pipe. Against these are the following disadvantages: Since the temperature of the exhaust steam is, roughly, about 212deg. F., and that of the chimney, say, in an average case 300deg. to 400deg., it follows that after the steam has lost its initial velocity it will be, if anything, detrimental to the draught, and for this reason the exhaust pipe would have to be carried practically to the top of the chimney. Again, a general and suitable velocity of the exhaust steam in land practice is about 4,000ft. per minute, while that of the gases in the chimney varies from 2,000ft. to 3,000ft. per minute, so that to get any material increase in the draught the velocity of the exhaust must be made greater either by a suitable blast pipe or by reducing the size of the exhaust, in either case thus increasing the back pressure in the engines—a most undesirable thing to do. To get the maximum effect from it, the end of the pipe must be vertical, and not bent round in a horizontal direction, as is usually the case, thus facilitating the accumulation of dust and dirt at the base of the pipe. The extra cost involved in erecting an exhaust pipe almost to the top of the chimney, as against the 30ft. to 50ft. usual in practice, will be very considerable. For instance, a 15in. cast-iron exhaust about 50ft. high would cost about £20, while to carry it inside the chimney to a height of, say, 150ft., would cost from £80 to £100. The deterioration at the base of the chimney will be very considerable owing to the high temperature of the flue gases, unless the lower part of the pipe is encased in firebrick. And, finally, considerable allowance will have to be made at the supports for expansion and contraction with so long a pipe and so great a range of temperature. For instance, the difference in length of a cast-iron pipe 150ft. long when cold and when at 600deg. F. will be about 6in. From this it will be seen that, unless there are some important local objections to an outside exhaust pipe, it is much preferable, the advantages gained by an internal pipe being more than counterbalanced by the disadvantages. With regard to the second part of the question, as mentioned above, the height to which the exhaust should be carried depends entirely upon the height of the chimney. If the latter is 150ft., then the pipe would have to be carried practically as high, say 140ft.—H. B.

Answer to No. 101 (*awarded* 5*s.*).—The advantage of carrying the exhaust steam up the inside of a chimney is that you will get a good draught. All engines of the portable type are built with the exhaust steam-pipe led into the chimney. The exhaust pipe takes a short bend up the chimney just sufficient to lead the exhaust steam up the chimney. The exhaust steam-pipe is fitted into the bottom of the chimney. Also, this class of engine have a jet of steam led into the chimney direct from the boiler by a small steam-pipe, with cock or valve fitted on boiler, with a cone fitted on the end in chimney. This is only used in case of emergency, such as raising steam in short notice, or in case of heavy load coming on the engine, or if the boiler is stiff to steam; it can be used all the time by opening steam cock or valve on the boiler. The disadvantage of this method is that the coal consumption will increase about 40 per cent. with only 15 to 20 per cent. more efficiency. In case of taking the exhaust steam up a brickwork chimney is a very bad practice, because the exhaust steam in going up the chimney causes a dampness, and the soot gathers in the chimney day after day until the chimney becomes choked with soot; also the dampness will cause the brickwork of the chimney to corrode away. I know of a case in Rawtenstall where the exhaust steam was led up the inside of the chimney, with the result that the chimney became choked with soot and the brickwork almost ruined. The exhaust steam-pipe was then taken out of the chimney and led into the roof of the building.—TELFORD.

THE STATE AND THE TELEPHONES.

BY ROBERT DONALD.

A most interesting article bearing this title, and also called a "Story of a Betrayal of Public Interests," appears in the October number of the *Contemporary Review*. Mr. Donald considers that the chief object of Mr. Hanbury's Committee was to knock holes in the existing monopoly of the National Telephone Company by isolated attacks from municipal corporations. It sought to counteract some of the wrongs which have been committed, and to avert greater dangers which threaten the State. The report recommends that under certain conditions municipalities should be empowered to establish competitive telephone services, but, as he endeavours to show, the remedy is altogether inadequate, and comes too late, although it seems to be the only practical course open. He considers that the whole action of the Post Office on telephones is a record of sins of omission and commission. At first it despised the telephone, and allowed private enterprise to have its own way. Caution, in the early days of experiment, was reasonable. When the telephone showed that it had come from America to stay, and looked like serious business, the Post Office discovered that the telephone and the telegraph were one and the same thing. The Courts held that the department had a monopoly in all such communications, but this discovery was not carried to its logical conclusion. The Post Office did not itself take up the telephonic business, but favoured a policy of free trade, and in 1880 began granting licenses with reckless liberality. After giving a good history of the subsequent movements which resulted in the National Telephone Company obtaining practically a monopoly, Mr. Donald criticises in no measured terms the actions of Sir James Fergusson and others concerned. Coming to the question of the solution of the present difficulties, Mr. Donald says the recommendations of the Select Committee do not adequately meet the situation. They are palliatives which may only be partially successful in a limited number of towns. The case in favour of municipal telephones is complete, but the period during which the towns can keep the service is too short. It is true that the cost of installation has greatly decreased in recent years, and that the mechanical switchboard offers great advantages in small areas, although not yet a certainty; but what we want is cheapness and efficiency at once, not 10 years hence. Unless it were agreed, when licenses are issued to local authorities, that the Post Office would, in 1911, acquire the municipal services at their then value, it is doubtful whether many towns will face the financial responsibilities. The Post Office is not under any obligation to buy any system in 1911, and if it were to acquire municipal undertakings where they existed, it would have to buy up the company elsewhere on the same terms. He does not think that, with the difficulties which exist, there will be a rush of towns to Parliament next session for telephone powers. Some important centres of population, such as Liverpool and Nottingham, are apparently quite satisfied with the company. Glasgow and about 20 other towns which have advocated this new development in municipal industry will presumably at once get to business. The corporations of these towns would have to face the formidable opposition of the Telephone Company, and, to judge from the past, the hostility of the Post Office. The local authorities will not be able to compete on equal terms with the company. It is in possession, and entirely free from restrictions. It can charge what it likes, give preferences, or, in order to kill opposition, give a service for nothing, as one of the concerns it absorbed did in Plymouth to destroy the Post Office service in that town. Again, were the corporations to provide an excellent service in their own areas, there is no danger that a subscriber, to obtain full facilities of communication, would have to join the company's system. The company has a powerful means of protection in the large areas which the Post Office very considerately provided for it.

In conclusion, Mr. Donald insists that municipal telephones can only be successful if licenses are granted for the same period as the company's—20 years—a course which the committee admit is equitable, or if there is a certainty

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that the Post Office will purchase the municipal plant in 1911. As far as the proposals go, it will be difficult to establish a municipal service, but easy to strangle it either by the company or the Post Office New competition will have to come chiefly from the Post Office, which in future must act less as the agent of the National Telephone Company and more as the guardian of public interests. After what has happened no one has much confidence in the Post Office as a competitor. The Select Committee have none, and, in concluding their report, they say that "in thus recommending a Post Office service [they] assume that it will constitute a real and active competition, and that concessions to the company not required by the agreement will cease. Such a competition should, in their opinion, be carried on by a distinct and separate branch of the department, and in future be conducted under strictly business-like conditions, and by a staff specially qualified for such a duty." Unless this change is made the new policy proposed cannot be successful.

LEICESTER CORPORATION ELECTRICITY WORKS.

The statement of accounts for the half-year ended June 30, 1898, of the above electricity works has just been issued. The total expenditure on capital account up to that date amounts to £53,074, of which £7,621 has been expended during the half-year. We give herewith the revenue account and general balance-sheet:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Fuel, including dues, carriage, unloading, and all expenses of depositing same on works	£318	16	6			
Oil, waste, water, and engine-room stores	124	11	2			
Wages at generating station	532	12	10			
Repairs and maintenance of works and plant, machines, apparatus, tools, materials, and labour	261	12	3			
				1,237	12	9
Distribution of Electricity.						
Wages of linesmen, fitters, and labourers	149	5	6			
Repair, maintenance, and renewal of transformers, meters, etc.	63	1	1			
				212	6	7
Rates and taxes				117	6	1
Management.						
Salaries—viz., engineer's department	125	0	0			
Stationery and printing	11	0	0			
General establishment charges	97	2	7			
Auditors	2	2	0			
				235	4	7
Bad debts				1	11	1
Total expenditure				1,804	1	1
Balance carried to profit and loss account				1,755	12	8
				£3,559	13	9

Cr.	£	s.	d.
Sale of current, 157,467 units at 5d. per B.T.U.	3,289	11	3
Rental of meters	109	2	10
Profit, fittings department	169	19	8
	£3,559	13	9

GENERAL BALANCE-SHEET.

	£	s.	d.
Sundry creditors	1,521	10	8
Stock and debenture interest to June 30, 1898	833	14	6
Sinking fund	3,923	2	10
Deposits	40	10	0
Leicestershire Banking Company, Limited	17,500	5	9
	£23,819	3	9

	£	s.	d.
Capital account—balance at debit thereof	10,725	12	7
Profit and loss account—balance at debit thereof	1,523	16	10
Cash in hand	63	4	10
Oil, waste, etc., in stock	37	19	10
General stores	656	0	4
Fittings in stock	1,315	18	5
Accounts due for current supplied and meter rental	1 038	3	3
,, for fittings and services	2 721	16	0
,, for sundries	13	8	10
Amount held by Leicester Corporation on sinking fund account	3,923	2	10
Machinery suspense account	2,000	0	0
	£23,819	3	9

NATIONAL PHYSICAL LABORATORY.

The following is the report of the committee appointed by the Treasury to consider the desirability of establishing a national physical laboratory. The committee consisted of Lord Rayleigh, D.C.L., F.R.S., chairman; Sir Courtenay Boyle, K.C.B.; Sir Andrew Noble, K.C.B., F.R.S.; Sir John Wolfe Barry, K.C.B., F.R.S.; W. C. Roberts-Austen, Esq., C.B., F.R.S.; Robert Chalmers, Esq., of the Treasury; A. W. Rücker, Esq., D.Sc., F.R.S.; Alexander Siemens, Esq.; and T. E. Thorpe, Esq., F.R.S., with Mr. L. Blaikie as secretary. The report is dated July 6, 1898, and reads as follows:

In accordance with the instructions contained in your lordships' minute of Aug. 3 last, we have proceeded to consider the desirability of establishing a national physical laboratory for the testing and verification of instruments for physical investigation, for the construction and preservation of standards, and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes. We have also considered whether the work of such an institution, if established, could be associated with any testing or standardising work already performed wholly or partly at the public cost, and we have now the honour to submit the following report upon the questions mentioned in the minute.

1. Before coming to a decision on the matters entrusted to our consideration, it appeared desirable in the first place to ascertain what means are at present available for the performance of the several classes of scientific work enumerated in the reference, and to this end the committee have taken evidence respecting the Board of Trade standards department and electrical standardising laboratory, and have also visited these laboratories. After obtaining information on this subject the committee examined other witnesses in order to ascertain how far existing facilities in these respects meet the demands of science and industry. Of these witnesses a large proportion were nominated, at the request of the committee, by scientific and technical institutions. The names of these institutions and of the gentlemen who were respectively nominated to represent them are given in the list of witnesses appended to the minutes of evidence. Many of the witnesses also represented large manufacturing and commercial interests. The committee have also visited the Physikalisch-technische Reichsanstalt, and the Königliche Mechanisch-technische Versuchsanstalt, at Charlottenburg, and the Königliche Magnetische Institut at Potsdam, to obtain information as to foreign institutions in which work of the kind indicated in the reference is performed.

2. It will be convenient to state shortly the origin and scope of the work of the Board of Trade laboratories. The standards department of the Board of Trade was established to carry out the provisions of the Standards of Weights, Measures, and Coinage Act, 1866. The duties of the department have been considerably extended, particularly by the Weights and Measures Acts, 1878 and 1889, and the Coinage Act, 1870. They may be summarised as follows: To preserve, and restore in case of loss or injury, the imperial, parliamentary, and secondary standards of weights and measures; to construct, if required, and verify, new denominations of standards being equivalent to or multiples or aliquot parts of the imperial weights and measures, and to construct, if required, Board of Trade metric standards. To conduct such comparisons, verifications, and other operations with reference to standards of measure and weight in aid of scientific research or otherwise, as the Board of Trade may deem expedient. To compare at stated intervals the parliamentary copies of standards with each other and with the imperial standards; and to compare the Board of Trade standards with the parliamentary copies, and, if necessary, to adjust or renew them. To compare, verify, re-verify, and stamp local standards of weights and measures. To re-verify at stated intervals the coin weights of the Royal Mint, and the decimal series of reference bullion standard weights, and to compare, verify, and stamp such coin weights as may be submitted to them. To preserve and produce at the trial of the pyx the standard trial plates of gold and silver. To preserve and verify at stated intervals the Board of Trade model gasholders, and to verify, re-verify, and stamp standard gas-measuring instruments for the use of local authorities. To preserve a model of the apparatus for testing petroleum described in Schedule 1 to the Petroleum Act, 1879, and to compare with such model, and verify, every apparatus constructed in accordance with the Act which is submitted to them for that purpose.

3. The electrical standardising laboratory of the Board of Trade was established as the result of the representations of a joint deputation from the London Chamber of Commerce and the Institution of Electrical Engineers which in 1889 requested the then President of the Board of Trade, Sir Michael Hicks-Beach, to take steps for the establishment of an electrical

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standardising laboratory. The department has undertaken to verify electrical instruments for the measurement of current, pressure, power, quantity, energy, and resistance, but not the certification of integrating meters for use in connection with supply. At the laboratory are preserved the standard instruments for the measurement of electrical quantities; the testing of meters as sub-standards or for scientific purposes is also undertaken.

4. The Board of Trade have power, under the Weights and Measures Act, 1889, to cause to be made and duly verified such new denominations of standards for the measurement of electricity, temperature, pressure, or gravities, as appear to them to be required for use for trade. Under the same Act they have power to charge and take such fees as may from time to time be approved by the Treasury for the comparison of weights and measures, not being standards for the use of a local authority or their officers, and not being coin weights, and for the examination or testing of weighing and measuring instruments.

5. In general, the committee are of opinion that the appliances and facilities of the standards office and of the electrical standardising laboratory are fairly adequate for the performance of their statutory duties. They understand, however, that on account of the want of means for the chemical analysis of the materials used in the construction of standards, those offices would find some difficulty, without extraneous assistance, with regard to any new standards that might be required.

6. They further desire to point out that many physical constants and data and numerical expressions are necessarily used in connection with standards and the standardising of instruments. Some of the data now in use at the Standards Office are known to require correction, and in the case of others further investigations appear to be desirable. There is, however, no legal obligation on the Board of Trade to establish new data and numerical expressions, and in consequence of the smallness of the staff of the office, the work of the department is limited to that which is strictly enjoined by the Acts of Parliament. The department is at the present time chiefly dependent for more exact knowledge on such investigations as may be undertaken at the Bureau International des Poids et Mesures at Paris, or by foreign institutions similar to that contemplated in this country.

7. The electrical units being based upon theoretical definitions are on a somewhat different footing from units of weights and measures. Investigations are continually being made as to the degree of accuracy with which the legal standards represent the absolute values. Furthermore, there is some uncertainty as to the permanence of the standard instruments. Investigations on both these points are being carried out systematically at the Reichsanstalt, but there is no provision for such work at the Board of Trade electrical laboratory or at any other public institution in this country. It is, however, in the highest degree desirable that the Government department which is the custodian of the standards should undertake, or have official relations with an institution which can undertake, to carry out, or to verify the results of such enquiries.

8. As has been mentioned, under the Weights and Measures Act, 1889, the Board of Trade have power to make such new denominations of standards for the measurement of electricity, temperature, pressure, or gravities as may appear to be required for use in trade. Before any such standards are legalised a considerable amount of investigation is probably necessary, but the appliances of the Board of Trade laboratories are not in general sufficient for such work. It would be of material assistance to the department if the investigations, when required, could be made in a laboratory such as is contemplated in the reference. The committee are of opinion that physical enquiries relating to standards are of the highest scientific and industrial importance, and that provision should be made whereby they can be carried out by a specially constituted body. They consider that both the above-named departments of the Board of Trade would derive much advantage from the power of consultation with such a body.

9. There is much evidence that further facilities are needed by the public for the standardising and verifying of instruments, both for scientific and commercial use; and also that it would be of great benefit to trade if means were provided for the public testing of the quality of certain classes of materials. In particular, the committee desire to draw attention to the evidence which has been laid before them as to the difficulties arising in certain Government departments in their dealings with contractors and others which might be overcome by the establishment of an independent testing authority. It would neither be necessary nor desirable to compete with or interfere with the testing of materials of various kinds as now carried out in private or other laboratories; but there are many special and important tests and investigations into the strength and behaviour of materials which might be conducted with great advantage at a laboratory such as is contemplated in the reference. As illustrations we may mention investigations into the behaviour of metals and other substances under continuous or alternating stresses, which investigations are not, so far as we know, conducted at the present time at any testing institution in this country, and which could only be undertaken with satisfactory and authoritative results at a public laboratory. There are other investigations, such as those into the strength and durability of metals, as influenced by alloying, which are of great importance in connection with the industrial interests of this country, and which would fall very properly, in our opinion, among the duties of a public institution. Again, the pressure of the wind on surfaces of differing areas and shapes is a subject which demands public investigation, and which, though it is a matter of great importance as affecting structures, has never been, we believe, authoritatively determined. We could give other instances of the same nature, and have merely referred to the above subjects as examples of such matters as would, in our opinion, be proper for investigation at a public institution, as distinguished from the ordinary testing of materials used in commerce or in construction and machinery, which can be and is now efficiently conducted at private establishments.

10. The testing of instruments at the Board of Trade laboratories might be considerably extended if the staff of these laboratories were increased, but there are numerous classes of instruments which do not fall at present within the scope of their work, inasmuch as there are no legal standards whereby the instruments could be tested, and it does not appear to be necessary that such legal standards should be established. The committee are of opinion that a public laboratory, in addition to the advantage to be obtained by the scientific investigation of problems useful to industry, would be of great practical use to the commercial community in testing the various forms of measuring instruments which cannot at present be tested under any legal authority.

11. For many years the testing of certain instruments has been carried out at the Kew Observatory under the direction of the Kew Observatory Committee of the Royal Society. There is much evidence that the existence of these tests has been of great benefit to both science and industry. On the one hand it enables the maker to give, or the purchaser to obtain, an independent and trustworthy statement as to the quality of the instrument. On the other hand, the existence of the tests has led in many cases to a marked improvement of the instruments, and similar results may be anticipated by an extension of these facilities to other branches of industry.

12. The Kew Observatory is a Government building leased to the Royal Society at a nominal rent, situate in the Old Deer Park, Richmond, which is Crown property. The institution has an endowment, the Gassiot Fund, producing about £470 per annum. From the Meteorological Office it receives annually £400, part of which is the ordinary grant made to a first-class meteorological station, the remainder being for scientific assistance. The fees received for the verification and testing of instruments amount to about £2,000 per annum. The institution is self-supporting, and has usually a small annual balance, which is devoted to scientific investigation and to the extension of the work, including the erection of new buildings, when required. The funds at the disposal of the Observatory Committee are, however, quite inadequate to any considerable extension of its operations. The work done with restricted means has been very useful. The total number of instruments annually verified or tested is about 22,000. Among these are included watches, thermometers, sextants, barometers, and other apparatus used for scientific or industrial purposes. Evidence was given of the beneficial effect which Kew has exerted on the watchmaking trade, and it is noteworthy that this is due to the introduction of tests for which there was little or no previous demand on the part of the trade, though there is now keen competition among the best makers to secure a high place in the report which is annually issued. In the opinion of the committee the principles which underlie the proposal for the establishment of a national physical laboratory have been tested on a comparatively small scale at the Kew Observatory with the most satisfactory results.

13. The testing arrangements of the Physikalisch-technische Reichsanstalt and of the Mechanisch-technische Versuchsanstalt at Charlottenburg are far more complete than those at present available in this country, and the committee understand that not infrequently English manufacturers are compelled to apply to these institutions for certain tests. Further, there is reason to believe that the fact that investigations of the highest order are conducted in these institutions gives a greatly enhanced value to the certificates that they issue.

14. The Physikalisch-technische Reichsanstalt was established on a site presented by Dr. Werner von Siemens. The cost of the buildings and equipment amounted to £175,000; and the annual expenditure is about £15,000, of which only a small part is covered by fees. The institution is divided into two parts: the first division undertakes physical investigations and measurements for the solution of scientific problems of theoretical or technical importance which cannot be undertaken by private persons or colleges; also the solution of problems properly falling to the second division whenever they cannot be dealt with by the means at the disposal of that division. The second division carries out physical or physico-technical investi-

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gations, which are either ordered by the superior department (the Home Office), or are likely to be of assistance to scientific instrument making, or to other branches of German industry. Further, it is charged with the duty of standardising or verifying instruments and apparatus not included under the law of weights and measures; also of constructing instruments and mechanical apparatus for the Reichsanstalt, and in special cases, for other State institutions, and for manufacturers. Both divisions are under the superintendence of a director of high scientific attainments and position, who is supervised in the execution of his duties and in the nature of the work undertaken or projected by a committee (the Curatorium) appointed by the Emperor. The staff of the institution numbers over 70 persons, among whom are permanent officials (at the present moment, 11) possessing high scientific qualifications. Investigations are undertaken at the cost of private persons, the results of which are not wholly published. The fees, in so far as they are not prescribed by the supervising authority, are fixed by the president of the Reichsanstalt, who has the right to remit these fees for examinations or investigations carried out in the public interest.

15. In addition to the physical constants and numerical data needed in connection with standards, there are numerous facts a knowledge of which would be of great value to science and industry. The determination of such data usually involves an investigation as to the method of making the determination, and a considerable expenditure of skilled labour in carrying out the determination. The committee are of opinion that, although the former part of this work will in general be initiated by individual experimenters of great skill and originality, it may in special cases be usefully undertaken by a public body. It is rather to the improvement in the details of the method of making the determination that they think that the work of a public institution will for the most part be directed. This cannot usually be carried out by private investigators on account of the expense and the length of time over which the experiments must extend. The scientific reputation to be gained is often incommensurate with the labour involved; and even when the results are of industrial importance, in many cases they cannot be protected by patents.

16. There is evidence that many questions of this nature are partially investigated for technical purposes by private persons, the results being not infrequently kept secret. More complete investigations carried out at a public institution and freely published would often be of great service to industry, and there is reason to believe that a large part of the cost of such work might be defrayed by the persons directly interested in the results.

17. One difficulty in connection with a scheme for the determination of constants and data arises from the fact that the number of subjects which might be pressed for investigation would be very large. The opinion was, however, generally expressed by the witnesses that a strong governing body would have no difficulty in selecting those branches of work which were the most important, and that it would be possible to confine the work of the proposed institution, if established, within moderate limits. Nearly all the witnesses also have expressed the opinion that those interested in industry as well as persons devoted to the study of pure science would be willing that the Royal Society should be ultimately responsible for the management of the proposed institution, provided that industry were adequately represented on the governing body, and that the choice of the members of that body, though nominated by the council of the Royal Society, were not confined to Fellows of the society.

18. After consideration of the evidence the committee have come to the conclusion that an institution should be established for standardising and verifying instruments, for testing materials, and for the determination of physical constants. Work useful both to science and industry could therein be performed for which no adequate provision is at present made, either in this country or at the Bureau International des Poids et Mesures. Such work could not, or, at all events, in all probability would not, be undertaken by individual workers, or by institutions primarily devoted to education. In the opinion of the committee the proposed institution should be established at the national expense on lines similar to, though not at present on the scale of, the Physikalisch-technische Reichsanstalt referred to above. The possibility of future extension should, however, be kept in view from the first.

19. To secure the efficient performance of the work, the committee are of opinion that the director of the institution should be a man of high scientific attainments, and should act under a governing body containing representatives of both science and industry. The director should not be called upon or allowed to undertake work not connected with the institution except with the consent of the governing body. He would require the support of an adequate staff. As regards locality, while it is desirable that the institution should be near London, it is necessary that the site be free from mechanical and electrical disturbance.

20. Among the most important questions considered by the committee was whether the proposed institution should be founded independently or should be a development of an existing institution. The duties of the Board of Trade, as custodian of certain standards, are defined by statute, and the committee consider that it is undesirable to alter existing arrangements in this respect. They are of opinion that the proposed laboratory, if established, should be managed by a governing body constituted and appointed as hereinafter described, and should not be under the direct control of a Government department. They recommend that the Board of Trade, as custodian of the standards, should be placed in close connection with the said governing body.

21. The character of the work done at the Kew Observatory suggests that all that is really necessary might be attained by the development of that institution. The site of the observatory is in many respects all that could be desired, but owing to the extension of electric traction in the neighbourhood of the Metropolis, it may become a question whether it will remain suitable for certain delicate magnetic work at present carried out there. In that case it might be necessary to remove the magnetic observatory to some more distant site, free from all danger of magnetic disturbance. The committee are of opinion that for general purposes no more suitable site than the Old Deer Park can be found, having regard to its proximity to London, and other conveniences, and they recommend that the new institution be established by an extension of the Kew Observatory, if, as they have reason to hope, such an arrangement can be made.

22. Together with the observatory, the proposed institution would have to take over the responsibility for the magnetic observations which have been carried on there for many years. The Kew Observatory is one of the oldest and best known magnetic observatories in the world. In equipment it is now surpassed by several foreign observatories, and in particular the committee were much impressed by the admirable arrangements in the magnetic observatory at Potsdam. The measurement of the magnetic elements is the determination of a physical quantity useful alike to industry and to science, and it is essential that this part of the work of the laboratory should be carried on under improved conditions. It is, however, probable that other portions of the work of the proposed institution would involve the use of powerful electric currents and magnets by which the self-recording instruments would be disturbed. This part of the work should be carried on in a separate building, about half a mile distant from the existing observatory. Laboratories appropriated to delicate magnetic work could, however, be placed near the present buildings.

23. The existing establishment at Kew is under the management of the Royal Society, and the management of the proposed institution, if established by an extension of the Kew Observatory, would necessarily be in the hands of the society. The committee are of opinion that the Royal Society should be requested to nominate on the governing body of the proposed institution a certain number of representatives of industry, not necessarily Fellows of the society.

24. The committee are of opinion that the governing body should be authorised to charge fees for standardising or verifying instruments, and for other similar purposes, and that such work ought to be self-supporting. These fees should be paid by Government departments as well as by private individuals. The results of investigations undertaken at the request of private individuals should, except in special cases to be approved beforehand by the governing body, be published or be accessible to the public, even when the cost of the investigations is fully defrayed by the persons in question. A report of the work of the laboratory should be annually furnished to the Government by the Royal Society, together with properly-audited accounts.

Conclusions.

1. That a public institution should be founded for standardising and verifying instruments, for testing materials, and for the determination of physical constants.

2. That the institution should be established by extending the Kew Observatory in the Old Deer Park, Richmond, and that the scheme should include the improvement of the existing buildings, and the erection of new buildings at some distance from the present observatory.

3. That the Royal Society should be invited to control the proposed institution, and to nominate a governing body, on which commercial interests should be represented, the choice of the members of such body not being confined to Fellows of the society.

4. That the permanent secretary of the Board of Trade should be an *ex officio* member of the governing body; and that such body should be consulted by the Standards Office and the Electrical Standardising Department of the Board of Trade upon difficult questions that may arise from time to time or as to proposed modifications or developments.

The committee, in conclusion, record their sense of the assistance which they have received from Mr. Blaikie and of the able and courteous manner in which he has discharged the duties of secretary.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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TELEPHONIC COMPETITION.

The London County Council at its meeting last Tuesday had before it a report from the Highways Committee on the telephone service. The report arose in the first place because of the bad telephonic service of London, and, secondly, on account of the recommendations of the late Select Committee on Telephones. The Council unanimously recommended: "That the attention of the Postmaster-General be called to the expression of opinion in the report of the Select Committee on Telephones, that general, immediate, and effective competition by either the Post Office or the local authority is necessary, and that a really efficient Post Office service affords the best means for securing such competition; and that he be asked whether, in view of that expression of opinion, it is his intention to take the necessary measures for establishing an efficient telephone system for the county of London." An excellent essay by Mr. Robert Donald in the current issue of the *Contemporary Review* puts the present position of affairs very clearly, and tends to prove that it is not likely that many municipal authorities will risk money in competing with the present system. We refrain from entering at any length upon a discussion of Mr. Donald's essay, especially as we desire to somewhat bluntly carry the matter further. A careful examination of the question brings us to one conclusion, and one only as satisfactory. The Government should make up its mind at once as to the course of action it intends to pursue. The preferable way would be to approach the company with a firm offer of purchase of apparatus as it stands, with a firm offer to pay the actual cost expended on extensions less depreciation as agreed upon, such extensions to be carried out under the direction and according to the specification of the Government. Few municipalities will enter into competition with the existing company, because it would mean in most cases the loss of a greater or less amount of money. Their licenses, if obtained, would elapse in 1911—that is, in about twelve years. It could hardly be expected that in face of keen competition—and the competition will be very keen—the capital expended would earn any return for a few years, much less earn interest, in addition to depreciation. The Government must either buy the installations in 1911, or with the lapse of the licenses telephonic communication stops—yes, blankly stops—or must erect installations to compete with the company up to the date 1911, and supersede the company's installation at that date. Assume that the Government will buy and not compete. The purchase money to the municipalities will not include the losses incurred by competition, hence they have little inducement to enter into competition, for under the most favourable conditions they can hardly hope to make sufficient profit in the time to equal the first losses and the annual depreciation. Then we must also take into consideration the march of "progress." Automatic or other central stations may be all the rage in 1911, but the Government may refuse to buy the present old-fashioned boards. Readers can work out these views at any length they please; they will

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hardly come to any other conclusion but this, "that immediate and effective competition" is not to be expected from many, if any, municipalities. If this conclusion is correct, the Government and the company are still face to face, and if "immediate and effective" competition is to come at all, it must come through Government action. Let us assume, then, that municipal competition is generally out of the question. The Government has two courses open: to at once enter into competition or to arrange to buy. If they decide to enter into effective competition, they must so arrange matters that the telephonic public does not suffer in 1911, and it is a little difficult to see how they can arrange for this unless they put instruments free into all places where the company has instruments. Many subscribers might be expected to change over to Government installations, but we doubt if the company would not, by fighting hard, succeed in keeping by far the greater number. The company should know what its fate is to be in 1911. Under competition it would be saddled with so much old material for the scrap heap, hence it would not feel disposed to make the competition easy for the incoming powers. All things considered, we believe our suggestion of immediate purchase to be the best one under the circumstances.

ELECTRICAL COMPANIES.

The third edition of the "Manual of Electrical Undertakings," compiled under the direction of Mr. Emile Garcke, deserves more prominent attention than would be given by a mere book notice. In the first place, the companies referred to in the compilation have an aggregate capital of eighty-four millions seven hundred and forty-two thousand pounds. In 1896, when the compilation was first issued, the aggregate was sixty-one millions one hundred and nine thousand five hundred and twenty-five pounds. The number of people concerned in what may be termed the financial side of this large sum must be great, and it is to these people this volume commends itself. Outside of this class, again, a large part of the information is of direct value to practical men. An important part of this edition is in the corrected maps showing the areas appropriated to various metropolitan companies or vestries, with the mains as laid to the present time indicated, the electrical railways in London constructed or authorised, and the diagram showing results of electrical undertakings. Only those who have had experience in the obtaining of statistics and their verification can understand the amount of labour involved in a book of this kind, and can appreciate the great care that has been taken to ensure accuracy. We do not know—we should, however, hardly think it likely—if this new edition was in the hands of the financial editor of the *Sketch* when he penned his last weekly article. If not, he will be still more strongly impressed with the value of certain electrical securities, and will from the figures given in the book obtain further corroboration of his views. He holds, and rightly so, that great as is the income of many companies, and hence high as stands the value of their shares, both must increase. We congratulate Mr. Garcke upon the care and attention given to, and the success achieved by, this book.

CORRESPONDENCE.

RE THE LATE DR. JOHN HOPKINSON.

SIR,—I have the pleasure of informing you that I have decided to continue both in London and Manchester the practice in which I was associated with the late Dr. John Hopkinson.

I have accordingly arranged to take into partnership my late brother's eldest son, Mr. Bertram Hopkinson, B.Sc., who has considerable experience of expert work in connection with patents. His university training and his close association with his father during the last few years equip him well for the electrical work which forms so important a part of modern engineering.

Mr. Ernest Talbot, who has been in my brother's personal employment for 25 years, and to whom he had of late years entrusted much of his detailed work of design and supervision, will also become a partner.

The new firm will have the advantage of all the records of the late firm, embodying a wide and varied experience in every branch of engineering.

My partners will be in constant attendance at the address given below, and I ask for them a measure of that confidence which was reposed in my late brother during his life.—Yours, etc., CHARLES HOPKINSON.

26, Victoria-street, S.W., Oct. 8, 1898.

A RIDDLE.

SIR,—I take the liberty of asking you a question on electric lighting. I may say that I am an electric light wireman. Some time back I did a job with about 26 points, consisting of something like 70 16-c.p. incandescent lights. I got a 2½ megohms test for the whole job. Soon after I had completed the job, and had the light in full swing—it might have been two days; I cannot say for certain—the main fuse blew. I then put in a fuse capable of carrying almost double the current required, and still the fuse blew. After it had been going almost a week like this it went all right; not because of anything I did to make it go all right—it went all right without anything I did. I should feel it a great favour, indeed, if you would kindly let me know your reason why the fuse should blow like that, and why it should get all right without me doing anything to make it so. Do you think it was any fault of my work, or a leakage off the supplying company's mains? I hope you will favour me by inserting answer on your "correspondence" page at your earliest convenience, as this is a very important matter to me, and I shall feel very grateful, indeed, if you do so.—Yours, etc., ANXIOUS.

[We have received the above letter and insert it as requested. The details given are too few to allow of any definite conclusion being arrived at, but we are sure our correspondent should have localised the fault when it was there. An installation in which there is an intermittent short-circuit should not be left to correct itself. The next time the fuses blow "Anxious" should cut off the sub-circuits one by one till the fuses do not blow, and thus determine where to search more carefully for the fault, which, we expect, will be found in a fitting.—ED. *E. E.*]

THE PRIMARY BATTERY BOOM.

The bottom seems to be dropping out of the Rowbotham primary battery, or rather out of the syndicate formed to finance it. Our exposure of the absurd claims made for the battery by certain prominent experts seems to be producing an effect, judging by the following extract from Thursday's *Pall Mall Gazette*, under the heading, "Wanted, a Bid!"

"There was a sharp drop yesterday in the shares of the New Electricity Supply Syndicate. The company has been in existence for no more than a few months, during which time the shares, of the nominal value of £1, have been run up as high as £13. They were made up on Tuesday at £11. Yesterday they were offered at this price, but no buyers being forthcoming, they were rapidly offered down to £9 per share, still without any resultant business. What has become of the supporters of this affair?"

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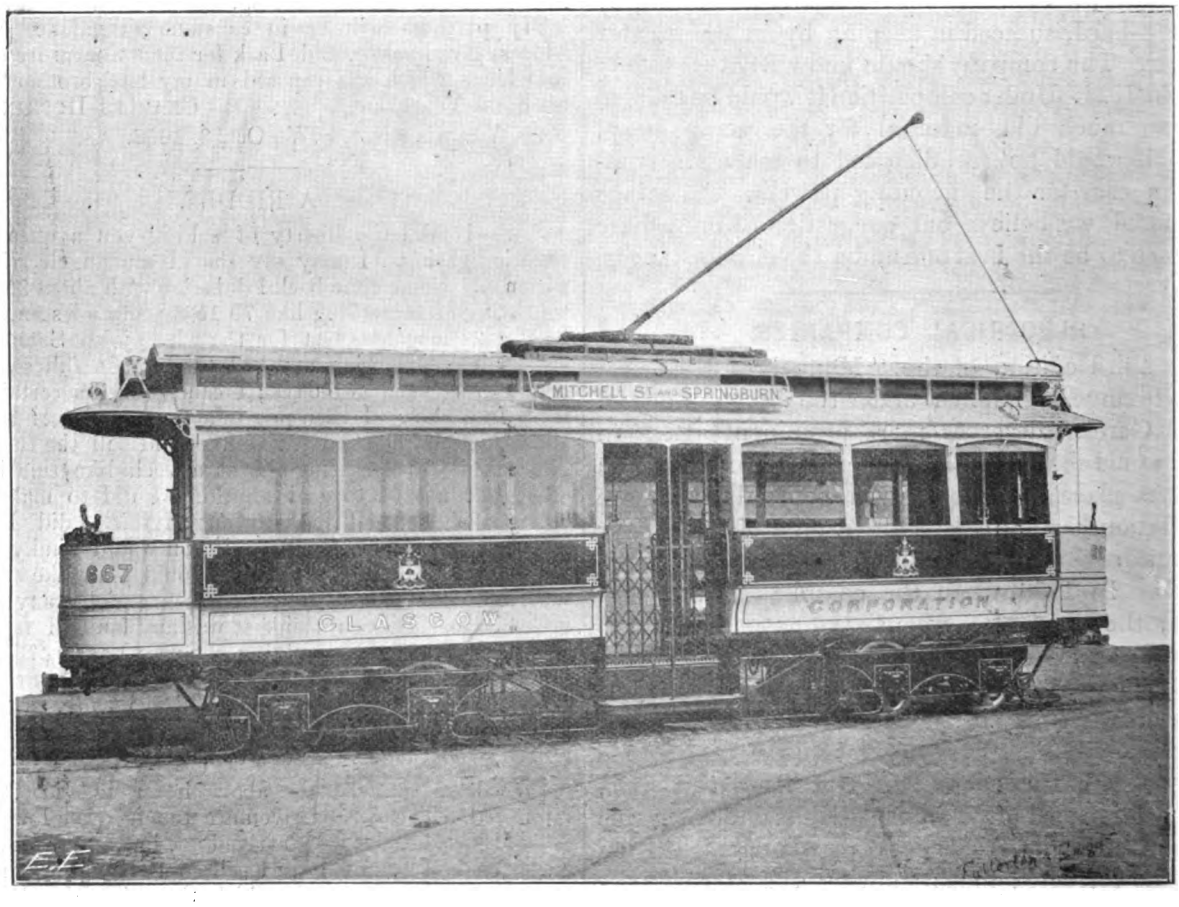
THE OPENING OF THE GLASGOW ELECTRIC TRAMWAYS.

The first section of the Glasgow tramways to be equipped electrically was opened yesterday, and the opening ceremony was the occasion of much congratulation to all concerned. As this is a departure of exceptional interest, it may not be uninteresting to trace shortly the history of tramways in Glasgow, which extends over a quarter of a century.

What was called the Glasgow Street Tramways Act, 1870, was originally promoted as two separate Bills by two syndicates in London. Both Bills sought power to lay tramways in the same streets, and were opposed by the Corporation. On June 30, 1870, an agreement was concluded between the Corporation and the promoters, under which the two Bills were amalgamated, and that within six months after the passing of th Act the Corporation should have the option of stepping in and substituting themselves for the promoters. This power was duly exercised, and in this way the Corporation obtained power not only to construct but also to work the tramways—a power which greatly facilitated the carrying out of the operations when 20 years afterwards the Corporation decided to take the working of the tramways into their own hands.



Side View of the New Type of Electric Car with Central Exits built for the Glasgow Tramways.

In May, 1871, the original promoters entered into another agreement with the Corporation, under which the latter undertook to lease the tramways to a company, which afterwards became the Glasgow Tramway and Omnibus Company, for 23 years from July 1, 1871, to June 30, 1894. After this the construction of the tramways was proceeded with, and on Aug. 19, 1872, the first section, that between St. George's Cross and Eglinton Toll, was formally opened by the Lord Provost and Town Council going over the line. By the end of 1872 nine miles of tramways had been opened, and, curious as it may seem, the people in America, after 20 years' experience of horse haulage, were beginning at that time to construct their first cable tramway. Since 1872 additional powers have been obtained for laying down lines in other parts of the city. Until now the lines operated by the Corporation extend to 32½ miles of double track and five furlongs of single track, owned by the Corporation, besides about four miles of depôt lines, and crossings and sidings. Over and above these, other four miles of double line have been laid in various districts of the city, and will shortly be opened for traffic.

The Town Council, on Nov. 12, 1891, resolved to take the tramways into their own hands on the expiry of the lease on June 30, 1894. Further negotiations with the tramway company for the acquisition of their premises, plant, and equipment also fell through, and the Corporation were therefore compelled to provide these for themselves. Under the Corporation Act, 1891, the Corporation obtained powers to work the tramways by mechanical or electric motors, and in July of that year a sub-committee was appointed to consider the matter. The committee set to work, obtained estimates as the cost for electric and cable traction, and considered a report on the gas motor in use at Dresden, and in May of 1892 recommended to the Town Council that the safest course would be to start with horses and await further developments in regard to the various forms of traction. Various considerations induced the sub-committee to recommend this course. The tramway lines, as all knew, could not be used for any purpose prior to the end of the lease; and besides that, mechanical traction both in this country and also on the Continent was only in its infancy, although electric traction had made great strides in the United States. The only installation of electric traction on the Continent was that at Budapest, where the underground conduit system was in use. In June, 1892, Mr. Young was appointed general manager, and the new tramway department formed. The equipment of the new system was then proceeded with. Depôts were erected in nine different parts of the city, 240 cars of improved pattern were built, more than 3,000 horses were purchased, workshops provided, and everything necessary for the working of the tramways obtained. A further advance made was the decision that there should be halfpenny fares for half-mile stages—an innovation which has since worked out exceedingly well. On July 1, 1894, everything was ready,

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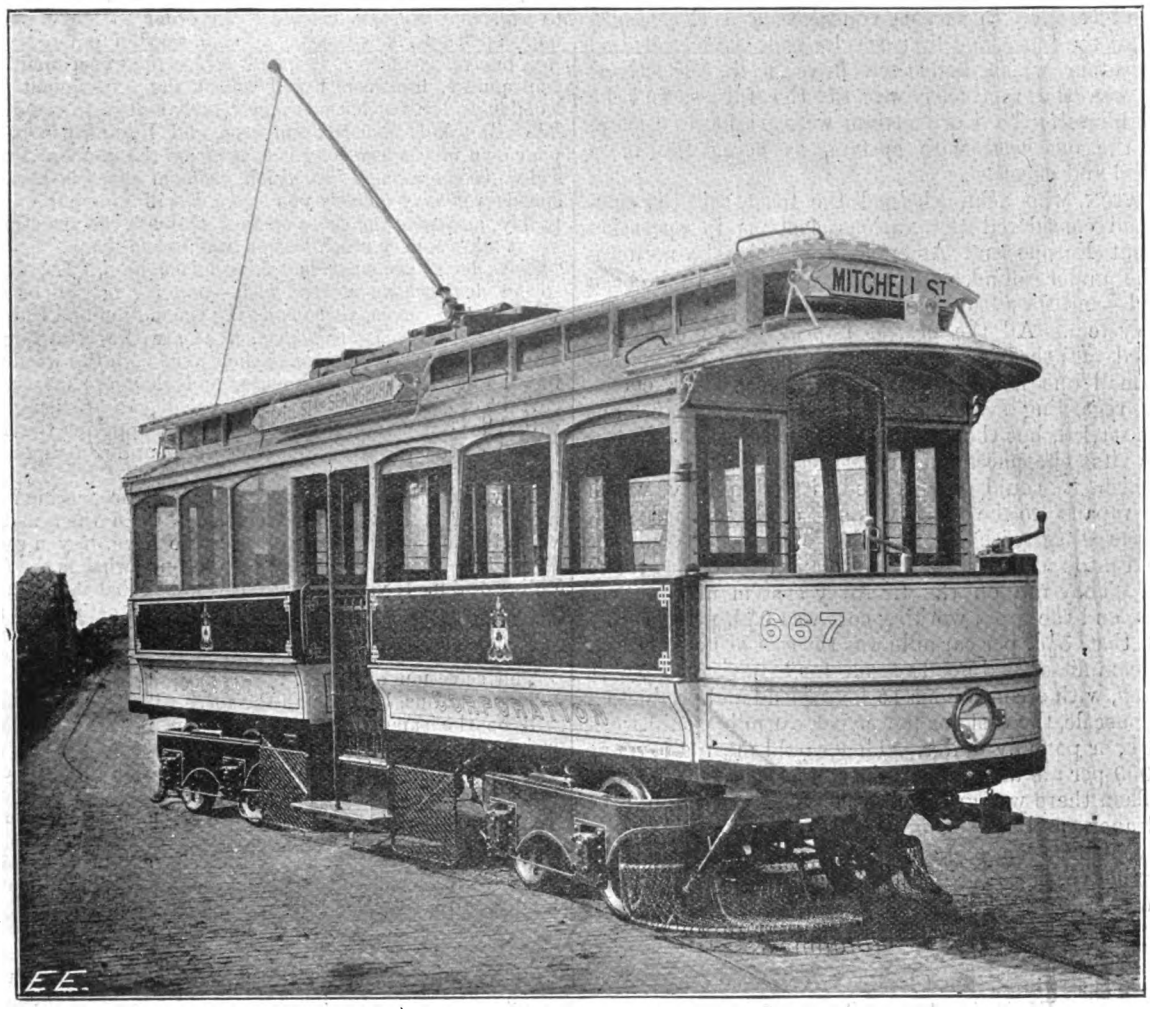
and on that morning the Corporation took over and worked the service with an entirely new plant and staff.

After the first report, to May 31, 1895, had been presented to the Town Council, and the success of the tramways assured, the question of the motive power was once more brought forward. In August a sub-committee was appointed to "further consider the question of mechanical motors, and to report." A deputation visited Brussels, Hanover, Hamburg, Berlin, Dresden, Budapest, Vienna, Milan, Genoa, and Paris, and examined every known system of mechanical traction, and the conclusion to which they came was that the "overhead system of electric traction is the best we have seen, and can be made quite applicable to any part of the city." The cities where typical installations could be seen were again visited, these including Brussels, Hamburg, Berlin, Hanover, on the Continent, and Coventry and Bristol in this country, and the conclusion arrived at was: "That the overhead system is the simplest, cheapest to construct and work, most accessible for maintenance and repairs, and, on the whole, the most efficient system of mechanical traction which has yet been demonstrated by practical working." The reports thus presented to the Tramway Committee were not deemed exhaustive or conclusive, and the general manager and the engineer were sent to America to make full enquiry into the practice and cost of the various forms of mechanical traction in typical American cities. These gentlemen confirmed the report of the sub-committee. This led to the decision of the Town Council in May, 1897, to equip the route from Mitchell-street to Springburn for overhead electric traction, and a remit was made to the committee to carry this out. It was further decided to light electrically as an experiment the route, utilising the traction poles for this purpose. In November, 1897, the offer of the Westinghouse Electric Company for the electrical equipment of the route was accepted and the work proceeded with. At the same time the renewing of the line and the laying of the pipes for the feeder cables and bonding the rails was done by the permanent-way staff of the department. A new type of car, illustrated herewith, designed by the general manager and engineer, was approved of by the committee, and the requisite number required for the route have all been built at the works of the department at Coplawhill. The largest number of the cars are single-decked, but four double-decked cars have also been built with top seats. To enable these latter to be used, it was found necessary to lower a portion of the Springburn-road at St. Rollox railway bridge by about 18in., at a cost of about £3,000, so as to give the requisite headroom.

The route which has been equipped for electric traction commences in Mitchell-street, only a short distance from the Central Station of the Caledonian Railway, and from St. Enoch Station of the Glasgow and South-Western Railway. It extends up West Nile-street, turning eastward along Sauchiehall-street and Parliamentary-road to Castle-street. At the end of Parliamentary-road the line curves northwards and proceeds along Castle-street and Springburn-road, passing St. Rollox Chemical Works, Sighthill Cemetery, and under the low railway bridge of the Caledonian Railway line to St. Rollox mineral station. At Keppochhill-road there is a branch into the car-sheds and power station, the northern terminus of the line being at the end of Springburn-road, about half a mile further on. The total length of the route is about 2½ miles. There is a double line of rails throughout the whole length of the route. This description of the history of the line we have taken from the *Glasgow Herald*, and we propose to give the full description of the electrical equipment next week.



View of the Glasgow Car on Curve.

The Opening Ceremony.

Yesterday afternoon the opening ceremony took place, when the electric tramway service in Glasgow between Mitchell-street and Springburn was inaugurated in the presence of a large number of guests from all parts of Scotland. For some days past the citizens manifested the greatest amount of interest in this new departure. Yesterday

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afternoon, when the first seven cars were run from Springburn to Mitchell-street, the streets were crowded with spectators all along the route.

The Lord Provost of the city and upwards of 200 guests assembled in the power-house a little after noon. Mr. J. M. Paton, the convener of the Tramways Committee, opened the main steam valve and set the machinery in motion. The party then took their seats in the cars and were driven along the route.

In the afternoon the guests were entertained to luncheon in the City Chambers, and the Lord Provost presided.

Mr. CALDWELL, M.P., proposed "The Corporation of Glasgow," and alluded to the reputation which Glasgow enjoyed throughout the United Kingdom. He pointed out that the municipal tramways had been worked with undoubted success. They had been worked economically, and the fares were extremely moderate. That day a new form of traction had been inaugurated. They had not acted rashly or too hastily, but with Scottish caution. The fullest enquiry had been made into the different systems of traction in various countries, and they might expect that the latest and best results had been embodied in the system which had been introduced. Electrical traction was the motive power of the future, and he thought himself the Corporation were right in having selected the overhead wire system, as being the more economical and effective.

Mr. PATON, who acknowledged the toast, said the committee had considered the various systems in operation throughout Europe and America—the cable, the accumulator, the underground, and many others had all been examined—and they had recommended the adoption of the trolley system. All the newest improvements had been introduced, and they believed that though the installation was a small one it would be very efficient. The controversy regarding system of traction was, perhaps, not even yet settled, but the many advantages of the trolley—such as its cheapness of construction, the economy with which it could be worked, its simplicity which enabled repairs to be simply and easily carried out, and the rapidity with which a horse tramway could be converted into an electric—all these commended the system to them. They ran on the tramway system nine million car miles, and the gross working cost was 8½d. per car mile run. Of that, 3½d. per car mile was the cost of horse-power, and the committee had good reason for believing that with the trolley, with a continuous 16 hours' load and production on a large scale, the cost for power per car mile would work out at 1d., or possibly under. That would mean a revenue of £75,000 per annum, less the interest on cost of conversion. Then there was greater speed, the streets would be kept cleaner, and the supply of cars could be easily increased at busy hours of the day.

A number of other toasts were proposed and responded to.

The cars were open to the public in the afternoon and were largely taken advantage of.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M I.E.E.

LECTURE II.

(Concluded from page 472.)

A short time ago I met with a very instructive illustration of this question of the current depending only upon the load on the motor. An electric street railway was being laid down in a town where there were several heavy grades. As soon as the line was opened it was found that the armatures kept on burning out. The matter was carefully considered by the engineer, who reasoned as follows. He said: "When a car is on a grade the load is so great that the drop in the leads is excessive. The result is that the tension at the terminals of the motor is very much reduced. Now, a certain amount of work has to be done in propelling the car, consequently, if the tension is reduced owing to the drop in the leads, we have to make it up in current. The result is that the motors take abnormally large currents when ascending the grades, and the remedy is to reduce the drop by putting in heavier leads." The engineer therefore telegraphed to the factory for a large supply of new feeders, which were sent down at great cost, under the impression that by reducing the drop in the leads the tension on the terminals of the car would be increased, and the amount of current per motor would be diminished. You will, of course, at once see the fallacy of his argument. For a given load the current per motor has nothing whatever to do with the tension, but depends only on the load.

Hitherto I have discussed only the question of uniform motion. I wish to draw your attention to the motor in the condition in which uniform motion is being gradually attained—that is to say, in which the motion is variable. And first of all let us make an experiment. I will take this motor in a state of rest. I will then send the current through the armature with the magnet circuit broken, as at g in the figure. I have now seven amperes passing through the armature of the motor; there is no motion because the magnets are not excited. I am going now to make the switch shown at g in Fig. 10, so as to send a current through the magnets. I want you to notice what takes place; the motor gradually speeds up from rest to a condition of uniform motion. I want you to notice particularly the time which elapses between the moment at which I make the magnet circuit, and that at which full speed is attained. Here we have an entirely new fact to deal with—viz., the question of the time it takes to get from a state of rest to a state of uniform motion. In order to make this a little more apparent, I will take off this wooden pulley and put an iron one in its place. Before I make the experiment with the iron pulley, however, I will repeat the experiment with the wooden pulley, so that you may clearly recognise the difference. We will take about six amperes, and I want you to judge in your own minds how long it takes from the moment I make this switch to the moment at which uniform speed is attained. It speeds up very quickly you see. I will now put on the iron pulley, and pass the same current through the armature. You see it takes a very much longer time to speed up.

Now, let us see what is taking place here. Let us go back to the idea that we started with—that for motion of any kind we have two forces, those assisting the motion and those retarding the motion. In this case, what are the retarding forces? They are exactly the same as they were with the wooden pulley in all our former experiments, and they are measured by a current of one ampere passing through the armature. If you work that out you find that the forces opposing the motion in this case are equivalent to a force of about 3lb. acting at a radius of 3in.

Now, what are the forces assisting the motion? At the moment of starting we had six amperes in the armature, and when the magnetic circuit is made we have, if you remember, $M=6{\cdot}1$, so that you can calculate at once what is the force at a radius of 3in. If you work it out you find that it comes to about 17lb. So that you see we have two forces acting at a radius of 3in., supposing that the whole weight that is being moved is travelling in a circle 3in. in radius.

The selection of a 3in. radius is quite arbitrary. We may take any radius, but though the force will be altered, one result will be the same. I have taken 3in. in this case because the weight of this pulley is practically concentrated at a radius of 3in. Here, then, is a very simple mechanical problem. We have a weight, which in this case is roughly about 30lb., travelling in a circle of 3in. radius. We have two forces acting on this weight. We have, in the first place, a force of 17lb. tending to assist the motion, we have also a force of 3lb. tending to retard the motion; the result is a force of 14lb. tending to move the pulley. The motor will begin to turn, and its speed will increase. If we measure the speed by the motion of a point on the rim, in feet per second, the rate of increase of speed—which we will call a, the acceleration—is given by this equation:

$$a = 32{\cdot}2\,\frac{T}{W},$$

where T is the difference between the assisting and the retarding force and W is the weight. Putting $T=14$ and $W=30$, we see that in each second there is an increase of velocity of about 15ft. per second. All this is simply a mechanical question—there is nothing necessarily electrical about it.

Now, we have here exactly what is going on in every car or train that is being driven by an electric motor. Suppose that the weight to be moved can be represented by a weight, W, acting at a distance of r inches from the centre of rotation. If the pulley itself has no weight, we may suppose that a string is coiled round it and carried along, and attached to the weight of W pounds, which moves horizontally. The only difference is that the weight, instead of moving round the circle, moves in a horizontal line. That is simply another way of representing what goes on here. If I had time I could put on our wooden pulley and carry a cord from it to an arrangement of this kind, where a weight of 30lb. could slide horizontally. You would see that we could get exactly the same motion that we have in this case. To get from this the case that we have in a railway, all we have to do is to suppose that instead of the shaft of the motor being fixed, the wheel rolls on a rail and that the weight acts at the centre of rotation. The velocity of a point on the

* Cantor lectures, delivered before the Society of Arts.

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circumference of the wheel then becomes the velocity of the weight, W, along the rail. We have here, then, exactly the same conditions of motion as when we attempt to move a train or a car along a horizontal rail. If the total force acting on the train is represented by 17, and the retarding forces by 3, the force available for acceleration will be represented by 14, and the acceleration or rate of increase of speed will be given by the equation

$$A = 32{\cdot}2\,\frac{T}{W},$$

where T is here represented by 14.

I want to emphasise specially the fact that the rate of increase of speed, or the initial acceleration, can be made anything we like by simply adjusting the value of the current at the moment of starting. To illustrate this I will make another experiment.

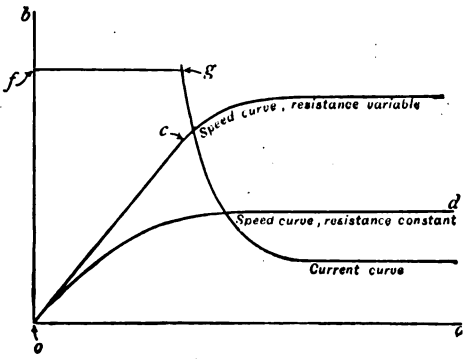


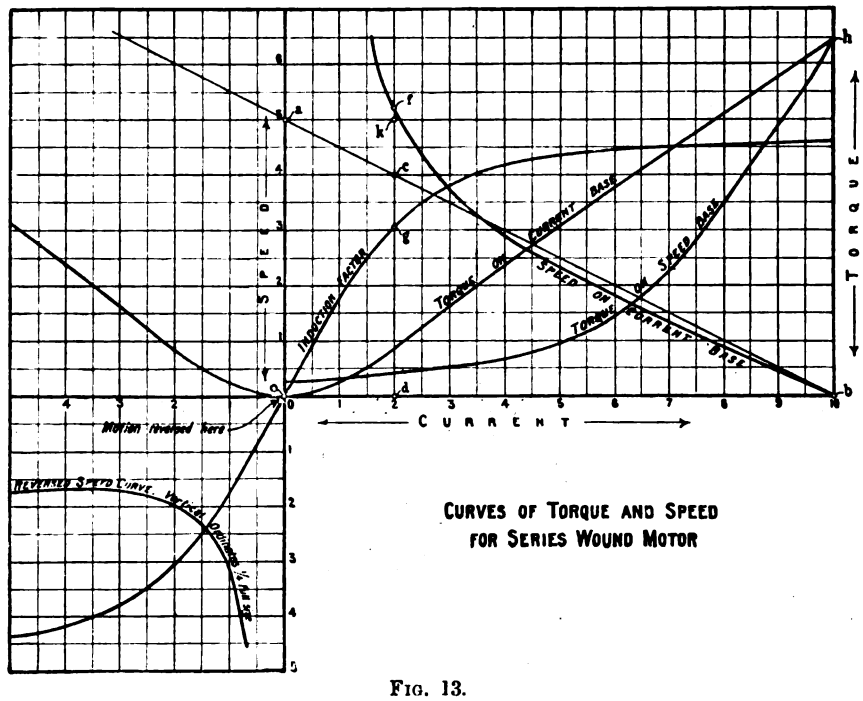
FIG. 12

This rheostat, shown at *h* in Fig. 10, is in series with the armature. I have adjusted it so that when the motor is at rest, there is a current of five amperes passing through the armature. Directly I make the magnet circuit, the motor begins to speed up, and the initial acceleration depends upon the difference between the assisting and the retarding forces. The force retarding the motion is 3lb., but the assisting force depends upon the current, and that we can make anything we like by simply adjusting the rheostat. Now in this case I adjusted the resistance so that the current was six amperes, and, consequently, it started off with an initial acceleration of about 15ft. per second per second. If I adjust this rheostat so that the initial current, instead of being six amperes, is 10 amperes, it will start very much quicker. The rate of starting up depends entirely upon the resistance in the circuit. You see that this entirely disposes of the popular impression that a heavy car or train "takes" a large current to start it. It does not of itself "take" any current at all. It takes just as much current as you choose to let it have, and the weight of the train does not make the least difference. The current that it takes at the moment of starting simply depends upon Ohm's law—*i.e.*, upon the value of the resistance that you choose to put in the circuit at the moment of starting. I have arranged this rheostat now in such a way that the current at the moment of starting is six amperes; on making the circuit it starts with an initial acceleration of 15ft. per second per second; if I increase the current by altering the rheostat, I can make it start at 32ft. per second per second, so that there is no foundation at all for the impression that a heavy train takes more current to start than a light one; you can make it take whatever current you like, but the rate at which it starts up depends on the amount of current.

As long as the difference between the assisting and retarding forces remain constant, the rate of increase of speed remains constant. We can represent this graphically. I will take a line, *o a*, as in Fig. 12, and another line, *o b*, right angles to it, and measure along *o a* the time in seconds, and along the *o b* the speed in feet per second. Let us now represent in this figure the motion of a point on the rim of our pulley. As long as the difference between the assisting and the retarding forces remains the same, the acceleration will be uniform, and the line of acceleration will be straight, such as *o c*. You will see that in order that the assisting force should remain the same, the current must remain the same. Now, does the current remain the same? Let us see. We will take a current of six amperes through the rheostat. Now, when I start the motor by making the magnet switch, you will see that the current does not remain constant. Why does it not remain constant? Because directly motion begins, the motor on its own account begins to induce a certain tension, and that tension tends to stop the flow of the current through the armature, and we know that that tension is given by the product M *n*; so that the quicker the motor runs, the greater will be the induced tension, and the smaller the current in the armature. Directly motion commences, the current begins to get less. Instead of getting a line like *o c*, we get a line like *o d*—that is to say, the acceleration, instead of remaining constant, gradually gets less and less.

There is, however, a way in which we can maintain the acceleration constant—namely, by keeping the current constant. How can we do this? I will try to do it with this apparatus. I will start off with six amperes, and what I want to do is to keep the ammeter pointed at six as the motor speeds up, and if I can do that I shall keep the acceleration constant. I have then to take the resistance of the rheostat out as the motor speeds up. It is clear that I can keep the current constant just as long as there is any resistance left in the rheostat; so that I am able to keep this line straight up to the point *c*, and as soon as the resistance is all out, the current begins to diminish, and the speed will increase until the final speed is increased.

Before we leave this diagram I want to draw a curve on it, which shall represent the variations of current. Let us represent along *o b* not only the speed, but also the current in



CURVES OF TORQUE AND SPEED FOR SERIES WOUND MOTOR

FIG. 13.

amperes. Let *o f* represent a current of six amperes. Then the current curve will be given by a horizontal line up to the point *g*, when the rheostat is all out, and the acceleration ceases to be constant. After this point the current rapidly diminishes, until it finally becomes constant again, when the speed is uniform. We shall find later on that these curves of speed and current are of great importance and practical use.

I want now to explain briefly how the car attains finally a uniform speed. Let me draw your attention once more to the induction curve of a series-wound motor, such as is shown at *o g* in Fig. 13. From this induction curve we can determine the amount of the torque for all values of the current, so that we get a torque curve, such as *o h*, representing for any given

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current the value of the torque in inch-pounds. We can also get a curve, such as *b k*, representing for each value of the current the corresponding value of the speed. Having obtained the torque and also the speed for any current, we can at once deduce the torque for any speed, and we are thus able to draw a curve giving us the torque at different speeds. This curve is shown in Fig. 13 as "torque on speed base," the speed in this case being measured horizontally in the figure. Let us see what this curve means. If we start at the point, *b*, where the speed is nothing, the torque has its maximum value, *b h*; as the motor or car speeds up, the torque gets less, and the more the car speeds up, the less the torque becomes, until finally, in this case, the torque for high speeds becomes very small indeed.

In Fig. 14 we have a curve giving the torque at different speeds for a railway motor. The curve of total torque, A, gives us for any speed the corresponding value of the torque, the speed being measured horizontally, and the torque vertically from the point *o*. Curve B gives us the variation of the retarding forces in the motor, also on a speed case. We find, in practice, that the force opposing the motion of a car or train are not constant—that it depends upon the speed. It is not difficult to determine how it varies with the speed. You will find that at the moment of starting the force opposing the motion is very great: after the driving wheels have made one or two revolutions it gets less, and then generally increases again with the speed. Curve C is called the curve of accelerating torque, since it gives us the difference between the total torque and the retarding torque—that is to say, it tells us how much force is available for acceleration. It is obvious that where Curve B cuts Curve A the accelerating torque must become nothing, and uniform speed will have been reached.

When we start up a car the total torque depends upon the amount of current passing in the motor, and the accelerating torque is equal to the difference between this and the retarding torque. As the car speeds up the total torque gets less, and the accelerating torque also diminishes, until at the moment when the total torque is equal to the retarding torque, the force tending to assist the motion is nothing and uniform speed will have been obtained.

To some minds this question of the starting of a car or train appears to be fraught with difficulty. One is sometimes confronted with the familiar dilemma that, if action and reaction

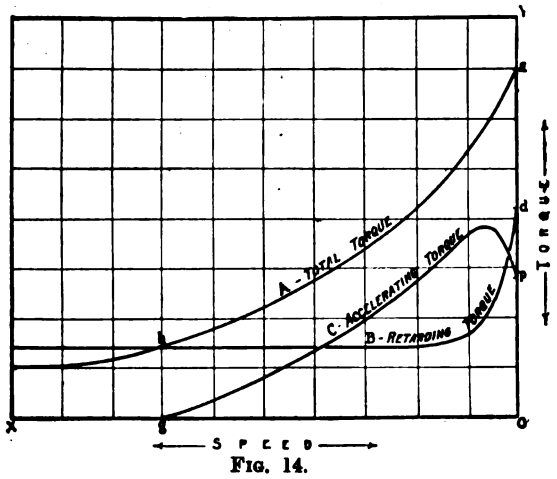

FIG. 14.

are equal and opposite—if, for instance, the force with which the horse pulls on the traces of a cart is equal to the force with which the cart resists that pull, how do we get any motion at all? There are, as we have already seen, two distinct forces acting, one assisting and one resisting the motion. If the force assisting the motion at the outset is not greater than that resisting the motion, the train cannot start. Unless we get enough current to go through the motor to give a horizontal pull greater than the force which resists the motion, the motor will not start, but if we allow enough current to pass, so that the assisting force due to the current in the armature of the motor is greater than the resisting force due to friction, etc., then we get a resultant force available for accelerating; the train will begin to speed up, and the amount of the initial acceleration will depend upon the difference between the assisting and retarding forces at the moment of starting.

In conclusion, I will take the case of a train on the City and South London Railway, with which you must be familiar, and see how the principles that we have been discussing apply there. I propose to try and predetermine what will happen when one of those trains is started.

We will take the tension of the line at 400 volts, and the weight of the train 35 tons. The driving wheels of the locomotive are 27in. in diameter, and there are two gearless motors in each locomotive, which are connected permanently in series, so that there is a tension of 200 volts on each motor. The initial acceleration of a train under those conditions depends entirely on the amount of current that you allow to pass through the motor at the time of starting. The average current, as shown by experiment, is 150 amperes. What is the effect of passing this current through the motors? I have already shown you the induction curve of these motors, and if you look at Fig. 2 you will see that for 150 amperes the value of M is 63; you can then calculate what will be the value of the horizontal pull with wheels 27in. in diameter. The total pull available for all purposes will be 984lb. per motor. From experiment we find that the force opposing the motion at the moment of starting is 426lb. Taking the difference between 984 and 426 we get a resultant of 558lb. available for accelerating. There are two motors, so that each motor has to accelerate half the weight of the train. You must now make use of the equation that I gave you for getting the acceleration—namely, $a = 32{\cdot}2 \frac{T}{W}$—and we see that a is 0·046 feet per second per second, so that if this acceleration remained constant for 40 seconds, the speed of the train at the end of that time would be about 18ft. per second. The current will be kept constant as long as there is any resistance left in the starting rheostat. Directly the starting rheostat is all out, the current will diminish in the way you saw on the ammeter in our experiment, and the acceleration will cease to be constant, gradually getting less and less until finally uniform speed is attained. This acceleration curve may be constructed by a graphic method when you have the induction curve of the motor.

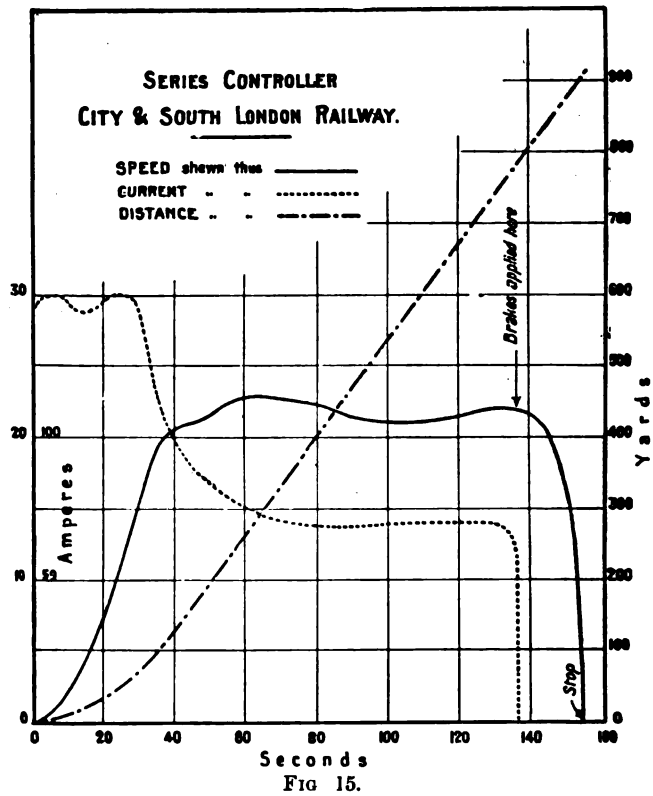

FIG 15.

Fig. 15 gives the actual result as obtained by experiment. The starting current is 150 amperes. You see the acceleration is held practically constant for very nearly 40 seconds, and at that time the speed of the train is 20ft. per second—very nearly what it was by calculation. Directly the rheostat is all out the current begins to decrease very rapidly, and the acceleration soon becomes constant. At the end of 137 seconds the current is cut off, the brakes put on, and the car comes to a standstill in 152 seconds.

You may remember that not long ago acceleration curves of the trains for the new Central London Railway were published predicting the action of the locomotives to be used on that railway. I was interested to see in one of the technical journals a laugh raised against the makers of these locomotives because they ventured to predetermine what they were going to do. Now, if we have the profile of a line, the resistances to motion and the induction curve of the motors, we can predetermine with remarkable certainty the shape of the acceleration curve. There is no other method of locomotion in which you can predict in that way what a train will do; steam engineers have not yet obtained that knowledge of the action of a locomotive that would enable them to predetermine their acceleration curves in this way. When, therefore, you see the diagrams of acceleration of a line such as the Central London Railway predetermined, you must not suppose that the makers of those motors are talking about what they do not understand.

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THE BRADFORD TRAM ACCIDENT.

The inquest held to investigate the circumstances of the death of Albert Drake and Joshua Walton Penny, who were fatally injured in the electric tramway accident which occurred in Great Horton-road on Monday, Sept. 19, was resumed and finished last week. We are indebted for the following notes to the *Bradford Observer*:

At the outset the **Town Clerk** observed that in his report Mr. Waugh gave the results of a number of tests with No. 16 car and another car attached to it. That was a method of testing to which he had objected as being essentially unfair, because the momentum of a pilot car placed in front of No. 16 called on the brake of the latter to exercise a power which it could never be called upon to exercise in any conceivable circumstance when running by itself. As they proposed to do, they had made tests with the No. 16 car running by itself, and he asked the coroner to take the evidence of Mr. Dawson (the deputy city surveyor) as supplementing the evidence of Mr. Waugh, who was present when the tests were made.

Mr. Waugh said that on the 27th ult. he made certain experiments with No. 16 car, both in the shed and on the road. On the 4th inst. he made additional tests, which he wished to be regarded as supplementary. On measuring the distances between the electric poles he found that they varied from 34 yards to 37 yards. Mr. Waugh then read his report of the supplementary tests which had been made on Tuesday with the car No. 16 He said that the day was foggy, and the rails were greasy, but virtually they were sanded for the whole length of the gradient. The report was as follows:

No. 1 Test—Hand-Brake Only.—The disabled car was taken on the road, preceded by a pilot car, to an incline at Horton Bank Top about 320 yards long in the straight, with a gradient of 1 in 14·24 and 1 in 14·34. Both cars were let go for a distance of 72 yards, when the forward hand brake was applied by Mr. Spencer, the tramways manager, and they were brought to a stand in 91 yards from the point where the brake was first applied, and this in spite of the wheels skidding.

No. 2 Test—Hand-Brake Only (conditions same as No. 1).—Both cars were let go for a distance of 72 yards, when a driver applied the forward hand brake, released it and applied it again, released it and applied it again, bringing the car to a stand in 70 yards from the point at which the brake was first applied.

No. 3 Test—Electric Brake (conditions same as for Nos. 1 and 2).—Both cars were let go for a distance of 72 yards, when the electric brake was applied by the driver, and the cars were brought virtually to a stand in 68 yards from the point where the brake was first applied.

No. 4 Test—As to Reversal.—The car No. 16 was taken on the level, the hand-brake applied as tightly as possible, and the wheels were locked, when the current was turned on for reversal. The power was sufficient to start the car.

The distances given in the tests made on Sept. 27 are not correct, but the deductions to be made from the supplementary tests are the same as those made in my report of the 29th ult. from the tests of the 27th ult., the distances being too great before the car was brought to a stand. That is to say: (1) in cases of emergency an additional brake is required in order to meet cases where, from one cause or another, the car has obtained a momentum exceeding that of ordinary conditions; (2) that the sanding arrangements should be so as to ensure the sanding of both rails.

Mr. Waugh added that he was very glad he made the No. 4 test, as to the reversal of current. He had not previously thought that such a result could be attained, and he was very pleased to find that it could.

Cross-examined by the Town Clerk, **Mr. Waugh** said that in his tests the No. 16 car was preceded downhill by a pilot car. Afterwards other tests were made on behalf of the Corporation with the No. 16 car by itself. Mr. Requier, the representative of the company which supplied the cars, operated. Before the brakes were applied the car was "let go"—that was the proper expression to use—for the same distance as in the previous tests—72 yards. Four tests were made on behalf of the Corporation. In the first the hand-brake only was applied, and the car was brought to a standstill at a distance of 36 yards 1ft. In the second test the hand-brake and electric brake were used in combination, and the car was brought to a dead stand at the distance of 25 yards 1ft. At his request this test was repeated, and the result was better—the car was brought to a standstill at 21 yards 1ft.

The **Town Clerk** explained that the next test—No. 4 "A"—was made at his own suggestion, as he thought it was important that the jury and the public should know what would happen if a car went down the gradient under ordinary conditions, and according to the instructions the Corporation gave to the men. The car was, therefore, taken down the gradient on the second notch of the electric brake—there were five notches representing degrees of power.

Mr. Waugh, proceeding, said he witnessed this test also. The car was taken down the gradient under the conditions described by the town clerk, and was brought to a standstill at a distance of nine yards after the signal had been given to stop. That distance represented approximately the length of the car. In this test the wheels did not skid at all.

Questioned by the Town Clerk with reference to the test which he (Mr. Waugh) made as to the reversal of the current, he agreed that the removal of the trolley pole would have the effect of depriving the driver of the means of reversal. In answer to a further question by the Town Clerk, **Mr. Waugh** said that in the tests which he witnessed the reversal of the current acted instantly.

Cross-examined by Mr. Atkinson, **Mr. Waugh** said that when the tests were made the rails were well sanded. They were in a greasy condition, and it was necessary that sand should be used. The sand, of course, made an appreciable difference to the tests. If there had been a full complement of passengers, or, at any rate, an average load on the car when the second tests were made, the effect would possibly have hardly been the same.

Mr. Atkinson: Providing there had been average number of passengers, the effect would have been that they would not have pulled up the car in the space mentioned in the report?—**Witness**: I cannot say what the car would have done if Mr. Requier had not been there.

The **Town Clerk**: I should like to know what foundation there is for that statement. Surely Mr. Waugh was there, and had full opportunity of judging as to the *bonâ fides* of the tests.

Witness: I consider that Mr. Requier was remarkably clever with the brake; so clever, in fact, that a doubt which at first existed in my mind was suggested by one of the tramway staff, and as he seemed incredulous about it I said that we would have that test repeated.

Mr. Atkinson: Suppose a car is travelling at full speed and anything happens to the driver—suppose that he loses his head—cannot the conductor pull up?—**Witness**: No. The conductor can only operate the hand brake, as the driver can. He might get it a notch higher if he had someone to help him, but that would not affect the speed of the car.

Can the conductor do anything towards pulling up the car?—No, nothing at all. The apparatus for controlling the car is with the driver.

The **Town Clerk**: Providing, I suppose, that the conductor, negligently or otherwise, has not already applied the hand-brake? I suggest to you that if the hand-brake is applied from the conductor's end it gets a grip of the wheels, and renders the driver powerless?—**Witness**: That is so. The wheels must be revolving before the electric brake can act.

The **Foreman**: I understand you to say that even when the hand-brake was on the motion of the wheels could be reversed?—**Witness**: Yes, but that is quite independent of the action of the electric brake.

A **Juror** asked if the three retarding influences to each car—the hand-brake, the electric brake, and a possible reversal of the current—did not all depend absolutely for their effectiveness upon the adhesion of the wheels to the metals.—**Witness**: Yes. The wheels could not be reversed unless they had a grip of the rails.

And if the grip fails when the car is descending a gradient, there is no emergency brake to fall back upon?—Under ordinary conditions, no. In an emergency they want a brake.

The **Town Clerk**: If the greasy line were sanded, as, of course, it ought to be, would there be any difficulty in resorting to these three methods?—**Witness**: No, if the rails were properly sanded. At present only one rail is sanded.

Then, I take it that to a certain degree, at all events, you would have the same difficulty with the slipper brake unless the rail were properly sanded?—To a certain extent, but not so much. It would be in a very mitigated form.

In the course of further cross-examination, **Witness** said that he was a believer in the emergency brake. He knew of no other means of preventing the wheels skidding than the use of sand and the intermittent application of the brake.

Mr. Waddington: Do you consider that the act of removing the trolley pole from the overhead wire in any way prevented appliances which might have stopped the car from being effective? **Witness**: Yes, decidedly. There was no sense in disconnecting it, for it removed one means of bringing the car to a stand.

Do you consider that the fact of the conductor requiring this disconnection showed that he had any knowledge of the brake power.

The **Coroner**: That is a matter of argument, and not of fact. An expert witness can only offer his opinion on scientific questions.

Witness: It was an error of judgment, at all events.

Mr. Waddington: Would such a proceeding show ignorance?

The **Coroner**: I should be loth to give an impression that I did not wish to allow anyone the fullest opportunity, but really you may not conduct your cross-examination in that way.

By **Mr. Richardson**: When the tests were made both rails were sanded, a condition which would ordinarily obtain on a single line, but there was a double line where the accident occurred, so that here only one rail of the down line would be sanded. To this extent there was a difference in the conditions.

The **Town Clerk**: In spite of the damage which the car received in the accident, do you find that, so far as its electrical equipment it concerned, it is to-day in thorough working order. **Witness**: That is so, absolutely.

At the close of Mr. Waugh's examination the **Coroner** said that he had given the driver and conductor of the car liberty to come forward at any stage of the enquiry and give evidence. He understood, however, that the conductor had not yet sufficiently recovered from his injuries to be able to attend, and with regard to the driver of the car, from the fact that neither he nor Mr. A. V. Hammond, his legal adviser, was present, he drew the conclusion that for the present Mungovin had been advised not to appear as a witness.

The **Town Clerk** intimated that he did not propose to call Mr. Dawson, as there was now no issue as to the tests.

The **Coroner** then proceeded to sum up the evidence. He remarked at the outset that the enquiry had occupied considerable

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time, but it was a matter of great importance to the public generally, as well as to the passengers who were injured in the accident, that the causes of the disaster should be fully investigated. So far as the immediate cause of death in the two cases which formed the subject of enquiry was concerned there could, of course, be no doubt whatever, especially after the medical testimony, and the proceedings had been devoted to the question as to the circumstances under which the injuries which proved fatal were sustained. He had endeavoured to keep the enquiry within proper limits, and the jury should bear in mind that their duties were of a quasi-criminal character, and had no reference to the civil rights of the parties concerned. The real question, then, for their consideration was whether the accident occurred through neglect, either by any act of omission or commission on the part of anyone which would render any person or persons legally responsible for the death of two of the injured passengers. This opened out a tolerably wide field, and very properly so, for if enquiries of this character were in any way restricted, there might be some danger of injustice being done, or of persons who required to be made amenable to the law escaping from the consequences of their acts. Accordingly, the jurisdiction of a coroner's court could be exercised within any reasonable limits, and the jury had the fullest liberty. In order to attach to anyone the responsibility for death, there must be some wilful or reckless conduct, either passive or active. In this event it would, of course, be necessary to return a verdict of manslaughter. In dealing with the evidence, the Coroner observed that it was important to consider the position of the driver in the light of the testimony which had been adduced with regard to his conduct. Although he was probably conscious of danger, and of the fact that his own life was jeopardised, he boldly said that he would "stick to the finish." One of the points to which the attention of the jury must be directed was whether that remark represented the conduct of a man who was acting carelessly and recklessly, and with utter disregard to all consequences. The statement made that this witness heard the conductor call out, "Pull the trolley off," suggested that the conductor was fully alive to the seriousness of the situation, and was endeavouring to do his duty. It was easy to say after the event that this or that might have been done, but the whole thing would have taken only a very short time, and they could easily see how, in the rush and hurry of the moment, a somewhat serious error of judgment might have been committed. But whether or not an error of judgment carried with it any criminal consequences depended upon the circumstances. The next witness, Bailey, said he saw both the driver and conductor endeavouring to apply the brakes, and that he heard the conductor on the top call out to one of the passengers to detach the arm. That might have been a serious mistake, as a matter of fact, but did it not go to prove that the man was attending to his duty? As to the expert evidence, he would not deal with it in detail, because they had only just heard it, and it would be quite fresh in their minds. The question for them was whether, in view of all the evidence which they had heard, they considered that there was any ground for bringing in a verdict of culpable and wilful negligence against anybody. It appeared to him that there was an entire absence of anything that could be treated as an act of omission or commission on the part of anyone concerned which would amount to culpable or criminal negligence. It was not for him to judge, however, but for them. If they thought that there was no such responsibility as he had mentioned, the proper verdict for them to bring in would be an open verdict, to the effect that the deceased died from injuries received in consequence of the accident, but that there was not sufficient evidence to show how the injuries were caused.

The jury then retired, and, after a short absence, returned into court with an open verdict in regard to the death of Albert Drake, the first victim of the accident. They added, as a rider: "That the recommendations of Mr. Waugh be immediately adopted, that slipper or emergency brakes be at once applied to all cars, that two sand-boxes be fixed to each platform, to enable the driver to sand both ways; and, further, we recommend, in the interests of the public safety, that until these alterations are carried out the cars ought to cease running."

The **Coroner**: I rather understood the other day that the committee had given instructions about these slipper brakes?

The **Town Clerk**: I was about to observe that I will at once bring these recommendations of the jury before my committee. They meet this afternoon, and the recommendation will be submitted to them. As regards the fixing of the slipper brakes, this has already been taken in hand. It is so far advanced that the slipper brake is in process of being fixed on the cars at the present time. With regard to the other matter of the sand-boxes, I do not anticipate that there will be any difficulty about that. The third recommendation is a rather more serious matter, but it shall be placed before the committee, and it will be for them to decide what they think best in the public interest.

The Tramway Committee's Decision.

The recommendations of the jury were submitted to a largely-attended meeting in the afternoon of the Tramways Committee of the Bradford Corporation and very carefully considered. After a long sitting the committee came to the unanimous decision that the slipper brakes already ordered to be fitted to the electric cars as an additional precaution to satisfy the public should be fixed with all possible dispatch, and that an additional sand-box should be fixed on each platform of the cars, to enable the driver to spread sand on both rails at once. In view of the reports made to the committee as to the efficiency of the brake power on the cars and of Mr. Waugh's own report "that car No. 16 is equipped with brake power to keep the car under control, and to bring the same to a stand if intelligently used," it was resolved that no action could be taken for stopping the service of cars on the Great Horton route. It was reported that the manager would be able to run the car with a slipper brake equipment in the course of the day, and, subject to this being found to work satisfactorily, the remaining cars would be immediately fitted in a similar manner. Mr. Requier, engineer to the Westinghouse Company, Limited, attended before the committee, and we understand that the committee were largely influenced in coming to their decision not to suspend the working of the Great Horton tramway by the very satisfactory results of the experiments that gentleman had conducted on the 4th inst. with car No. 16 as detailed in Mr. Waugh's evidence at the inquest.

SOUTH STAFFORDSHIRE MINES DRAINAGE.

PROPOSED ELECTRICAL SCHEME.

On Wednesday last week the annual meeting of the South Staffordshire Mines Drainage Commission was held at the Drainage Offices, Dudley. The following report of the meeting, giving fuller details of the proposed electrical pumping installation, is taken from the *Birmingham Post*:

The **Chairman**, in moving the adoption of the annual report of the engineers and general manager, remarked that notwithstanding a serious decrease in revenue they had been able to hold their own. They had not quite paid the amount of the sinking fund as well as the interest, but they had carried out new works at an expenditure of £486. 11s. 9d., and had also paid £200 in respect of the water rights of a mill on the termination of the lease, and if these sums had been put to the capital account they would have paid their way absolutely. It was, however, a serious matter that, owing to the decrease in the draught of coal, the receipts of the Commission, as compared with the previous year, had fallen off to the extent of about £1,000. Where they used to pump 36,000,000 gallons per day they now only pumped 9,000,000, and they hoped to reduce it to 6,000,000. They reasonably anticipated that the mines liberated by the Moxley and Bradley levels would have been opened by the parties concerned, but this had not been done to any great extent. He considered that they had no right to spend any more of the £100,000, of which they had already borrowed £10,000 or £11,000, if the owners failed to open out the mines when they were released from the water, and the Commissioners did not derive any benefit from the outlay. He was pleased to say there was now an indication of a revival in trade in the Tipton district, there having recently been more coal drawn there than for some time past. The Old Hill district was in a very satisfactory state. They had not increased their loans in that district, and they fully expected that when the next dividend on the loan was paid they would be able to pay 10 per cent. of the original loan to the bondholders on the overdue bonds.

Sir Benjamin Hingley seconded the adoption of the reports.

Mr. Wilson Lloyd considered that surface works alone would not accomplish all they desired, and was in favour of the introduction of underground pumps placed at a low level.

The reports were then adopted.

An important joint report of Mr. E. B. Marten (surface engineer) and Mr. E. Howl (engineer to the Tipton district and general manager), with reference to the drainage of the surface and the mines embraced in the Tipton engineering scheme, was then read. Having traced the history of the early stages of the surface works, the report stated that, seeing that the water had been reduced from 36,000,000 gallons per day in 1873 to 9,000,000 gallons in 1898, it might be reasonably argued that this should have been a sufficient reduction to enable the revenue from rates to pay for the pumping, also interest and sinking fund on the capital expended. Unfortunately, from a drainage standpoint, many causes had risen, such as the drowning of the mines themselves, the competition of coal from other districts, the economy in the use of coal reducing the demand, and the abandonment of ironstone working, to bring about a diminution in the output in the Tipton district from 3,660,000 tons in 1875 to 577,000 at the present time. This showed that in 1873 22 tons of water were raised to one ton of mineral, whereas in the year terminated June, 1898, 30 tons of water had been raised to one ton of mineral, which meant that the proportion of water per ton of coal was greater now than ever it was. When application was made for an electric power order by the Midland Electric Corporation for Power Distribution, Limited, a fresh element was introduced, which offered much promise if power could be obtained on rental almost anywhere, the capital cost of which would be borne by the company referred to, and the power supplied where required at a very low price per Board of Trade unit. Upwards of 50 sites have been located where automatic electric centrifugal pumps could be placed so as to drain 2,250 acres, which it is practicable to extend to 3,000 acres, from which 3,000 acres it is estimated that two-thirds of the rainfall, equalling on an average 3,600,000 gallons of water per day, are passing into the mines. This would form a new and most valuable means of draining the low-lying areas. Much of this water when caught on the surface would only require raising some 15ft., whereas when it escapes below the surface it is next met with, and has to be raised from depths of 400ft. to 600ft. Fifty electrical pumps raising half a million gallons per day (1½ pump horse-power each) would equal 25,000,000 gallons per day. This apparently excessive power is proposed to be installed to meet heavy storms, and more particularly rapid thaws during the time

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the earth is covered with a thick layer of snow. If the pumps dealt with 3 000,000 gallons per day on the average of the year, which it is estimated might be caught by the additional surface drainage above referred to, it would mean that they would only have to work one-eighth part of their time, or less than one day per week. The cost of the electric energy, calculated at 1½d. per Board of Trade unit, would be £670 per annum, after allowing 50 per cent. for loss in the current and slip in the pump, which is only £100 more than is at present expended on surface pumping. To this cost would have to be added wear and tear, stores, and the attention of, say, two men. The cost of carrying out the work or making the catch reservoirs and the courses leading to them in order to drain 3,000 acres, and also making the channels for conveying the pumped water into the nearest stream or canal, together with their side branches, would be about £10,000. Fifty electrical pumps, installed in brick or iron houses, powerful enough to raise 500,000 gallons each per day to an average height of 15ft., equalling 1½ pump horse-power each, would cost (including the wires for delivering the electric current from the company's mains) £200 each, making a total to be expended on surface works of £20,000. The engineering scheme of 1895 was based on the expectation that when certain points were reached with the underground levels large areas of coal would be unwatered, and that it would not be necessary to extend the hydraulic power distribution pipes more than over a length of about 10 miles. That this expectation has not been realised, nor that it is likely to be realised, is very clearly shown by the fact that the extension of the north level from the Bradley pumping engine through Hawkins's engine pit to the Bradley Lodge pit, and onwards to the Moxley old engine pit, has not had the effect of draining mines except within a very limited area of those pits, although 1,000 yards has been recently driven, and has reached the very heart of the old Bilston district, where the height of the water was found to be 102ft. above the floor of the underground level, giving a pressure of 45lb. to the square inch. The attempt to form a scheme on the basis of bringing the water to the pumps (no doubt, if feasible, the most economical way) must, under the present circumstances, be modified—the alternative which is to increase the number of pumps and take them to the water becomes practicable, if the reduction of water by means of the surface pumping can be effected. The proposal is to deal with the water in the various sub-divided pounds, which are evidently more numerous than was anticipated, by installing a number, say six, semi-portable compound Bull condensing engines (34 pump horse-power), capable of raising 400,000 gallons per day from an average depth of 400ft., erected in a girder-work frame over the shaft, and worked with high-pressure boilers under the most economical conditions. Such an engine has been specially designed to meet the purpose by Mr. Henry Davey, consulting engineer. Plans have also been prepared as an alternative of a direct action compound pump, suspended on double lengths of wrought-iron rods in the shaft, and raised or lowered by means of lifting tackle on the bank to the level of the water in the pit; the steam to be conveyed to the pump from high-pressure boilers on the surface. The present five pumping engines—Bradley, Moat, Stow Heath, Deepfields, and Rough Hay—would still be kept at work, but the quantity that each would have to pump would be so reduced that the gross expenses, although proportionately increased by the greater number of plants employed, might still be kept down to the working cost of the present engines at the present time. The total estimated cost of working the present five engines and the six new semi-portable engines would be £11,100. It is estimated that, proceeding on this principle, £60,000 might carry out the underground scheme, including the £7 000 already received for underground level driving, and £5,000 used for parliamentary and legal expenses. The Public Works Loan Commissioners might be asked to lend £20,000 to the surface drainage on the understanding that £60,000 only would be required for the Tipton engineering scheme, instead of the £100,000 mentioned in the mortgage. As regards the positioning of the six semi-portable engines, arrangements would have to be made with the proprietors of mines that they would start working the mines as soon as one or more of the semi-portable engines had effected a clearance of the water in the pounds concerned. If the water to be pumped were reduced to a 6,000,000 gallons basis, such engines as Stow Heath and Rough Hay, which now merely act in preventing overflow to adjoining pounds, and do little or no draining on their own account, would be able to lower the water in their own pounds so that mining could take place there. The reduction in the water to be pumped would also prevent the auxiliary engines at Gospel Oak and the Moat being worked. Owing to the difficulty of connecting surrounding pits with the levels recently driven, and also to increased pound room in the event of the stoppage of the Bradley engine, it appears to be quite practicable for the Commissioners to make arrangements with the mineowners that they would give them a strip of coal in the bottom coal-holer's seam in the Bilston district 40 yards wide, and the Commissioners might work this coal by means of gob roads to adjoining pit shafts now waterlogged, one of the roads to be specially cogged so as in future to act as a drainage level. The practicability of the scheme as a whole, and the possibility of its being carried out, entirely depends upon whether electrical energy is forthcoming within a reasonable time. The Midland Electric Corporation for Power Distribution, Limited, gave notice to 18 local authorities, all of which were in the South Staffordshire mines drainage area, of their intention to apply to the Board of Trade for an order to supply electrical energy for lighting and power purposes. The opposition which the company received has been removed so far as 12 of the local authorities are concerned, 11 of which practically form the whole of the Tipton district mines drainage area, and the Act has received the Royal assent this session. At what date electricity will be supplied by the power company must depend to a great extent upon how the matter is taken up by the manufacturers of the district.

It was resolved to have the report printed, and to discuss the scheme at a future meeting.

LEGAL INTELLIGENCE.

COMPANY PROSECUTION.

The Hampstead Electric Supply Company, Limited, of 64, Victoria-street, S.W., were summoned at Westminster by Walter Cope, on behalf of the Companies' Guardian Society, Limited, 9, St. Mildred's-court, Poultry, E.C., for having, on various specified dates, refused inspection of their register of shareholders during business hours, the legal charge for such inspection being tendered.

Mr. T. D. Dutton, who appeared for the complainant company, stated that their object was to supply information to subscribers, and protect the public against fraudulent companies. That was their main object. With a desire to obtain information as to the Hampstead Electric Supply Company, which was registered in July, and for which a public subscription was taken at the end of that month, an agent of the complainant company called at the registered office of the defendants on various dates in August and demanded an inspection of the register, tendering 1s. on each occasion. Every time application was made excuses were advanced, and the register could never be seen, although since the summons had been issued and served notification had been received inviting inspection of a register. This was found to be incomplete in important particulars.

Evidence was given by **Walter Cope** on behalf of the complainant company, who bore out what Mr. Dutton had said as to the failure of witness to obtain an inspection of the register. On one or two occasions he saw the secretary, Mr. Goffin, who informed him that the register was not made up, the allotments not being completed. Mr. Goffin added that as soon as the allotment was completed intimation of the fact would be given.

Mr. Edmunds, for the defence, contended, on the authority of a case, that the refusal to allow inspection must be distinct and definite.

Mr. Shell said there was plenty of evidence of refusal, and if excuses of that sort were allowed the register might never be completed.

Mr. Edmunds then submitted that the case was one in which there were extenuating circumstances, as the secretary had sustained a severe domestic bereavement.

Mr. Shell said the company was registered in July, and certainly the register ought to have been completed within a month. He should take no excuse for the neglect that had been shown, for the protection of the public demanded that the provisions of the Companies' Acts should be most rigidly adhered to. He imposed a fine of £10, and, as it was a very proper prosecution, should allow £5. 5s. costs.—*Daily Telegraph.*

TELEPHONE AND THEATRICAL VENTURES.

The first meeting of creditors was held recently at the London Bankruptcy Court under the failure of A. Gerald Duncombe, Queen's Anne's-mansions, Westminster, and formerly of Woodstock, Uttoxeter, gentleman. The debtor in March, 1898, accepted two bills for £1,000 each, the proceeds of which were to be invested in the Randall Telephone Patents Enterprise. The Randall Telephone Company, Limited, was to be formed to take over the patents, and on completion of the contract the debtor was to receive £2,000 cash, £250 debentures, and £3,000 in fully paid-up shares. The company has not yet been floated, and to his liability on the bills given by him last March the debtor partly attributes his appearance at the court.

Mr. Hasties appeared for the debtor, and no offer being submitted, the creditors passed resolutions for the estate to be administered in bankruptcy, and for Mr. F. S. Salaman, C.A., Bucklersbury, E.C., to act as trustee, with the assistance of a committee of inspection.

SWANSEA TRAMWAYS DISPUTE.

A Board of Trade arbitration case was commenced at the Swansea Guildhall, on Saturday, before Major-General Hutchinson, the referee appointed by the Board of Trade in accordance with an order of Mr. Justice Phillimore for the purpose of settling a dispute with the Swansea Corporation and the British Electric Traction Company—which has purchased the Swansea tramways—as to the right of the Corporation to stipulate conditions before allowing extra passing places to be made on the system, or the present ones to be continued. The company in relaying the line in order to adapt it to electric traction found it necessary to make more passing places, and the Corporation, taking advantage of powers under the Act, refused to allow this unless the company agreed to carry out certain street widenings which the tramway company undertook to effect on condition that it was given the powers which the traction company has just acquired.

Mr. S. T. Evans, M.P., appeared for the Corporation, and Mr Arthur Powell for the electric traction company. Amongst those

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present were the Mayor (Mr. Aeron Thomas), Messrs. Wood (Liverpool) and Lynde (Manchester), experts for the Corporation; Messrs. Kincaid, Sellon, and Scott Russell, experts for the electric traction company; a number of members of the Corporation, directors of the traction company, and several officials.

Before the proceedings commenced it was noticed that the two sides were in consultation, and rumours of a settlement at once arose. On the arbitrator opening the proceedings there was little surprise when **Mr. S. T. Evans**, addressing the arbitrator, said if he would kindly grant an adjournment to a date to be fixed, he thought it was quite possible that the differences might then have disappeared, and, subject to the arbitrator's sanction, it had been agreed by both parties that the enquiry should be adjourned till Oct. 20 to the Surveyors' Institute, London.

Mr. Powell: I assent entirely to that course.

The **Arbitrator** agreed, and the arbitration was thus abruptly adjourned.

The sub-committee of the Corporation declines to reveal at the present stage the terms of the suggested compromise, but it is understood that before it can be definitely arrived at a special meeting of the Council will have to be held.

IMPORTANT TO ELECTRICIANS.

In the Westminster County Court, on Friday last, his Honour Judge Lumley Smith, Q.C., had before him the case of Lambert *v.* the Electric Light Company, in which a question of some importance to electricians was decided.

The plaintiff is a builder, and he sued the Electric Light Company to recover payment in respect of certain work carried out at the house of a Miss Goodrich, in Brook-street, Grosvenor-square, and which, it was alleged, was rendered necessary to make good certain parts of the wall which had been cut by the defendants in the course of fixing an electric installation.

For the defence it was contended that the defendants were in no way liable for the work, and that if Miss Goodrich had been applied to she would have paid it without any question.

The defendants' **Foreman** was called, and said he never gave the order for the work in question, but had he known that the plaintiff looked to him for payment he would have added the amount to his bill for the lighting, and would have got the money without trouble.

His **Honour** said he did not think the plaintiff had made out his case, and gave judgment for the defendant, each party to pay their own costs.

COMPANIES' MEETINGS AND REPORTS.

WIRELESS TELEGRAPHIC AND SIGNAL COMPANY.

Mr. Henry Jameson Davis, presiding last week at the ordinary general meeting of this Company, in moving the adoption of the report and accounts, said that when the Company was started Mr. Marconi happened to be in Italy making experiments at the request of the Italian Government and other officials. He then gave a detailed account of what had been done since. Recently they had erected an installation for Lloyd's between Ballycastle and Rathlin Island. They had been asked to put this installation up so that the system might be thoroughly tested. They were endeavouring to enter into a contract with Lloyd's. He thought that there was no doubt that the wireless system of telegraphy would be of great advantage to naval authorities and the mercantile marine, lighthouses and lightships, and that in the course of time the Admiralty was bound to adopt the system. He had had a telegram that day asking him if it were true that the General Post Office had tried to stop the further operations of the Company. So far from that being the case, they had actually been requested by the Post Office to put up an installation between Guernsey and Sark, the post offices at each end to be placed at their disposal. That matter was occupying their attention at the present moment. They also desired to work the system in France, and they now intended to put up a station between Calais and Dover. They had asked permission for the privilege some time ago from the French Government, and that Government had replied that the Company might put up a station anywhere on the northern coast of France except at Cherbourg. He concluded by stating that out of 29 applications for patents in foreign countries 22 had been granted.

Mr. J. F. Bannatyne seconded the motion, which was adopted.

An extraordinary general meeting followed, at which it was resolved to increase the capital from £100,000 to £200,000.

The **Chairman** explained that this addition to their capital was for the purpose of enabling them to manufacture their own instruments, by which their trade secrets would be kept in their own possession.

A vote of thanks to the chairman concluded the proceedings.

HAWAIIAN TRAMWAYS COMPANY, LIMITED.

The eleventh ordinary general meeting was held on the 11th inst. at the Cannon-street Hotel, Colonel C. M. Davidson presiding.

In moving the adoption of the report, the **Chairman** stated that lately a tramway company to use mechanical traction, called the Rapid Transit Company, in direct competition with this Company, had been sanctioned by the Hawaiian Legislature. The directors opposed this Bill, and presented one on behalf of the Company to extend their line and use electricity. Simply because they were an English company, however, their Bill was shelved. When they endeavoured to obtain capital in Honolulu to adopt electric power, which was wanted by the people there, they could not obtain a cent. While mechanical traction was in its experimental stage, the directors did not consider it advisable to recommend the shareholders to subscribe the capital to make an alteration, which at that time had a doubtful future. Now that the installation was much less expensive, and that cars could be bought to suit their light rails, the case was different; but they were met by opposition. The English company, which had spent £95,000 in constructing the tramway, and which had run the industry at very small profits for nearly 10 years, was not to be allowed to make the alteration, but the concession must be handed over to a new local company. That was what the Hawaiians said. The directors, however, maintained that the right conferred upon the Company to use electricity had never lapsed, and they had perfect confidence in the integrity of the Government of the United States of American to confirm and uphold the rights of English investors in the Hawaiian Islands, which had recently been annexed to that great country. They had, therefore, begun to carry out an electric installation from Palama towards the town, and should this prove successful, they might have to ask the shareholders to help them to continue the alteration.

The report was adopted, and a dividend of 2½ per cent. was declared. Mr. Charles Fricker was elected a director.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Ghent (Belgium).—The Corporation are advertising for tenders for public and private electric lighting on Oct. 27 and 29 respectively.

Paris.—Tenders are invited for 40,000 kilos. copper wire, in two lots. Particulars are to be obtained from and tenders addressed to Post and Telegraph Department by Oct. 27.

South Shields.—The Corporation are inviting tenders for the supply and erection of (1) vertical triple-expansion engine, 800 to 1,000 i.h.p., with surface condenser; (2) alternator, iron-clad or inductor type, 400 or 500 kw. Tenders by Oct. 19.

Knowle.—Tenders are invited for the supply and fixing of two engines and dynamos, equal to an output of 24,000 watts each, etc., for the County Lunatic Asylum, Knowle, near Fareham. Tenders by Nov. 10. Further particulars appear in our advertising columns.

Johannesburg.—Tenders for the supply of electrical plant, comprising engines, boilers, dynamos, condensing engines, etc., have been called for by the Johannesburg Town Council. Tenders are to be forwarded to the secretary, Mr. M. Adolfs, on or before the 28th inst.

Wakefield.—Tenders are invited for the various works necessary for a complete installation of electric lighting at the Wakefield Mechanics' Institution. Plans, specifications, and conditions may be seen at the Library. Tenders, marked "Electric Lighting," must be delivered at the Institution by 17th inst., addressed to Mr. G. F. Nurse, hon. secretary.

Bury (Lancs.).—The Corporation invite tenders for the wiring of the public baths, St. Marie's-place, Bury. Specification and form of tender may be obtained on application to the Borough Engineer, Bank-street, Bury, on payment of 10s. 6d. Sealed tenders, endorsed "Wiring at Baths," to be delivered at the office of Mr. John Haslam, town clerk, Bank-street, Bury, by 26th inst.

Halifax.—The Guardians invite tenders for supplying and fixing at the new union hospital, Skircoat, Halifax, about 85 small electrical ventilating fans. Specifications and particulars can be obtained from Messrs. Shepherd and Watney, consulting engineers, 71, Albion-street, Leeds. Tenders to Mr. A. T. Longbotham, clerk, 4, Carlton-street, Halifax, in sealed envelope, endorsed "Electrical Fans," by 9 a.m. on 25th inst.

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of transformers and accessories. Specification, form of tender, and general conditions can be obtained at the offices of Mr. A. H. Preece, A.M.I.C.E., 29, Victoria street, S.W. Tenders, sealed and endorsed "Tender for Transformers," must be delivered at the office of Mr. W. H. Whitfield, clerk, Council Offices, Wimbledon, by 5 p.m. on Nov. 7.

Warsaw.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Warsaw, stating that the Municipal Council of that city invite tenders for the exploitation of the tramways of Warsaw under municipal control. Horse traction is at present in use, but it is intended to introduce electricity as soon as possible. Information as to the conditions can be obtained from the Magistrat de la Ville de Varsovie, Varsovie, Russia.

Potteries (Staffs.).—The British Electric Traction Company, Limited, Donington House, Norfolk-street, London, W.C., invite tenders for the overhead construction of the Potteries extension tramways. Specifications, quantities, and plans may be obtained from Mr. C. H. Gadsby, contract engineer, at the above address on payment of £5 per set. Sealed tenders, addressed to the Secretary of the Company, marked "Tender for Overhead Construction of Potteries Extension Tramways," must be delivered at above address by noon on 22nd inst.

London, W.—Tenders are invited by the Great Western Railway Company for the supply of the following, among other stores:

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indiarubber goods, telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, and incandescent electric lamps. Samples and patterns may be seen at Swindon from 12th to 21st inst. on application at the office of the Stores Superintendent, Swindon, where specifications and forms of tender may be obtained. Tenders by 24th inst.

Bangor.—Tenders are invited by the Corporation for erection of buildings, chimney shaft, etc., for its electric lighting station. Plans and specification may be inspected at the offices of Mr. John Gill, A.M.I.C.E., borough surveyor, and at the offices of Mr. F. Hastings Medhurst, B.Sc., M.I.E.E., the consulting engineer to the Corporation, Westminster-chambers, 13, Victoria-street, S.W., from the latter of whom the bill of quantities can be obtained on payment of a deposit of £5. 5s., which will be returned on receipt of a bona fide tender. Tenders by Oct. 15.

St. Helens (Lancs.).—The Corporation invite tenders for the supply and erection of boiler-house plant in connection with their new electric lighting and traction works, including Lancashire boilers and accessories, superheater, economiser, feed pumps, injector, and steam and water pipes. Specification, terms, conditions, and forms of tender may be obtained at the office of Mr. J. S. Highfield, electrical engineer, Electricity Works, Warrington Old-road, St. Helens, on payment of £5. Tenders, addressed to the Chairman, Electrical Committee, Town Hall, St. Helens, endorsed "Boiler-House Plant," by 19th inst.

Hull.—Tenders are invited by the Electric Lighting Committee for the supply and erection of certain plant in connection with their electric lighting works. Forms of tender and specifications for the following are now ready: (Contract 4) high and low tension mains, casings, trenchwork, etc.; (5) switchboards, continuous-current rotary transformers, motor-generator, etc.; (6) centrifugal pump, condenser (ejector type), steam-pipes, etc. Specifications for any one of the above three contracts may be obtained from Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Cheques or postal orders to be made payable to Thos. Geo. Milner, city treasurer. Tenders, endorsed respectively "Tender for Mains," "Tender for Transformers," "Tender for Steam-Pipes," to be delivered to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on Oct. 27.

RESULTS OF TENDERS.

Maritius.—The contract for the electric lighting of Port Louis has been placed with the Birmingham Installation Company, the estimated cost being £75,000.

Whitehaven.—The Whitehaven Harbour Commissioners have accepted the tender of the Corporation for electrically lighting the harbour, including the quays, workshops, and offices.

Hammersmith.—The Electric Lighting Committee have received the following tenders for the construction of the temporary engine house: Mr. R. M. Heywood, £115 (accepted); Mr. Henry Wright, £137; Messrs. G. Wimpey and Co., £147.

West Hartlepool.—The Town Council have accepted the tender of the Horsfall Furnace Syndicate, Limited, Athenæum-buildings, Park-lane, Leeds, for the erection of refuse destructor, boilers, etc., adjoining the electric lighting station, Burn-road.

Bloemfontein (S.A.).—The Town Council have accepted the tender of Messrs. Reunert and Lenz, of Johannesburg, for the installation of electric light. The total estimate is £16,500, out of which £1,000 is allocated for the provision of an engine-room.

Halifax.—The Council have accepted the following tenders: C. A. Parsons and Co., Newcastle, for the supply and erection of two steam turbine dynamos, with own surface condensers, £4,400. Supply of car trucks and electrical equipment as follows: British Thomson-Houston Company, Limited, £3,419. 16s. 9d.; Westinghouse Electric Company, £3,450. 4s.

Stanford-le-Hope.—The Parish Council have accepted the tender of Mr. Simpson to light the parish by 50 incandescent electric lamps of not less than 16 c.p. each, and lay down the necessary mains, erect works, lamp-posts, and machinery, and maintain lighting on the low-tension continuous system for six months from Oct. 1, 1898, to March 25, 1899, for £135.

Buxton.—The Urban District Council have accepted the following tenders: boilers, R. Hornsby and Sons, Grantham, £1,659; electrical plant, Mather and Platt, Limited, Manchester, £4,236; battery, Tudor Accumulator Company, £820; annual charge for maintenance, £52; switchboard, James White, Glasgow, £1,353; steam exhaust and other pipes, Jno. Spencer, Wednesbury, £950.

BUSINESS NOTES.

Buxton.—It is expected that the town will be lighted by the electric light next Midsummer.

Halesowen.—The Rural District Council have resolved to apply for an electric lighting provisional order.

Belfast.—The Police Board have recommended Mr. S. Edgar Fedden, of Edinburgh, for the post of electrical engineer.

West London Tramways.—The workmen have started on the road-bed of the Hounslow-to-Hammersmith electric tramway.

Slough.—The Urban District Council have instructed a committee to prepare a scheme for supplying the town with electric light.

Penzance.—The Town Council have adopted the committee's recommendation dissenting to a company's scheme for electric lighting.

Greenock.—Mr. S. Edgar Fedden, of the electrical engineer's office, Edinburgh, has been appointed electrical engineer to the Commissioners.

Durham.—The Council intend to apply for an electric lighting order, and a preliminary report is to be obtained from Mr. W. C. C. Hawtayne.

Paisley.—The agreement between Paisley and the Corporation of Glasgow as to construction of electric tramways within the burgh has been signed.

Romford.—The Urban District Council have decided to take immediate steps to obtain powers to supply electric light in the district for public and private purposes.

West Hartlepool.—It is stated that the cost of the electric lighting scheme will exceed the original estimate, and Prof. Kennedy has been requested to prepare fresh plans.

Catalogue.—We have received a price-list (fifth edition) giving details of the various articles manufactured and supplied by the Universal Electric Supply Company, of Moss Side, Manchester.

Indo-European Telegraph Company, Limited.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum, tax free, payable on Nov. 1.

Colchester.—It is intended to have a ceremonial inauguration of the establishment of the electric lighting works. The time proposed for the inaugural ceremony is a month after the oyster feast.

Elland.—A resolution that steps be taken to obtain a provisional order for electric lighting was proposed at the Urban District Council meeting last week, but was defeated by eight votes to three.

Carlisle.—The promoters of the Carlisle tramways scheme propose to adopt the electric overhead traction system for the tramways as the simplest and most effective of any form of electric traction in use.

Brierley Hill.—The Lighting Committee have arranged for a meeting with the Midland Electric Corporation for Power Distribution, in order to discuss the latter's object in applying for a provisional order.

Whitehaven.—The Harbour Commissioners have entered into a contract with the Whitehaven Corporation for the lighting of the harbour by electricity for five years. Current is to be charged by meter at 3d. per unit.

Newport.—The demand for the supply of electricity continues, and during the last month several orders for the light have been obtained, bringing the total number of lights supplied or on order to 20,021 lamps.

Isle of Man Tramways.—The directors have declared interim dividends for the half-year ended Sept. 30 at the rate of 6 per cent. per annum on the preference shares, and 7½ per cent. per annum on the ordinary shares.

Aston Manor.—An application from the Birmingham and Aston Tramways Company for the consent of the Urban District Council to the use of steam on the lines of the company running through the district has been refused.

Coventry.—The works for the new Coventry tramways are making good progress under the supervision of the company's resident engineer, Mr. C. F. Fielder-Smith, late of the Blackpool Corporation electricity works.

Driffield.—An electric lighting company is about to be formed in the town. It is stated that the Urban District Council, having just purchased the gasworks, a solid opposition to any scheme of electric lighting will be made.

Halifax.—The Tramways Committee have been authorised to carry out the work in connection with the erection of a tramway depôt on land at the junction of Shaw-hill and Free School-lane, at an estimated cost of £4,200.

Maidstone.—The Urban District Council have decided to purchase about two acres of land west of the Lock Meadows belonging to Lord Romney as the most suitable site for an electric lighting station and refuse destructor.

Canterbury.—The Town Council have entered into an agreement with the National Free Wiring Company. It appears that the works are making satisfactory progress, and the light will probably be in working order by Christmas.

Stafford.—The Gas and Electricity Committee have engaged Mr. Charles Hopkinson to complete the report as to the best means of extending the supply of electricity which the late Dr. Hopkinson had commenced as their consulting engineer.

Whitechapel.—The Electric Lighting Committee have asked the Vestry for power to expend a sum not exceeding £100 in relation to the investigation now being made by the committee upon the subject of electric lighting and destructors.

Newington.—The Vestry have entered into an agreement with the South London Electric Supply Corporation, Limited, for taking electrical energy until such time as the station in Penrose-street is opened, up to a maximum amount of 100 kw.

Grimsby.—At the last meeting of the Town Council notice was given that the portion referring to the tramways company should be rescinded from the minutes, the mover objecting to the extension of the lease to the company for a further period of 21 years.

Poplar.—A meeting of ratepayers has been held with a view to dissent from the resolution reported in our last issue referring to the action of the Electric Lighting Committee with regard to the

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purchase of property. A motion with the above object was rejected.

Buckley.—A special meeting of the Council will be held on Nov. 9 for the purpose of instructing the clerk to apply for a provisional order for electric lighting. Mr. Peers, of Deansgate, Manchester, has been appointed electrical engineer. There were six applications.

Willesden.—The Urban District Council have appointed Mr. E. T. Ruthven Murray, electrical engineer of the Worcester City Council, as their electrical engineer in connection with the proposed electric lighting scheme for Willesden, Kilburn, Kensal Green, and Harlesden.

West Bromwich.—The Electric Lighting Committee have decided to request the Town Council to empower them to employ an expert to advise them as to the best means of carrying out the lighting order, and to authorise them to obtain any requisite information for that purpose.

Perth.—Mr. W. C. C. Hawtayne, M I E.E, London, has been selected by the Electric Lighting Committee as the Commissioners' engineer in connection with the introduction of the electric light. The appointment has been deferred for further consideration and information by the Police Commission.

Leicester.—The Corporation have agreed to take over the Leicester Tramway Company's assets and liabilities, and to pay the company £129,500. On the 10th inst. an amendment was adopted to the effect that the undertaking should be purchased when it could be acquired compulsorily.

Swansea.—In consequence of the difficulties in acquiring the necessary additional land, the provision of a dust destructor has been deferred, and Mr. Manville has been requested to prepare amended plans and estimate of the cost of an electric lighting station only, on Corporation property in the Strand.

Tunbridge Wells.—At the last meeting of the Council the Electric Light Committee reported the gradual extension and improvement of the street lighting within the borough boundary. A discussion arose upon the question whether the lighting of Mount Ephraim was justified after the close of the season.

Northallerton.—The Urban District Council will at their next meeting consider a letter from Mr. John E. Hutton, Solberg, stating it was proposed to start electric light in the district of the Northallerton Urban Council, and applying for consent to erect the necessary works and make application to the Board of Trade.

Acton.—Prof. Ayrton is to be asked by the Urban District Council to furnish two separate reports—one upon the two reports presented by Messrs. Lacey and Trentham as to which report the Council should accept, and another making some general suggestions on the reports, and also on the best system of electric lighting for a place like Acton.

Northwich.—The Urban Council have instructed the electric supply company to fix an arc and an incandescent light as an experiment to test the efficiency of electricity compared with gas for street-lighting. Five miles of cable and 2,500 8-c.p. lamps have been installed within the last 12 months, and another 1,500 will be in use before Christmas.

Marylebone.—At the meeting of the Vestry yesterday evening a report was submitted by the Electric Lighting Committee, recommending that formal notice be given, on or before Nov. 1, to the Metropolitan Electric Supply Company, Limited, of the Vestry's intention to proceed for a provisional order for the public and private, or public or private, lighting of the parish by electricity.

Accrington.—At a special meeting of the General Purposes Committee of the Town Council to consider the proposal from a London syndicate to substitute electric traction for steam on the lines of the Accrington Corporation Tramways Company and to take over the concern, it was decided that whatever negotiations took place should be on behalf of the Corporation, and not of the syndicate.

Bacup.—The town clerk has received offers from three companies of the terms and conditions upon which they are prepared to carry out the electric lighting provisional order within the borough, and has made a report upon the question. The Town Council have agreed that it is desirable that the order should be transferred to a company to carry into operation providing suitable terms can be arranged.

Bury St. Edmunds.—The modified electric lighting scheme not having found favour with the Town Council, a resolution has now been adopted in favour of a deputation waiting upon the Local Government Board in the hope of obtaining their consent to the original scheme, which is estimated to involve an expenditure of £21,500, the cost of building being likely to be about £3,700, instead of £2,500, as first reckoned upon.

Manchester.—The new generating station for electricity which the Corporation are erecting near Philips Park, Bradford, Manchester, will supply electrical energy of 100,000 h.p., and the outlying districts of Moss Side, Withington, Levenshulme, Failsworth, Droylsden, and Heaton Norris have agreed to take their electrical supply from Manchester. The Whitfield District Council also have applied for terms.

Wigan.—The County and Borough Council have authorised the members of the Electric Lighting Committee to visit other towns where combined systems of electric lighting and electric traction have been adopted. The following resolution has also been carried: "That the time has arrived when this Council should very seriously and earnestly consider the advisability of acquiring the tramways in the interests of the ratepayers of this borough."

Liverpool.—The Town Council have approved of the supplementary estimate for the construction of the experimental line of tramways from St. George's Church to the Dingle at £35,000. It is stated that altogether out of the £85,000 which the committee considered it would cost to complete the line there is a sum of £36,561 for items which were not originally contemplated in the £50,000 which the committee first asked for the purpose.

Finchley.—At the last meeting of the Urban District Council the Highways Committee recommended that a special meeting of the Council should be summoned to consider the advisability of applying to the Board of Trade under the Electric Lighting Act, 1882, and to pass such resolutions thereon as might be deemed expedient for the purpose of obtaining a provisional order for the supply of electricity for public and private purposes. This was agreed to.

Hartlepool.—The Town Council have carried a resolution to the effect that application be made to the Board of Trade for a provisional order to empower the Corporation to supply electricity for all public and private purposes within the area of the borough, and have authorised the town clerk to take the necessary steps. The streets along which the distributing mains will be laid are Northgate, Middlegate, Brougham, and Durham streets, and Milbank crescent.

Sheffield.—The Health Committee have recommended the Council to make application to the Local Government Board for sanction to borrow the sum of £3,799, balance of amount required partly for the erection of a new refuse destructor at Penistone-road. The Tramways Committee's recommendation accepting the tender of Messrs. Scott, Anderson, and Beit for a combined engine and dynamo for lighting the power house at Kelham Island, at the price of £500, has been referred back for further consideration.

Brighton.—The General Purposes Committee's report, adopted by the Town Council at its last meeting, referred to the suggestion that the Council should consider the question of themselves constructing and maintaining a service of electric trams from the top of North-street to the Seven Dials, Dyke-road, and also a similar service from the centre of the town to the Queen's Park district, and recommended that the consideration of the matter should be deferred. Strong opinions were expressed against overhead wires.

Removals.—The Penny-in-the-Slot Electric Supply Syndicate, Limited, have removed to Bartholomew Works, end of Lawford-road, Kentish Town, N.W.—The British Blahnik Arc Light Company, Limited, have removed their showroom and testing-room from 50, Parliament-street, S.W., to their factory, Iliffe Works, Iliffe-street, Newington-butts, S.E.—Mr. Killingworth Hedges, C.E., M.I.C.E., has removed his electrical, testing, and experimental laboratory to 1, Emery Hill-street, Ashley-gardens, Victoria-street, Westminster, S.W.

Johnstone.—The Town Council have written to the British Electric Traction Company expressing regret at the failure of their efforts to extend the tramway to Johnstone, and urging them to spare no efforts for the attainment of this most desirable benefit for the people of Johnstone and district, at the same time requesting the British Electric Traction Company to use the motion in any appeal they may yet make in opposing the Bill promoted by the Glasgow Corporation for power to go to Paisley, to the exclusion of Johnstone and the districts.

Buenos Ayres and Belgrano Tramways Company.—At an extraordinary meeting of this Company, held at the offices, 52, Moorgate-street, last week, a resolution authorising the winding up of the concern was confirmed. It was stated that although only a small portion of the line was at the present time being run by electric instead of horse traction, it was hoped that in about six months a considerable part would be under the electric system. Moreover, it was expected that in about 18 months or two years the whole of the horse-traction system would cease to exist.

Leamington.—The Town Council at its last meeting discussed the proposal of the General Purposes Committee, that the offer of the Warwick Town Council for a joint conference on the subject of the placing of overhead wires in the streets for the purposes of electric tram traction should not be entertained. It was pointed out that if the Corporation agreed to meet the Town Council in the matter they would not in any way commit themselves to overhead wires, but merely to the discussion of what was regarded as a most important question. Finally the question was referred back to the committee.

Hampstead.—The Electric Lighting Committee has been empowered to take the necessary steps for obtaining tenders for supplying the requisite plant for the completion of the scheme. The same committee have under consideration whether a reserve fund should be formed in connection with the Vestry's electric lighting undertaking. The Vestry will take no further action towards joining other corporations in defending the action brought by Mr. Rucker in respect of the patents connected with electric lighting. Mains for the supply of electric current to private consumers in Denning-road and Parkhill-road are to be laid.

Kirkcaldy.—At the meeting of the Town Council on Tuesday, the electric lighting and tramway question was again under consideration. It was explained that the Light Railway Commissioners had considered the tramways scheme too much of an urban proposal to fall under their jurisdiction. It was agreed to apply for a special Act of Parliament for powers to construct the tramways, and to have a clause inserted giving the Council the option of handing over the construction and working of the tramways to a company. In connection with the proposal to acquire the gasworks, it was pointed out that the Council were statutorily debarred from taking up the matter for a year.

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Cardiff.—At a meeting of the Building Committee of the Guardians on Tuesday an estimate for the lighting of the workhouse was submitted by Mr. Stephens, architect, showing £2,850 initial expenditure for electricity to be generated on the premises, with a maintenance of £350 per annum, as compared with £450 per annum for Corporation supply, and £370 per annum for gas. A motion that electricity was preferable to gas, and asking the Board to allow an electrical expert to consult with the architect and committee and report on the point of Corporation supply or generation on the premises, was carried.

Walsall.—Upon the discussion of the estimates at the Town Council it was stated that the greater part of the general increase in expenditure was no doubt due to the gradual growth of the borough. The sum of £400 represented the loss on the electric lighting undertaking. A similar amount had previously been wiped off, there having been a gradual accumulation of loss on that undertaking of between £900 and £1,000, to reduce which the committee thought it only right some provision should be made in the rate. Now that the department was getting into better working order, their position would probably show a material improvement by the end of the next half year.

The Edison-Swan Shade Lists.—The Edison-Swan United Electric Light Company have sent us a series of leaflets illustrating the fancy shades stocked by the company. The illustrations are coloured with the same tints as the shades, which is a somewhat new departure. The difficulty which arises in this respect is the different tints seen by transmitted and reflected light. Thus a shade which looks hideous when examined by daylight may give most pleasing effects when surrounding an incandescent lamp. In the present case the attempt is made to represent the shades as they appear in use. The combination of etching and variously-tinted glass in many of the shades illustrated is most artistic.

Wiring Contracts.—The order for the electric lighting of the Chatsworth-road Baptist Chapel, Tulse Hill, has been placed in the hands of the National Electric Free Wiring Company, Limited, who have just completed the lighting of the York-road Congregational Chapel, York-road, S E. This firm have also been entrusted with the complete electric light wiring and fitting of the new offices of the South London Electric Supply Corporation, Limited, in Coldharbour-lane, S.E. This company is also now prepared, in addition to the free-wiring system, to carry out complete electric light wiring and fitting on the hire-purchase system for periodical payments arranged to suit the consumer.

Micanite.—We have recently had the opportunity of examining some samples of the standard micanite articles now being stocked by Mr. Bergtheil, of 12, Camomile-street, E.C. The use of micanite instead of mica for placing between adjacent commutator strips is determined largely by the size of the segments. With large commutators it is cheaper and quite as good. Flat strips for such purposes are not stocked in regular sizes. It is, however, in the insulation of the ends of the commutators that micanite has the greatest advantage. For this purpose the sheet material is moulded under pressure and heated at the same time. The results are wonderful, both from an electrical and mechanical point of view.

Hyde (Manchester).—No terms have been arranged for a contribution towards the cost from the Oldham, Ashton, and Hyde Electric Tramway Company, whose lines cross the bridge, but the Cheshire County Council have made an offer subject to the tramway company fulfilling their promise to give £300. The tramway company, it was said, at this week's Town Council meeting, were laying cables under the footpaths in the borough in defiance of the Corporation, and although counsel's opinion had been taken, the Highways Committee did not deem it advisable at present to take severe steps against the company. If nothing could be arranged, the Corporation could stop the current at any time they thought proper.

Ludlow.—At the last meeting of the Town Council the report of the Public Lighting Committee was presented, and stated that, with regard to applying to the Board of Trade for a provisional order to authorise the Corporation to supply electricity for public and private purposes within the borough, certain data should be gone into before the various papers were drawn up and submitted to the Council. The capital proposed to be expended in connection with the undertaking was £6,500. Mr. Marston, who moved the adoption of the report, said they could borrow the money for 30 years, and the sum for repaying the principal would be either £325. 7s. 8d. or £353 8s. 9d., which was less than they were at present paying the local gas company. The report was adopted.

Birkenhead.—The minutes of the Parliamentary Committee, which were passed at this week's meeting of the Town Council, recommended the Council to obtain a Bill rather than a provisional order for providing electric tramways on the overhead trolley system. The committee stated they had also decided to run a line from Park Station through Ashville-road, which would put the station in direct communication with Claughton. To make the Argyle-street South line would cost over £12,000. Although the cost of a Bill might be more than that of a provisional order, they hoped it would in the end effect a saving on account of the additional powers which a Bill would give them. Owing to the tramway companies' leases the Corporation must get the powers of a Bill or wait until the end of the leases.

Sunderland.—We regret to hear that a large concentric cable broke down on Sunday evening last, which necessitated the discontinuance of the direct-current supply for about two hours. An attempt was made to clear the fault by "burning out," but this was unsuccesseful. On examination it was found that a length of some 50 yards had been burnt out, so it will be evident that the short was a bad one, starting in one place and spreading backwards. Strangely, no intimation was given at the station beforehand, during all Sunday afternoon the station ammeters standing at zero. This is the first case of interruption of supply in 3½ years, excepting the Havelock House fire, but is none the less regrettable. The alternating-current supply to the residential district was not affected.

Presentation.—On Saturday last, Mr. E P. Grove, the resident engineer for the British Thomson-Houston Company, who laid down the electrical installation for the Middlesbrough, Stockton, and Thornaby tramways, was presented in the Palatine Hotel, Stockton, with a handsome testimonial from the staff and workmen of the British Thomson-Houston Company. The presentation, which was subscribed for by the staff and friends in Stockton and Middlesbrough, consisted of a very handsome silver tea and coffee service, inscribed as follows: "Middlesbrough, Thornaby, and Stockton Electric Tramways. Presented to E. P. Grove, Esq., by the workmen and staff of the British Thomson-Houston Company, Limited, on the completion of the above plant, Oct. 1, 1898."

Ilkeston.—At the last meeting of the Town Council the report of the Electricity Committee stated that sanction had been given by the Duke of Rutland and other property owners for the tramway to go through Thurman-street and across some of the Duke's land into Corporation-road, which is a direct line to Hallam Fields, instead of having to go through the narrow Little Hallam-lane. The number of streets to be included in the electric lighting order has been reduced to five, as the streets mentioned in the order were obliged to have an underground cable laid for private consumers within two years of the passing of the order. It was explained that the street lamps in other parts of the town would be lighted from the overhead wires, but private consumers could only be supplied from the underground cable.

Bradford.—At the meeting of the Tramways Committee of the Corporation last week, the proposal of the Leeds Corporation to extend their tramway system to the Bradford city boundary at Thornbury was discussed. The laying down of such a line by a private syndicate was recently prevented by the united opposition of the two Corporations. The Bradford committee decided to recommend the Corporation to lay a counter application before Parliament for the construction of a line from Bradford to Stanningley, subject to the consent of the various local authorities being obtained. It was also agreed by the committee to give orders for the construction of 12 new cars, to provide for increased traffic on the Bolton and Great Horton sections, in connection with the football and cricket matches at Park-avenue and the galas at Peel Park.

Stockton.—The Electric Lighting Committee have informed the Brush Electrical Engineering Company that the sanction of the Local Government Board had been obtained for the loan required for the electric light installation, and that their tender, as amended and improved, was accepted subject to a formal contract being signed—the position of the site being reserved for the decision of the Corporation—the contractor's schedule of prices to apply in the case of either site. The Imperial Tramway Company propose at the next meeting to apply to the Light Railway Commissioners to authorise extensions of their system to the east of their present system through North Ormesby and South Bank to a point on the Eston-road, at Grangetown; in Middlesbrough, south to Grove Hill; and in Stockton, westward along Yarm-road to Eaglescliffe Station.

Dudley.—A committee of the Sedgley District Council and the representatives of the directors of the Dudley, Sedgley, and Wolverhampton Tramway have been considering what steps could be taken to improve the present very unsatisfactory tramway service between Dudley and Wolverhampton, and have adopted a resolution to the effect that, the period during which the tramway company was authorised to run having expired, and pending any fresh license or consent, if any, the company should discontinue the half-hourly and run a hourly service, and, further, that the Council, failing immediate compliance by the directors with this request, instruct their clerk to take all necessary steps to stop the tramway company from running. A sub-committee has been appointed to meet the representative of the Board of Trade with reference to the renewal of the license.

East Barnet Valley.—The Urban District Council having considered a letter from the Finchley District Council informing them of the decision arrived at at the Westminster conference with regard to the proposals of the North London Electric Lighting Company, and stating that it had been left with the Finchley Council to call a meeting of the representatives of those councils favourable to combination, the clerk has been instructed to reply "that the Council have no suggestions to make, but if a further meeting is convened they will send representatives." With regard to a proposal of the Electrical Power Distribution Company, the Council do not entertain the idea of adopting their proposals. With regard to the Council's own application for a provisional electric lighting order, the clerk has been instructed "to report on the cost of the application, and to call a special meeting to deal with the matter if necessary."

Glasgow.—The sub-committee appointed by the Police Board to consider the future working of the tramways between Port Glasgow, Greenock, and Gourock have had a conference with the authorities concerning the feeling expressed at the meeting, that when the present lease expired the cars should be worked by electricity. It was stated that if it was decided to work the cars by that power, the tramway company were in a position to provide the money for the erection of the electrical machinery. It was also suggested that it would be a considerable source of revenue

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to Greenock if the works were fitted by the Corporation, and worked in unison with the authorities in Port Glasgow and Gourock. Money could be borrowed much cheaper on the security of the Greenock rates than on the security of a private company. The conference adjourned until the Port Glasgow authorities, who were unable to be present owing to the recent death of their town clerk, were in a position to take part in the discussion — The Springburn route of the Glasgow Corporation tramway system has now been equipped with overhead wires for the propulsion of cars by electricity.

South Africa.—We are indebted to the *British and South African Export Gazette* for the following particulars: An order for the electric lighting installation for the Pretoria Theatre has been placed with an American firm. The Johannesburg Town Council having been empowered to raise by a debenture issue the sum of £150,000 for electric lighting purposes, two-thirds of which sum will be devoted to the purchase of new machinery, street extensions, and other works, opportunity for the securing of some valuable orders should be afforded. A company, with a capital of £5,000, has been formed at Ladysmith, Natal, for the purpose of promoting the electric lighting of the town. The scheme comprises, for a beginning, a boiler, steam dynamo, pump, switchboard, four storage tanks of 2 000 gallons each, 860 lamps of 16 c.p., etc., of an estimated cost with the building, of £3,500. The electric lighting and tramway installations for East London and the electric lighting of the Grahamstown exhibition, besides the installation of an electric equipment of a large building in Johannesburg, and the electric plant for the Bank of Africa's branch at Lourenço Marques, are being carried out by Messrs. Reunert and Lenz, of Johannesburg.

Middlesbrough.—At the meeting of the Town Council on Tuesday last an amendment to refer back in favour of the earlier scheme—the larger electric lighting proposal—recommended by the Electric Lighting Committee, was defeated, and it was decided to adopt the larger scheme and to apply to the Local Government Board for sanction to borrow £36,000 for 30 years. The area included in the Corporation's electric lighting scheme covers the whole of Middlesbrough. The estimated cost of the scheme for the smaller area was £25,000, but in the larger scheme adopted the cost amounted to £35,000 Under the larger scheme the cost of manufacture per unit would be very much less. Mr. Hammond suggested that they should put down in a building 120ft by 170ft. one triple-expansion engine of 500 h.p. and a small engine with 250 accumulators, to supply 10,000 lights each, leaving accommodation to provide a second engine, which would probably be required in a few years. This arrangement would enable them to stop the large engine at 10.30 p.m. and supply the lights of the town from then until four o'clock in the morning with the accumulators. Mr. Hammond has stated that the plant will be so arranged as to be adaptable for either lighting or motor power.

Plumstead.—The first meeting of the new Electric Supply Committee of the Vestry was held recently, when Mr. J. J. Clark was elected chairman and Mr. W. Coton vice-chairman. It was resolved that a draft provisional order for electric lighting and power be prepared, with the necessary schedules, and printed, that a memorial to the Board of Trade be prepared and printed, and that the proposed area of supply be the parish of Plumstead. The streets in which it is proposed that electric lines shall be laid down within two years after the commencement of the order are High street (to Wickham-lane), Griffin-road, Plumstead-road, Eton-road, Burrage road, Plumstead Common-road (from Herbert-road to Ennis-road), and Herbert-road. The committee further resolved that the sum to be stated in the statement accompanying the memorial as proposed to be expended should be £30,000, that advertisements be issued of the application by the Vestry in the local papers and the *London Gazette*, and that such advertisements be deposited at the Board of Trade and with the clerk of the peace on or before Nov. 30. It was also decided to visit the electric light works of St. Pancras, Shoreditch, and Leyton, and such others as may be considered necessary. The report was adopted.

Lewisham.—At the meeting of the District Board the Works Committee reported that they had considered the notice given to the Board by the Blackheath and Greenwich District Electric Lighting Company, Limited, of their intention to lay electric mains from the boundary of their parish next Greenwich, along Lewisham-road, Lewisham-hill, and Aberdeen-terrace, Haddo villas, Eliot-vale, and Eliot-place, Blackheath. The surveyor recommended that from the bottom of Lewisham-hill to Walerand-road the mains should be laid in the footpaths, and in the other streets in the roadways, and on those and the usual conditions as to reinstatement of roads, etc., the committee recommended the approval of the works subject to the consent of the London County Council being obtained, to which the Board agreed. The committee also reported consideration of a letter from the company, stating that they had purchased the site for their generating station, and placed contracts for the erection of works and laying of mains, and, referring to the agreement as to price for public lamps, asking how many lamps the Board would wish lighted, and in what position they would wish to place them. On the recommendation of the committee it was decided that the company should be informed that the Board did not at present wish to make any provision for lighting the public lamps in that part of the district by electricity.

Ayr.—The electricity supply works have now been in operation for two years, and extensions on a large scale have recently been made, and are partly in use. The original installation was for 225 kw., giving a total light equal to 7,650 8-c.p. lamps, and the works cost £25,000. The additional plant, which has been laid down at a further cost of £15,000, nearly trebles the means of production, the amount of light the combined plant is capable of producing being equal to 20,000 8-c.p. lamps. The producing capacity of the works is now such that they are likely to be sufficient to meet the demand for a number of years. Several miles of streets have been lighted with arc lamps, and many of the shops are lighted both by arc lamps and incandescent lamps, and many private houses are also lighted on the incandescent system, while all new houses where the cables are available are being fitted up solely with the electric light. The length of cable laid down already extends to eight miles, and the Corporation have entered into a contract to light the harbour and dock with 15 arc lamps. This will bring up the total arc lamps within the burgh to 105, and it is intended to further increase the number, one of the most important extensions being to the esplanade along the seashore, on which it is proposed to fit up 18 arc lamps. According to the *Scotsman*, to which paper we are indebted for the above, when the system is fully in operation Ayr will probably be the best lighted town in Scotland.

Bangor.—Mr. W. O. E. Meade-King, Local Government Board inspector, held an enquiry on the 12th inst. into the application of the City Council for sanction to borrow the sum of £13,500 for carrying out the electric light scheme, and £650 for the purchase of land as site for the yards, and for the purposes of a storeyard.—According to a report of a joint meeting of the Sanitary and Lighting Committees on the question of erecting a refuse destructor, presented to the City Council last week, the borough surveyor estimated that the disposal of the town refuse on a new site at Glanadda would be £195 annually. The cost of a two-cell refuse destructor would be £3,000, and the annual expenses of working it £210. The erection of a destructor on the present refuse depôt site would not be free from objection from a sanitary standpoint. The committee recommended that a destructor be erected in conjunction with the electric light works, and that plans for a two cell destructor be prepared. After a prolonged discussion the matter was deferred for a month. A committee was appointed to visit two or three towns where destructors were in use. The gas manager reported that during the four weeks ended Aug. 20 1,931,300 cubic feet of gas had been manufactured, an increase of 168,300 cubic feet on the corresponding period last year. The Lighting Committee reported that 66 tenders had been received for electric light plant, and it was resolved to forward them to the electrical engineer, and that he should make recommendations for the guidance of the committee.

Appointments Vacant.—The East Ham Urban District Council require an electrical engineer for the preparation of a scheme of electric lighting combined with tramways, and the ultimate management and maintenance of the same after completion, at a salary of £300 per annum, with necessary offices and assistance. Further particulars, with form of application, may be obtained from Mr. W. H. Savage, A.M.I.C.E., engineer and surveyor, Public Offices, East Ham. Applications to be sent in the printed envelopes provided, enclosing copies of three recent testimonials, by 24th inst. Canvassing is prohibited.—The Barking Town Urban District Council require an electrical engineer to superintend the laying of mains and the erection of the plant in the lighting station now being erected, and afterwards to take charge of the station. Applicants should be good engineers and competent to test mains, meters, etc. Salary, £150 per annum. Applications, endorsed "Electrical Engineer," stating age and experience, together with copies of three recent testimonials, are to be forwarded to Mr. E. H. Lister, clerk, Public Offices, Barking, by 5 p m. on 24th inst.—The Heckmondwike Urban District Council require the services of a practical and efficient electrical engineer to consult with and advise them on a scheme for an electric lighting installation for their township, and, if required, to superintend the construction of all works and the laying down of the necessary plant for that purpose. All particulars may be obtained on application to the clerk. Applications, endorsed "Electric Lighting Engineer," stating terms, and enclosing copies of not more than three recent testimonials, must be sent to Mr. Aulay Macaulay, clerk to the Council, Heckmondwike, by 4 p.m. on 26th inst.—The Scarborough Electric Supply Company are advertising for a resident engineer. Applications are to be sent to the secretary, 24, Westborough, Scarborough, by 24th inst.

Wolverhampton.—At the monthly meeting of the Town Council on Monday last the town clerk read letters from the Board of Trade relative to the proposed purchase by the Corporation of so much of the undertaking of the Wolverhampton Tramways Company, Limited, as is within the borough, and he announced that he had given notice to the tramway company of the desire of the Corporation to purchase a portion of the undertaking. There was now a contract for the sale and purchase, and the only thing was the question of the purchase money, which would have to go before an arbitrator appointed by the Board of Trade. The report of the General Purposes Committee relative to the promotion in the forthcoming session of Parliament of a Bill or provisional order or both, for conferring on the Corporation further powers in relation to various matters, was adopted. A report of the Tramways Committee providing for the reconstruction of the existing lines, and for 12 new lines and extensions, and based upon the recommendation of Mr. W. H. Beattie, C.E., of Edinburgh, was adopted. The Lighting Committee also submitted a report advocating additional plant for the electric light undertaking to meet the demand which in every likelihood will be made upon the works during the autumn and winter of 1899-1900. The maximum load generated of the year 1897-8 was 324 kw. out of a total available capacity (including spare plant) of 480 kw. The maximum output from the transformers was 222 kw. out of a total available capacity of

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315 kw. These loads represent a 35 per cent. increase on the previous year. We quote from the report as follows: "The committee are of opinion that it will be the best practice to develop the undertaking by the establishment of a three-wire system of supply, with a standard pressure of 440 volts between the two outer wires and 220 volts between the middle wire and each outer. As, however, it would be inadvisable on the score of economy to have in operation two distinct systems of distribution supplying current at different standard pressures, it would be necessary to change over the existing 110-volt network to the three-wire system, the result of which would be to establish a standard pressure of 220 volts (instead of 110, as at present) throughout the whole system of supply. This change-over of pressure would have to be made gradually, small portions at a time of the existing 110-volt network being transferred to the three-wire system, and the total period occupied in completing the transfer might extend to a couple of years. By so doing none of the existing plant would be thrown idle, and each of the present transformers, when no longer required in the centre of the town, would be moved to other sub-stations situated in outer portions of the borough. The portions of the network that your committee propose to change over next summer would comprise both sides Lichfield-street from Five-ways to Princess-square, one side Canal-street, Fryer-street, and Stafford-street, both sides Queen-street from Piper's-row to Market-street, both sides Worcester-street, and both sides of Darlington-street from Chapel Ash to Waterloo-road. The approximate estimated expenditure for carrying out this scheme will be as follows: generating station, £15,422; mains and distributing system, £9,228; sub-stations, £4,790—grand total, £29,740."

Tottenham.—At the last meeting of the Urban District Council the General Purposes Committee reported that having further considered the general question of electric lighting they recommended that application should be made to the Board of Trade for a provisional order to supply electricity within the district, and that the applications made by other parties (the Tottenham and Edmonton Gas Company and the Electrical Power Distribution Company, Limited) should be opposed. Speaking with reference to the subject of electric lighting, Mr. Malone said that four or five years ago a similar recommendation was made and carried, but nothing further was done in the matter except to keep the ratepayers from having the light brought to them by others who were prepared to lay it on. They had had what appeared to him a very fair offer from one company—namely, 8d. per unit for the first hour and 2d. per unit afterwards. Theirs was a large, straggling parish, and the initial cost of the plant, etc., would be considerable. He thought they should first negotiate with some of the companies to see what were the best terms they could obtain. Mr. Broadbank said the statement that that was a large, straggling parish, and therefore not suitable for the electric light, had been made over and over again. The same thing had been said in other districts. Those arguments were on a par with those that were used against the introduction of Stephenson's iron horse. But he knew a hamlet near Portsmouth where they had had the light four years, during which time the Council had obtained the return of their initial outlay, and it was now working at a profit, being carried even into the farmhouses. As to the offer referred to by Mr. Malone, they did not wish to apply for the order themselves, but asked the Council to get the order, and then they would supply the light. So the Council could not negotiate there until they had obtained the order. Then the Council had a hand in a scheme for a dust destructor, which would raise the question as to what they could do with the heat generated there—whether they should use it for heating baths and wash-houses, or for generating the electric light. They could not go thoroughly into those schemes until they had decided what they would do in regard to the electric light. Mr. Peart strongly supported the recommendation of the committee. The company referred to by Mr. Malone said they would allow the Council to take the concern over in 10 years' time on paying, in addition to all their costs and charges, 6s. 8d. in the pound, which he should regard as a waste of the ratepayers' money. It was well known, too, that electric current could be supplied at less than 4d. Mr. Ward took exception to the supposition that the Council were going to let four or five years elapse before doing anything further in the matter. He thought the time would come when the Board of Trade would say that if the local authorities did not undertake to supply it they would authorise companies to do so. Mr. Brown thought, after what the committee saw at Shoreditch last week, when inspecting the dust destructor, they would be wise to go in for the order. When the light was started in Shoreditch the price was 7d. or 8d.; now it was 4d. and 2d. after a certain time. There was no doubt they must have a destructor at once. The report was adopted unanimously.

PROVISIONAL PATENTS, 1898.

OCTOBER 3.

20774. Improved conduit for electric traction. Edward Jennings and Christopher Edwin Malley, 149, North Hill-street, Liverpool.

20794. Improvements in electric signalling apparatus for ships. Richard von Horváth and Moritz Cohn, 8, Quality-court, Chancery-lane, London. (Complete specification.)

20823. Improvements in or connected with electric arc lamps. George Thomas-Davies, 40, Chancery-lane, London.

20814. Improvements in mirrors and in arc lamps for searchlights. Nicolas Frédéric Désiré Barbier, 46, Lincoln's-inn-fields, London. (Complete specification.)

20829. Improvements in electric generators and motors. Albert Bocquentin, 65, Chancery-lane, London.

20832. Improved arrangement for the electric lighting of railway carriages with the assistance of wind motors. Stanislaw Stückgold, 40, Chancery-lane, London. (Complete specification.)

OCTOBER 4.

20847. Improvements in electromotors and dynamos. William Peck, City Observatory, Calton Hill, Edinburgh.

20850. Improvements in and in relation to the trolley head of electric tramcars. John William Towle, 9, Westland-row, Dublin.

20894. Improvements in trolley cars for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoener, United States.) (Complete specification.)

20895. Improvements in electric surface-contact railway systems. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (William B. Potter, United States.) (Complete specification.)

20904. Improvements in underground conduits for electrical conductors. Edwin Stanley Clark, 6, Lord-street, Liverpool.

20919. An improved electrolyte for primary batteries. Richard Joseph Crowley, Samuel Sidney Bromhead, and Henry Fairbrother, 171, Queen Victoria-street, London.

20921. Improvements in advertising apparatus. The Electric Sign and General Advertising Company, Limited, and William Joseph Blagden, 46, Lincoln's-inn-fields, London.

20923. Improvements in arc lamps. Walter Crudgington, 128, Colmore-row, Birmingham.

OCTOBER 5.

20945. Improvements in electromagnetic machines. James Matthew Hiley, 41, Reform-street, Dundee.

20972. An improvement in the adaptation of the telephone to "electric bell pushes," such as are used in ordinary bell and indicator systems for private houses, offices, hotels, etc. George Lee Anders and Alexander Johnstone Wilson, jun., 33, Peak Hill-gardens, Sydenham, London.

20989. A new or improved composition for electrically firing detonators. George Percy Bickford-Smith, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20991. Improvements in or relating to phonographs. Josef Cohn and Jacob Simon August, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20994. Improvements in or connected with electric regulating switches. Owen David Lucas, 37, Essex-street, Strand, London.

21002. A new or improved construction of electric glow lamp applicable for general lighting purposes. Thomas Edwin Andrews, 11, Burlington-chambers, New-street, Birmingham.

21005. Improved end connections for electric cables. W. T. Henley's Telegraph Works Company, Limited, and Richard Oliver Wright, 53, Chancery-lane, London.

OCTOBER 6.

21025. Improvements in electric arc lamps. English Industrials, Limited, and George Edward Heyl-Dia, 55, Market-street, Manchester.

21043. Improvements in electric meter systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

21044. Improvements in prepayment electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank P. Cox, United States.) (Complete specification.)

21045. Improvements in speed indicators for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Ernst J. Berg, United States.) (Complete specification.)

21046. Improvements in electric meters for alternating-current circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.) (Complete specification.)

21047. Improvements in electric fuses. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le Roy Emmet, United States.) (Complete specification.)

21048. Improvements in prepayment electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edmund Allo, United States.) (Complete specification.)

21050. An improved safety fuse or cut-out. John George Dixon, 70, Palace-chambers, Westminster, London.

OCTOBER 7.

21125. Improvements in and relating to the electrical communication of signals. Henry Mechan and David Muirhead, 96, Buchanan-street, Glasgow.

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21129. An improved instrument for the measurement of magnetic permeability, magnetic hysteresis, magnetic induction, and other quantities. William Peddie, 115, St. Vincent-street, Glasgow.

21150. Improvements in or connected with electric traction by means of underground conduits. Emil Hungerbuhler, 37, Essex-street, Strand, London.

21155. Improvements in electrically-propelled vehicles. Jules Pierre Juvenet, 65, Chancery-lane, London. (Edmond Marie Doumet de Siblas, France.)

21165 Method of, and appliances for, exciting alternating-current dynamo machines, whether acting as generators or as motors. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

21169. Improvements in electric batteries. Reginald Haddan, 18, Buckingham-street, Strand, London. (Columbus Electrizitäts Gesellschaft (Limited Company), Germany.)

21171. A new or improved construction of electric motor, with equational box or componsating differential gear combined. John Henry Boll and Percival Waddams Petter, 31, Southampton-buildings, Chancery-lane, London.

21172. A new or improved method and means of electrically operating apparatus, such as valves, electrical switches, or the like. Charles Orme Bastian and Francis Malger Staunton, 31, Southampton-buildings, Chancery-lane, London.

OCTOBER 8.

21216. An improved trolley for taking electric current applicable to the electric traction of vehicles, boats, and the like. Louis Lombard-Gerin, 6, Lord-street, Liverpool. (Complete specification.)

21224 Improvements in or relating to electric clocks or watches. Emilio Rosi and Guiseppe Vacotti, 111, Hatton-garden, London. (Complete specification.)

21233. Improvements in apparatus for coating metal articles by electro-deposition. John Thornton and Thomas Richard Canning, 4, South-street, Finsbury, London.

21240. An improved telephone call counter. Friedrich Max Richter, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21241. Improvements in telephone switchboards. Friedrich Max Richter, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

20883. Apparatus for working electric tramways by means of underground cables. Anderson.

21119. Reflector for electric incandescent lamps. Houbois.

21249. Methods of, and apparatus for, preventing the sticking through leakage currents or the like of electric railway section switches. Lorrain. (The Esmond International Electric Traction Company.)

23513. Telephone receivers and the like. Nussbaum. (La Société Industrielle des Téléphones.)

24470. Joint-boxes for electric cables. Shipp and Telegraph Manufacturing Company, Limited.

25653. Devices for, or applicable to, incandescent electric lamps. Biheller.

26399. Electrical measuring instruments. Elphinstone and Heap.

26880. Electrical furnaces, specially applicable for the production of calcium carbide. Crees, Durban, and Gore.

1898.

8603. Waterproof contact apparatus for electric railways with underground conductor. Ihle.

10690. Starting devices for single-phase alternating electric current motors The British Thomson-Houston Company, Limited. (Stone and Doane.)

12680. Electric alternating-current cable systems. Clouth.

13010. Electric arc lamps. The British Thomson-Houston Company, Limited. (Fleming.)

13011. Electric arc lamps. The British Thomson-Houston Company, Limited. (Spinney.)

14793. Electric insulators. The British Thomson-Houston Company, Limited. (Willard.)

14959. Switch and contact apparatus for the cars of electrical railways and tramways. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

15028. Manufacture of electrodes for secondary batteries. Haddan. (Francke.)

15347. Electric switches. Dixon.

Cambridge Electric Supply Company, Limited.—An appeal made by this Company against the rating of their concern will be heard at the Quarter Sessions, to be held at the Guildhall, Cambridge, on the 18th inst. Mr. Castle, of 40, Chancery-lane, and Mr. R. E. B. Crompton will give evidence on behalf of the Company.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Oct. 8	4,051	3,691	+ 360	—	—
Blackpool and Fleetwood Tramroad	,, 8	573	—	—	12,044	—
Bristol Tramways and Carriage Co.	,, 7	2,974	2,749	+ 225	—	—
City and South London Railway	,, 9	982	970	+ 12	14,251	13,591
Dover Tramways	,, 8	201	124	+ 77	6,618	—
Dublin U.T., elec. cars	, 7	444	†305	+ 139	7,935	5,398†
Dublin S.D. Electric Tramways	,, 7	929	533	+ 396	15,514	10,771
Halifax Corporation Tramways	,, 8	261	—	—	3,963	—
Liverpool Overhead Railway	,, 10	1,399	1,321	+ 78	—	—
South Staffordshire Tramways	,, 7	668	670	− 2	25,281*	25,503*

* Receipts since Jan. 1. † Horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	14½-15½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	9½-10½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	10-10½
——	6	6 6½
—— Pref. Half-Shares	1	1½-1½
—— " "	5	4½-5
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	24-25
—— 90,001-100,000	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	50	70-72
—— Ordinary	3	2¾-3½
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14 15
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	13-14
—— " " No. 30,000 40,000	6	10½-11½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅝ 2
—— 5 per cent. Debentures	—	90-95
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2⅝
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5⅝
Electric Construction, Limited	2	2⅛ 2⅜
—— 7 per cent. Cumulative Pref.	2	2⅜-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅞ 1
Elmore's Wire Company	2	1¾ 2
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9 10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22½-23½
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	13½-14½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3⅜-4⅛
Metropolitan Electric Supply, Limited, Ordinary	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5⅜-5⅝
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7⅛-8
—— £4½ Shares, New	4½	6½-7
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	3	2⅜ 2½
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	104-107
Telegraph Construction and Maintenance	12	39-43
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	100	115-120
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Telephone Licenses.—The Corporation of Newcastle-on-Tyne is also to apply to Parliament for power to erect a municipal telephone exchange.

Rather Too Pushing.—We understand that Mr. J. W. Swan is much annoyed that many of his friends have been solicited to subscribe for a lithographic portrait of himself with a lithographed signature. We are informed that this is being done entirely without his consent, and that the matter is more annoying because the portrait is not a good one.

Webb Testimonial Fund.—We are desired by the hon. secretary of the Webb Testimonial Committee to state that since the date of the presentation the sum of £51. 12s. 7d. has been received by subscriptions and interest on the bank deposit. The account at the bank has now been closed, but the amount of any further subscriptions that may be received will be handed direct to Mr. Webb.

A Forerunner.—A bazaar, arranged in the form of a Japanese village, has been in full swing in Darlington during the present week. From what we can gather from the local papers, the fact that the bazaar was lighted electrically was one of its greatest attractions. We hope that the stimulus so given to the electric light in Darlington will induce the authorities to push the electric light undertaking much more earnestly.

Physical Society.—The next meeting of the Physical Society will be held in the rooms of the Chemical Society on Oct. 28 at 5 p.m. The following papersare to be read: "On an Influence Machine," by Mr. W. R. Pidgeon, M.A.; "The Repetition of an Experiment on the Magneto-optic Phenomenon discovered by Righi," by Prof. Silvanus Thompson; and "The Magnetic Fluxes in Meters and other Electrical Instruments," by Mr. Albert Campbell, B.A.

Forthcoming Book.—The first edition of a book, entitled "Continuous-Current Dynamos," by M. J. Fischer-Hinnen, was issued in Germany, and rapidly ran through three editions. An English edition has been prepared under the direction of M. Fischer-Hinnen, with his revisions and additions to date. M. Fischer-Hinnen is now reading the final proofs of the book, which will be issued immediately by Messrs. Biggs and Co. The price will be 10s. 6d.

Aerial Navigation.—Mr. A. Graham Bell, the inventor of the telephone, has recently gone on a holiday to Japan. He is preparing a series of papers on the subject of aerial locomotion for the United States Academy of Science. They will be published on his return to America. He stated to an American reporter that lately aerial navigation had absorbed his time to the exclusion of all other scientific problems, and that he thought that very soon it would become an accomplished fact.

Copper and Aluminium in the States.—The United States Geological Survey, in a recent report for the year 1897, states that the production of copper during that year was 491,638,000lb., this being an increase of about 7½ per cent. over the previous year. The production of aluminium is given as 4,000,000lb., against 1,300,000lb. for the previous year, the value for 1897 being estimated at £300,000. The great increase in the production augurs well for the future of the large power plants supplied to aluminium factories.

Institute of Mining Engineers.—The annual meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers was held at Mason University College, Birmingham, on Monday last, Mr. R. S. Williamson presiding. The council, in the thirty-first annual report, reviewed the work of the year, and mentioned an increase of membership, there being 172 members, as compared with 161 at the corresponding period of last year. Mr. J. Lindop was elected president, and Mr. G. C. Robinson vice-president for the ensuing year.

Lectures on Electric Traction.—Prof. Jamieson delivered on Thursday of last week the first of a series of lectures on electric railways and tramways at the technical college at Glasgow. The first part of the lecture was historical, but it concluded with a general description of the plant put down at the Glasgow electric traction station. He prophesied that when the public had the opportunity of testing the facilities afforded in the Mitchell-street and Springburn line, they would not rest satisfied until electric tramways were laid down on everyone of the busy car routes.

Electrical Locking Devices.—The *American Electrician* draws attention to the fact that the possibilities of electrical combination locks for cash-drawers and similar receptacles have not yet been realised to their fullest extent. It requires but little ingenuity to arrange four or five push buttons in such a way that only one combination will close the circuit of an unlocking magnet, and any other will ring an alarm. The alarm could be placed at any convenient point, and at other points could be placed cut-out switches, which, when manipulated, would render it impossible even for one who knew the combination to succeed in opening it. The device is easily developed, and marketable.

Speed of Electric Cars.—The electric tramways owned by the Dublin United Tramway Company are at present bound by the old Board of Trade regulations, limiting the speed of cars to eight miles per hour. The tramway company has asked the Board of Trade to extend this to 12 miles per hour on the Clontarf section. We gather from the proceedings of the Clontarf Commissioners that they have no objection to this speed being used at night-time. Surely if the higher speed is not excessive at night-time, it could be used with perfect safety in the daytime. We certainly think that little harm would be done if the limit were raised to 12 miles per hour universally. As regards the Clontarf section the matter will be again brought before the Board of Trade.

The Value of Church Lighting.—The electric light is finding great favour in churches and chapels, and, as providing a Sunday load, such consumers are valuable to the electrical undertaking. The following extract from a local paper is amusing in its discrimination as to the relative values of the meeting places of the various religious denominations from an electrical engineer's point of view: "To have a number of Episcopal churches all drawing on the dynamos for a couple of hours once a week is not a thing to be desired by the corporation, because it won't pay for the additional plant required. But churches like the Congregational are better customers: they are scarcely ever away from some part of their premises, what with one organisation and the other; and they must run well into tens of pounds per quarter for lighting." From the above we gather that a Salvation Army barracks would give the best load, but our contemporary does not go that length.

The Northern Society of Electrical Engineers. We are informed by the secretary of the Northern Society of Electrical Engineers that their fifth session will be opened on Tuesday evening next, the 25th inst., with an inaugural address by the president (Mr. John S. Raworth), the subject of which will be "The Rapid Development of Electrical Engineers in the Year 1898." We presume that Mr. Raworth will refer to the physical development in the

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members of the new volunteer corps. Papers will also be read during the session by the following gentlemen: Mr. Paul Sehon, Mr. E. S. Shoults, Mr. Samuel Joyce, Mr. H. Kilgour, and Mr. S. V. Clirehugh. Meetings of the society will be held in future on Tuesday evenings at the Grand Hotel, Aytoun-street, Manchester. A later announcement giving the synopsis of the address has just reached us, and we see that the real title of the presidential address is to be "The Rapid Development of Electrical Engineering during the Present Year."

Electric Ship-Lighting.—The terrible disaster to the liner "Mohegan," on the Manacle Rocks, is said to have been rendered still more fatal on account of the fact that the electric lights went out as soon as the water flooded the engine-room. This is used as a plea in favour of oil lamps, particularly for masthead lights. It is argued that an oil lamp at the masthead would have kept burning, and would have been of assistance to the lifeboats. With this we quite agree, but the fact that electric lamps were more reliable in such positions than oil lamps has led to electricity being adopted for such purposes. More accidents have occurred through extinguished side lights, resulting in collisions, than from any other reason except fog. It would be unwise, therefore, not to adopt oil lights because of the exceptional case above. It may not be known to some of our readers that in all electric side lights two incandescent lamps are used in parallel, so that the failure of one filament does not put out the light. We are glad to note that in spite of the darkness there was no disorder, and the crew acted as British sailors should.

Power Consumed by Wood-Working Machinery. Prof. O. G. Dodge, of the U.S. Navy, who was chief electrical inspector at the World's Fair, recently made some useful tests to find the power required to drive the wood-working machinery in the Navy Yard at Washington. With a circular rip-saw, 28in. in diameter, and running at 1,200 revolutions a minute, and ripping seasoned hard oak $7\frac{5}{8}$in. thick, with a feed of 10ft. per minute, 18·8 mechanical horse-power was used. The motor and saw running idle absorbed 2·1 h.p. A band saw running at 160 revolutions a minute (or 3,017 lineal feet a minute) required 10·4 mechanical horse-power when the motor was running idle. When ripping seasoned ash $10\frac{3}{4}$in. thick, with a feed of 6ft. a minute, 14·8 h.p. was consumed. In ripping yellow pine 12in. thick and running 20ft. a minute, 17·6 h.p. was consumed. Tests were also made with motors driving boring machines. With a speed of the bit running at 375 revolutions a minute, with the motor belted to the bit-shaft and running idle, 0·5 h.p. output was required. When boring 4in. holes in seasoned oak at the rate of $9\frac{3}{8}$ft. a minute, 1·2 mechanical horse-power was consumed. The above figures were first published in the *Railway Gazette*.

Presentation.—At the House-to-House electric light supply station, Earl's Court, on Saturday morning last, Mr. J. A. Constable was presented with a gold watch and framed address by the staff and employés on the occasion of his leaving the service of the company to take up the post of engineer to the Blackheath and Greenwich District Electric Lighting Company, Limited. Mr. H. W. Bowden, the manager and engineer, who made the presentation in the main engine-house, where all the employés met, referred to the progress of the company during the past four years, and to Mr. Constable's tact and perseverance in carrying out instructions which were perhaps at times difficult to comply with. He stated, further, that the ready compliance by all the employés and earnest desire on their part to carry out work in its true intent—viz., in the interest of the company—had largely contributed to the success of the undertaking during the past five years. In conclusion, Mr. Bowden said: "We are all very sorry to lose Mr. Constable. He, however, takes with him a little memento from us and our very heartiest wishes for every success in the future." Mr. Constable replied in a few suitable words, and the proceedings terminated with cheers for Mr. Constable, the House-to-House Company, and Mr. Bowden.

A New Fetish.—

We have made us gods as we wanted
Since the earth-life first began,
When the need of a mighty protector
Filled the soul of the primitive man.
We have praised the yoke of the flame and smoke,
We have kneeled unto H_2O,
We have wept and prayed to an image, made
Of the offal of carrion crow.

With the birth of a civilised knowledge,
The element gods and the wrought
Were scrapped to make room for the symbols,
And a new code of morals was taught.
We have doffed at noon to Il Allah's moon,
We have bowed to a cross of wood,
We have wept and prayed to a Jewess's shade:
And the sum of it all is good.

We have all divergent opinions,
Some seek still a symbol new:
That will represent them a fetish,
And the better if grander than true.
Let their god be might, let their god be light,
Let their god be death-at-the-touch—
Then their prayers should flow to the dynamo,
Which twists from the nought all such.

J. H. C. B.

Institution of Civil Engineers.—The prize-list of the Institution of Civil Engineers for 1897-98 is as follows. The awards will be presented at the institution on Tuesday, Nov. 1, at 8 p.m.: Telford Medals and Premiums—A. H. Preece (London) and H. C. Stanley (Brisbane, Queensland). Watt Medals and Premiums—H. L. Callendar, M.A., F.R.S. (London) and J. T. Nicholson (Montreal, Canada). George Stephenson Medals and Premiums—Whately Eliot (Plymouth), W. O. E. Meade-King (London), and W. P. Marshall (Birmingham). The Crampton Prize—E. W. Anderson (Erith). Telford Premiums—L. B. Atkinson (Cardiff), Henry Fowler (Horwich), W. L. Strange (Bombay), F. J. Waring, C.M.G. (London), D. W. Brunton (Denver, U.S.), Wilfred Airy, M.A. (London), E. M. Bryant, B.Sc. (Newcastle-on-Tyne), D. B. Butler (London), and H. V. Champion (Victoria). The James Forrest Medal—W. L. Brown, M.Sc. (London). Miller Prizes—C. E. Wolff, B.Sc. (Derby), A. D. Keigwin (Ashford), Harold Williams (Kingston), J. T. Morris (London), H. C. Adams (Birmingham), H. O. Eurich (Bradford), B. K. Adams (Colombo), A. B. E. Blackburn (Wednesbury), Thomas Carter (Newcastle), P. F. Story (Manchester), D. E. Lloyd-Davies (Bewdley), and Wilfred Hall, B.A. (Corbridge-on-Tyne).

The Electro-Harmonic Society.—A smoking concert in connection with the above society will be given at the St. James's Hall Restaurant this evening at eight o'clock under the direction of Mr. T. E. Gatehouse and Mr. Alfred E. Izard. Programme—Part I.: vocal duet, "Flow Gently, Deva" (Parry), Mr. Herbert Emlyn and Mr. Robert Grice; pianoforte solo, "Spinnerlied" (from "Flying Dutchman") (Wagner-Liszt), Mr. Alfred E. Izard; ballad, "So, Fare Thee Well" ("Doris") (Alfred Cellier), Mr. Herbert Emlyn; whistling solo, "L'Ardita" (Arditti), Mr. Charles Capper; mimetic sketch, "Campobarrinolus Spoofisbiroinism," Mr. George Robins; violoncello solo, "Berceuse" (B. Godard), Mr. Bertie Parker; aria buffa, "So, Sir Page" (Mozart) (from "Le Nozze di Figaro"), Mr. Robert Grice; humorous sketch, Mr. Tom

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Clare. Part II.: vocal duet, "Tenor and Baritone" (H. Lane Wilson), Mr. Herbert Emlyn and Mr. Robert Grice; whistling solo, "Echo Song" (Eckert), Mr. Charles Capper; new song, "'Tis All in Vain" (D'Auvergne Barnard), Mr. Herbert Emlyn; humorous sketch, "Imitations of Popular Performers," Mr. George Robins; violoncello solo, "Caprice Hongroise" (Dunkler), Mr. Bertie Parker; song, "A Soldier's Song" (Angelo Mascheroni), Mr. Robert Grice; humorous sketches, Mr. Tom Clare.

The Institution of Junior Engineers.—The annual general meeting of this institution was held last Friday at the Westminster Palace Hotel, the retiring chairman, Mr. H. B. Vorley, presiding. There was a large attendance. From the report of the council which was presented it is evident that the society continues its work with a vitality which has always characterised it. During the past year nine meetings have taken place. At one of them a conference was held with the discussion section of the Architectural Association on "The Desirability of a Closer Relationship between the Architect and the Engineer." Twelve visits to engineering works in and around the Metropolis had been made, and at the summer provincial meeting at Liverpool a week was spent in this way. The special fund started with the object of opening an office and reading-room for the members—now much needed—makes but slow progress, the total to date being but £80. The total membership stood at 516—a net increase of 36 on the year. Sympathetic reference was made to the loss which the institution had sustained in the death of Dr. John Hopkinson, past-president; and of Sir Benjamin Dobson, of Bolton, and Mr. Thomas Mudd, of Hartlepool, honorary members. The ballot resulted in the election of the following: chairman, Mr. Basil H. Joy; vice-chairman, Mr. Kenneth Gray; hon. librarian, Mr. L. H. Rugg; hon. auditors, Messrs. W. B. Clarke and E. King; council, Messrs. J. N. Boot, F. D. Napier, J. E. Raworth, and A. E. Taylor; secretary and treasurer, Mr. W. T. Dunn. Sir W. H. White has accepted the position of president for the ensuing session, and will deliver his address to-night at the Westminster Palace Hotel. Prof. Ewing, of Cambridge, has consented to give the hon. member's paper at the January meeting on "Measurement by Electricity."

Positive and Negative Economies.—A paper on this subject was recently read before the Ohio Electric Light Association by Mr. E. P. Roberts. The main point the author has had in view in writing the paper is the consideration of whether certain economies which are possible are practicable from a financial point of view. He illustrates his arguments by practical examples, of which the following is one: In an installation where 75 i.h.p. have to be supplied for eight hours nightly, he shows that by using an engine of exactly this capacity much greater economy is obtained than if a larger engine, say 200 h.p, is used and run below its output. By using the larger engine 53lb. of steam is used per brake horse-power, and with the smaller 33lb. per brake horse-power, or a difference of 20lb. per brake horse-power. From this he argues, "Do not get your engine cylinder too large—only large enough for the maximum work it may be called on to do—and do not get your other parts too small." This refers to an engine for a variable load. The best proportions for a constant load are different, especially if the engine is compound. In some cases the steam pressure carried is too low, and in others it would pay to condense. In conclusion, the author advises the engineers of small plants to ascertain the facts as to the present condition of operation, and make such improvements as are possible by better adjustment or handling. Only those additions which will bring 15 per cent. or more on the investment, at the same time adding to the reliability and lessening the depreciation, should be made. These should be put in hand as fast as the necessary money can be obtained to pay for them. By keeping records and studying them, one obtains and maintains a desire on the part of the employés to better the record.

Electrically-Lighted Cars on the Canadian Pacific.—The Canadian Pacific Railway has recently placed in service some cars fitted with electric lights operated from the car axle. The system, as described in the *Railway Review* of New York, consists of a dynamo mounted upon the truck of the car, one end of which is supported by a stirrup from the truck and the other by the axle. It is driven by a direct gear, which revolves 2½ times to every revolution of the car wheel. A regulating device is so arranged that, although the speed of the train may vary greatly, the dynamo being directly geared would normally generate a high voltage. The voltage is kept substantially uniform during all the variations of speed between 20 miles per hour and the maximum ability of the locomotive. In other words, although the dynamo at a speed of 60 miles per hour is revolving three times as fast as it is at a speed of 20 miles per hour, the voltage or pressure generated is the same. In connection with this regulating device there is an automatic cut-out, so adjusted as to throw the dynamo into circuit with the lamps upon its reaching a voltage equal to that of a small storage battery supply, and throwing it out of circuit upon its dropping below. The effect of this is that when the lamps are burning, and the train running at 20 miles per hour, the lamps are fed directly from the dynamo, and the small surplus of current goes through the batteries. When the speed falls below 20 miles per hour, the cut-out works automatically, and as long as the train continues at its low rate of speed the lights are drawn direct from the storage batteries, which are capable of supplying the lights independent of the dynamo for from six to twelve hours. Should it be desirable, as it very frequently is, to introduce electric fans into the vehicle during the heated months, the capacity of the dynamo is made amply sufficient to keep a number of them constantly in operation if required while yet serving the batteries with all that they required.

American Volunteers.—The late war between the United States of America and Spain drew a large number of volunteers for active service from the electrical engineers of America. Out of these a signal service corps was formed, which has done and is doing great service. Naturally their work in Cuba and Porto Rico was by no means ended when fighting ceased. We gather from references in the *Western Electrician* that many volunteers wish to get back to their ordinary vocations, and that their friends at home have put pressure on the authorities to allow them to do so. The result has been a telegram from General Greely, the chief signal officer, which reads as follows: "Neither the United States Government nor the chief signal officer desire to retain patriotic volunteers in service one day longer than public interests demand. The occupation of Porto Rico and Cuba, with extensive government telegraph lines to temporarily care for and the creation of division camps throughout the United States, imposes on the signal corps additional work instead of lessening it. Discharges in detachments or in large numbers cannot at present be promised, and efforts to secure discharges through political influence is discreditable to soldiers employing it. The chief signal officer will give personal and considerate attention to every application for a discharge coming through military channels, and will recommend discharges of individuals to the extreme point consistent with public interests. Such applicants must give cogent reasons, and

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their applications must be carefully considered by you personally and endorsed without fear or favour. Soldiers with dependent families and who have made pecuniary sacrifices for the country, and also those whose physical condition warrants the belief that they will be of no further service within 90 days, will receive especial consideration as applicants for discharges. The chief signal officer will see that they receive proper attention on receipt here. You will cause this telegram to be read to the command."

Interruption to Lighting.—We notice that a contemporary devoted to gas interests has much to say about breakdowns in electric light supply. It is certainly regrettable that three such interruptions should have occurred in three different towns at such short intervals, but in each case the faults were repaired quickly. Still, our contemporary, assured of its own lighting agent, says that "from time to time the electric light provides irritating reminders that the unreliability which has always characterised it remains an incurable weakness of the system. Like epilepsy in the human subject, this liability of the electric light to 'go out' without warning, at inconvenient moments, persists from youth to middle age, and is completely destructive of confidence in its serviceability. Nor is there the smallest prospect of the system outliving this detrimental character." The *tuo quoque* reply would be that the unreliability of the gas supply has persisted from youth to middle age, and that now in old age the hoary sinner is as unreliable as ever. We should cap this with the statement that gas had an evening out at Bournemouth last Sunday. On that evening the town, so far as the gas supply was concerned, was suddenly enveloped in darkness. When soon after seven o'clock the gas went out, the various congregations had assembled for evening service. Some consternation was created where the electric light was not installed, and evening service at many places of worship, including that at the parish church, had to be terminated. One or two preachers endeavoured to continue the service in darkness, but their congregations rapidly disappeared. Great inconvenience was caused at the post office, where by the light of candles the evening dispatch was made up. Streets were in total darkness. At the churches where electric light was installed they were in total ignorance of the state of affairs until the congregations left the buildings. The hardest nut our contemporary has to crack is that of explaining the reason why the electric light progresses so rapidly if the public have "no confidence in its serviceability."

Electric Power Distribution.—Mr. G. L. Addenbrooke read a paper last Monday before the South Staffordshire Institution of Mining Engineers on "Electric Power Distribution." In it he described the project of the Midland Electric Corporation and its bearings on the mining in the district. He reviewed the steps taken to form the corporation, and the difficulties met with in dealing with local authorities. Royal assent had been obtained to a provisional order giving the corporation power to supply electricity over the areas of the following 12 local authorities: Heath Town, Wednesfield, Short Heath, Bentley, Willenhall, Bilston, Darlaston, Wednesbury, Sedgley, Coseley, Tipton, and Rowley Regis. Arrangements were in progress for taking over two other districts (Oldbury and Kingswinford), where the local authorities had obtained provisional orders. Walsall Rural District Council had also consented, but owing to the opposition of West Bromwich the connection with the rest of the area would have been so slender that the Board of Trade cut off that district. He anticipated, however, that a fresh application would be successful, and 15 of the local authorities in the district would then be supplied. Powers were being sought to supply Brierley Hill, Quarry Bank, Amblecote, Stourbridge, Lye and Wollescote, Hales Owen, Handsworth, and Perry Barr. With regard to West Bromwich, Smethwick, and Dudley, the result of the overtures to the authorities could not be predicted. The area over which they already held powers contained a population of 250,000, and the total would be increased to 350,000 if the applications to be made during the coming session were successful. With a population of 350,000 to serve, Mr. Addenbrooke thought that the corporation would be in a position to supply isolated places like Dudley with a population of 45,000, West Bromwich with a population of 60,000, and Smethwick with about 40,000, cheaper than they could do it by setting up their own isolated works. In illustration of the application of electricity to the working of mines, Mr. Addenbrooke showed a number of lantern slides, and concerning the cost he contended that, speaking generally, the rates would work out at 25 per cent. less than the cost of isolated steam plants, and, in addition, all the other conveniences and economies of electricity would be thrown in.

Reports on Electric Traction. — This summer reports on electric traction have been issued by many town councils, but these reports have been, if anything, too descriptive. The reports have in most cases been drawn up by more technical men, and hence have suffered from want of critical analysis. Mr. J. Allen Baker's report to the London County Council on some forms of mechanical tramway traction that have been tried, and more or less successfully worked in various towns and cities in England, on the Continent of Europe, and in America, is a marked advance in this respect. The author has not only seen, but has thought over what he has seen, and the result is a report which is most interesting to all, even if some of his conclusions may not obtain universal consent. Mr. J. Allen Baker discusses the various systems of traction by steam, oil, gas, compressed air, cable, and electricity. After due consideration he considers that in solving the problem of haulage the public must look to some species of electric traction. It has, he says, been demonstrated in scores of cities in America and on the Continent, as well as in this country, that the cost of operating by horse traction is from 50 to 100 per cent. greater than by the electric system, while the latter has been proved to be more economical than any other form of mechanical haulage. Chief among its advantages are the following: (1) its great elasticity—the ease and speed with which the cars can be started and stopped; (2) going backwards and forwards at will; (3) greater cleanliness and absence of wear to the streets; (4) greater comfort; (5) greater average speed than can be obtained as compared to horse or other forms of mechanical traction; (6) trailer cars can be put on during the "rush" hours, mornings and evenings, and on holidays. Mr. Baker gives his preference to the underground conduit for London. He states that it is simply a consideration of the difference in first cost between the street construction of the conduit *versus* the overhead—a matter, perhaps, of £1,000 to £2,000 per mile of track for the cheaper form of conduit, and £2,000 to £4,000 for a heavier construction similar to that of New York and Washington—and the question whether for so comparatively small a sum any portion of our great city should have anything but the best system obtainable.

Telegraphs in Persia.—The current issue of the Society of Arts *Journal* contains some interesting details about the telegraphs and telephones in Persia. The items appeared to have been taken from an U.S.A. consular report. It seems that the actual administration of the local telegraphs in Persia is deputed to one man, who until

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very recently contributed to the Government £2,400 a year. This royalty has now been raised to £6,000 a year. The yearly receipts of the telegraphs have been about £12,000, and the expenditure equals, if not exceeds, the income. In consequence certain reforms are to be initiated in the direction of compulsory payments. It is stated that fully 50 per cent. of the telegrams are sent free. Officials of the Government (central and local), priests, expounders of the law, relatives of persons connected with the working and the administration, and everyone who can provide himself with a reason or excuse, send their telegrams free of expense. As this system has been growing for many years past, and most of those who have benefited by it are in a position to give trouble, the management find it difficult to introduce changes necessary for their own protection. The Persian local system comprises about 3,100 miles of wire and 86 offices for the receipt and dispatch of messages. The wire provided by the Indo-European administration, gratis, is about 1,300 miles long, and extends from the Persian Gulf to the Russian frontier. Messages are restricted to 10 words, at a charge of 2½ krans (about 9d). The actual charge for the message is 2 krans, and the half kran is for the paper on which it is written. As regards telephones, the late Nasredin Shah, on Dec. 8, 1889, granted to the then Minister for Foreign Affairs a concession for electric lighting, the introduction of telephones, phonographs, and the application of electricity to industrial purposes to the whole of Persia, with protection to the monopoly for the period of 60 years. This concession was transferred to an American citizen for a certain valuable consideration, but for want of means the purposes of the concession have not been put into execution. In order to protect the concession from lapsing, two or three wires were put up and kept in a workable state, and are now in use. Five years ago the railway and tramway company commenced erecting private wires for anyone who would undertake the expense, and they established an exchange office on their own premises at Teheran. It has not been extended to any other town.

The Hopkinson Memorial Laboratory.—In his opening lecture to the engineering students at Cambridge on Friday last, Prof. Ewing announced that a gift of £5,000 had just been made for the addition of a new wing to the engineering laboratory in memory of the late Dr. John Hopkinson and of his son John Gustave Hopkinson, who recently lost their lives in the Alps. Dr. Hopkinson's son was to have begun work at this time as a student of engineering at Cambridge. This splendid and most welcome gift was made by Mrs. Hopkinson jointly with her son Bertram and her surviving daughter. Prof. Ewing, says the *Daily News*, went on to say: "I feel compelled to add a few words as to the loss which our profession—the profession on which you look forward to entering—has met with in the untimely death of Dr. Hopkinson. If I were to select any name to put before you as that of an engineer whose work and methods you would do well to follow, it would be his. He was a peculiarly conspicuous example of that union of scientific knowledge and genius with practical sagacity which goes to make a great engineer. His work was brilliantly original; in more than one department he led the way where a great host is now following. And his work was as sound as it was brilliant. His opinion was constantly being sought, partly because it was always fair and unbiassed—his character was too fine for anything mean or unworthy to find a place—and partly because his judgment came near to being infallible. You know that he took in Cambridge the most distinguished place that any student can take. He at once plunged into engineering work, and from that time to the end his professional life was an unbroken series of successes. But he made time for much original work of lasting value in science, and the world of pure physics is deploring his loss as much as it is deplored by engineers. Such a man may, I think, be said to live on not only in the results of his work, but in the force of his example. Dr. Hopkinson took from the first a warm interest in this laboratory and in the establishment of an engineering Tripos at Cambridge. It was only a few days before his death that he spoke to me of his intention to promote a subscription for the much-needed extension of the laboratory. It is a peculiar pleasure to me to think that this laboratory will, through the noble gift of Mrs. Hopkinson, and of his son and daughter, be henceforth associated with his memory and name."

Electric Remedies.—Mr. J. L. Morgan contributed to a recent number of the *Electrical Engineer* of New York an article on what he calls "The Illegitimate Watt." In short, he summarises the various swindles of recent years in which the word electric has been used to charm the dupes. The Rev. Jernegan's Electrolytic Marine Salts Company takes a prominent place amongst them. The article concludes with the following account of a recent experience of the author, which we leave in his own words: "As city electrician I received a telephone call from a doctor in one of the large office buildings to come and inspect an 'electric lounge.' I had never heard of an electric lounge, but putting on a bold front and a look of infinite wisdom, I knocked at the office door. I was admitted by the doctor, and he 'looked the part.' Tall, melancholic, and dressed in sombre black, he looked the typical wizard; and although his long Prince Albert coat, *negligé* shirt, and lay-down collar were a bit odd, his horn spectacles and curly wig gave him a look that was not soon to be forgotten. After showing me the mechanism of the lounge, which consisted of 32 electromagnets underneath the surface, he explained that with the double-throw switch he could get a steady stream of magnetic lines through your system, much like you would squirt water on a chained dog, or with the other throw of the switch you get the short-arm jab effect derived from the alternating current. All that he wanted was a certificate stating that it was a good and safe institution to patronise, which no doubt it was, as he told me that he had reclined all morning on the lounge, and that the effect was marvellous. Upon closer examination I saw that one of the wires was disconnected. The wily contractor had simply wound the magnets with any old scrap wire he happened to have and then left the circuit open, knowing that the machine was as potent without the current as with it. An employé of the firm that made the machine was present, and at my suggestion he reluctantly closed the circuit and threw the switch on the 'short-arm jab' side of the switch for a trial trip. And the effect was marvellous. The 32 magnets vaporised like shots from a rapid-fire six-pounder, the excelsior stuffing took fire, and to all this the doctor danced wildly and howled, 'Turn her off!' 'Turn her off!' The device was getting its current from a keyed socket on the chandelier, and although it was working grandly, I turned the key, but the current was too heavy to be broken by such a small 'break,' so we had pyrotechnics at two places. When the current was finally turned off and the room cleared of the dense white smoke from the excelsior and the sickening fumes from the burnt shellac and varnish, an inventory showed one electric lounge in a wreck, a chandelier in the same condition, a tremendous heap of law books in the area way, where they had been thrown by an excited tenant, two music teachers and a voice culturist in a swoon, and a very mad and disgusted doctor,"

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THE BELFAST ELECTRICITY WORKS.

McCowen, Victor A. H., the city electrical engineer, was born in 1866, and is the third son of Mr. Robert McCowen, J.P., Barrow House, co. Kerry. Before starting electrical work he spent about eight years at mechanical engineering, going through the shops and drawing office, and had considerable experience with mill machinery and water-power work. He studied for a couple of years under Profs. Thompson and Perry, and was employed on the staff of Messrs. J. E. H. Gordon and Co., London, in the estimating department, and was also engaged as one of that company's engineers at the Crystal Palace Electrical Exhibition in 1892. He also took an active part in the work of the Sydenham district central

station during erection, and was there one of the engineers-in-charge and at the lighting of Bray Island. For about two years he was chief engineer to the Killarney Electric Light Company, when he designed the scheme and carried out the work for the company. In 1894 he was appointed electrical engineer to the Belfast Corporation, and superintended the carrying out of their original scheme, designed by Prof. Alex. B. W. Kennedy. He is a member of the Institution of Electrical Engineers and of the Mechanical Engineers, and read a paper before the latter institution about two years ago on "Electric Lighting in Belfast," this being specially interesting owing to the fact that the station was gas-driven. He has also been one of the vice-presidents of the Municipal Electrical Association. The works just opened, and which we are describing, has been designed and engineered throughout by Mr. McCowen. The Corporation decided not to employ another consulting engineer, being confident that he was quite capable of carrying through the scheme, notwithstanding the size and importance of the undertaking, the outlay on which up to the present is about £70,000. The cost of the gas-engine scheme was about £25,000. Further extensions brought this to about £35,000, so that up to date the Corporation have expended over £100,000. We heartily congratulate Mr. McCowen on the successful way in which he has spent this money.

It is our purpose here to describe particularly the new electricity works erected in Belfast by the Corporation, but a few notes as to the history of this undertaking may serve as a fitting introduction. Thus the first electricity works were placed in Chapel-lane, and were designed by Prof. A. B. W. Kennedy. These were equipped entirely with gas-engines as the motive power. The size to which the gas plant has grown may be seen from the fact that there are now in these works two engines of 60 i.h.p., four of 120 i.h.p., and three of 150 i.h.p. These last three engines ran at 400 revolutions per minute, and were directly coupled to their respective dynamos. The station therefore gave a fair trial to gas-engines using the town gas supply, and the results have not been such as to warrant the extension of the system. Thus in 1897 the gas per unit sold cost 1·5d., which is much above what the cost would have been for fuel with a steam plant. The repair items also were heavy, and we are sure that Mr. Victor McCowen is right in his change over to steam for the new works. In spite of the difficulties caused by the gas plant and the irregularities which were sometimes noticeable, the demand for electrical energy has steadily increased, as is shown by the following figures. The first station was opened by the late Sir William M'Cammond on June 23, 1895. At the end of 1895 there was the equivalent of 8,500 8-c.p. lamps connected, and 1,500 applied for but not connected. A year later there were 14,500 lamps connected, and 3,000 additional ones applied for. At the end of 1897 the number of lamps connected had risen to 21,000, with 2,500 more applied for, and at the present time there are about 29,000 connected, and 8,000 applied for.

The following is an extract from Mr. McCowen's report of September, 1896, recommending the change of system to the Electric Committee: "Seeing that you have already expended about £33,000 in your present station and mains, and that all the available room for engines is taken up, and therefore the necessity of building another station, it is desirable that the system employed be such as will work in with the present one, and make use of your existing plant and mains to the best advantage. At present the distribution is on a three-wire continuous-current system at a pressure of 110 volts on each side, or a total of 220 volts. The distance of the farthest lamp from the station being 770 yards, or less than half a mile—for such an area of half-mile radius, I believe you could have employed no better system of distribution—viz., three-

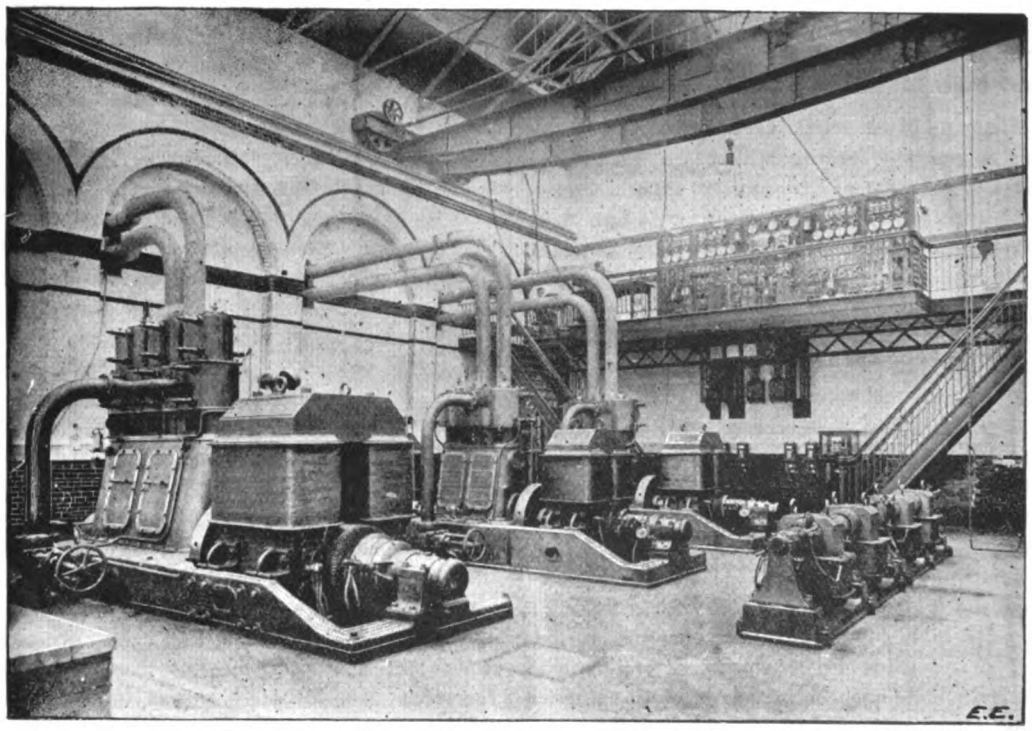

FIG. 1.—View of the Engine-Room at the New Electricity Works at Belfast.

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wire 220 volts; but when you desire to supply from one station an area of, say, two-mile radius, this pressure is too low to get economical results on account of the excessive capital outlay on heavy feeders. The riverside site on the Lagan Bank next the Albert Bridge is convenient for the delivery

system of distribution, and the value of the mains already laid, I recommend that the three-wire continuous-current system, with a pressure of 220 volts on each side, or a total of 440 volts, be adopted. This pressure will allow you to distribute current economically to a distance of about

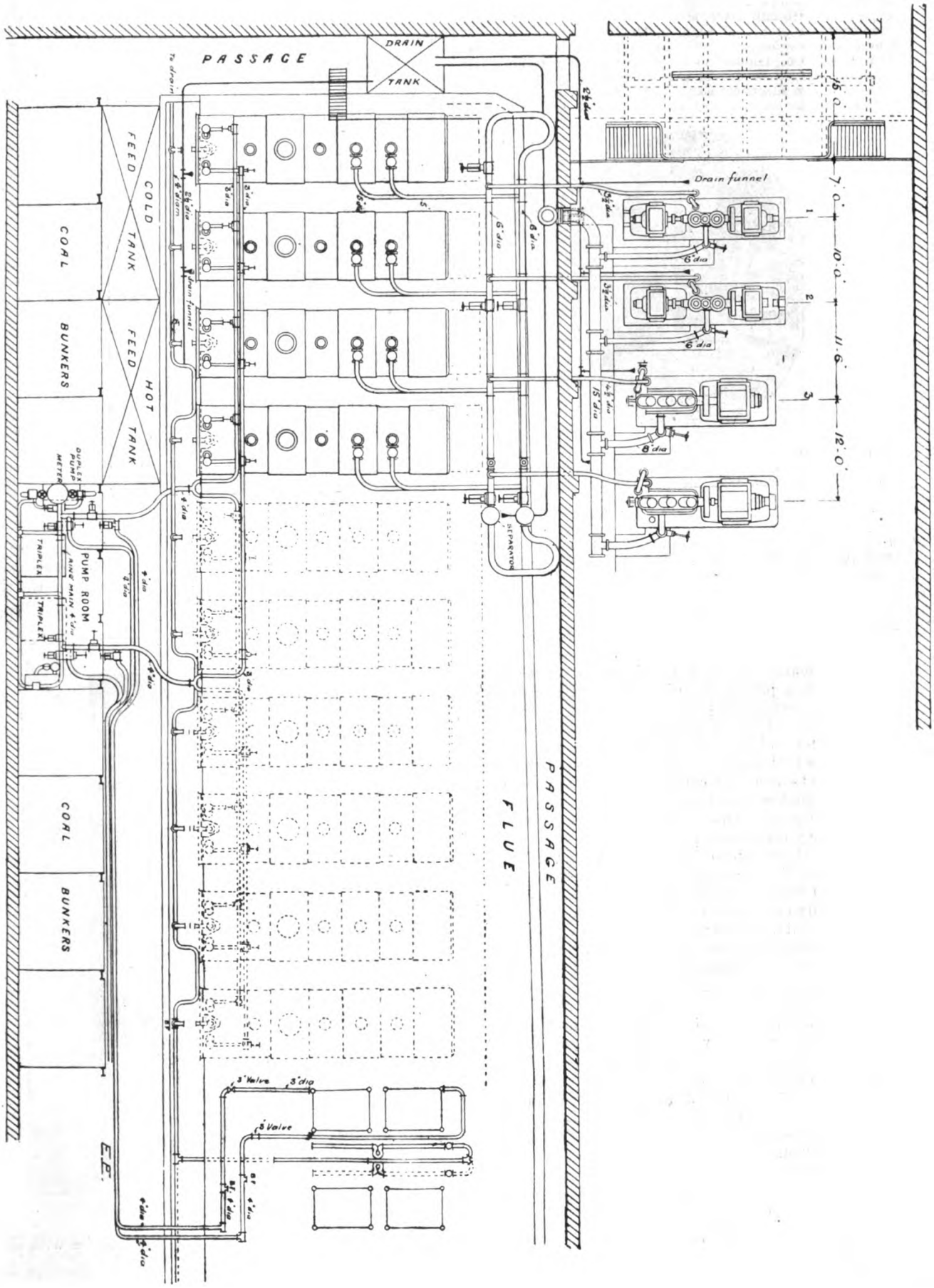

FIG. 2.—Plan showing General Arrangement of the New Electricity Works at Belfast.

of coal, removal of ashes, and condensing water will be available, and is large enough to accommodate plant capable of supplying the city's requirements for a number of years. After taking into consideration the area you desire to supply, the position of the site, and the present

two miles from the station. A radius of two miles from the proposed site would include from Cliftonville on the north side to the Windsor district on the south side of the city. Consumers beyond this area could be supplied on a high-pressure alternating system from the same station,

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or else from battery sub-stations, these sub-stations being placed at the end of the longest feeders, and the batteries charged at time of light load from the central station, and in this manner getting longer running hours out of the works, so that trucks of coal can be run in over the bunkers in the boiler-room. The site is central for supplying to the different districts of the city, though up to the present mains have not been laid on the co. Down side of the river.

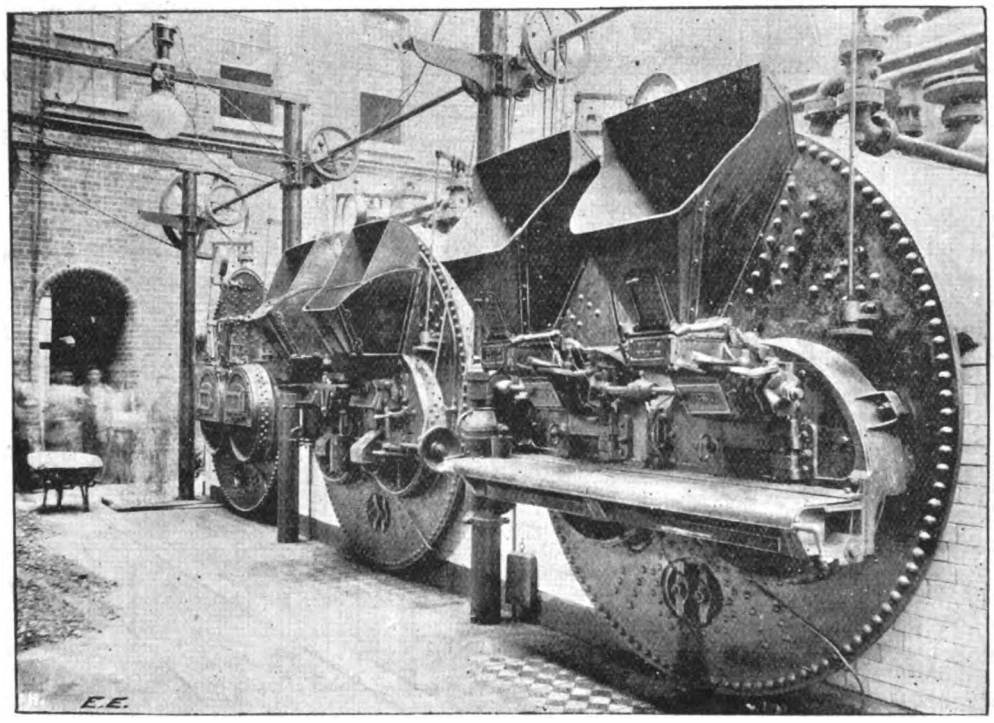

FIG. 3.—View of the Boilers, showing the Mechanical Stokers.

plant. It will be possible to change over the present station to work at double the voltage. These two stations would then deliver current into the same network of distributing mains, and help each other in dealing with the load. By the doubling of the present voltage the value of the existing distributing mains will be considerably increased, as the capacity of them will be increased fourfold, and as these mains are laid in the parts of the city where there is a probability of a heavy lamp density, the increased capacity will be a distinct gain. The higher voltage will allow of better regulation and a smaller percentage variations of pressure at the lamps. It may be well to mention that working at this pressure the dynamos would be made to generate current at a voltage which is approximately that required (and allowed by the Board of Trade) for electric traction—*i.e.*, 500 volts. So that should you desire at any time to supply current for this purpose you can put in plant which can be used either for lighting or traction, without the necessity of introducing transforming apparatus for at least the greater part of the present tramway area. The supply of current to the extremities of the system could be arranged for by storage batteries charged from the central station at night, or by a high-pressure transmission. By the combination of a steam-driven station and a gas-driven station supplying the same network of mains you should be able to get economical results. The steam station would take the bulk of the winter load, the gas-driven station helping over the peak of the load, and being always ready to take up a fog or dark-day load. The gas-driven station would be able to do the summer load when the steam station might be shut down for a few months (with the exception of a run off and on to charge the batteries, or arrangements could be made to charge these batteries in summer from the gas-driven station)."

We come now to the new works, built in accordance with that report, for the design of which Mr. Victor A. H. McCowen has been entirely responsible.

WORKS.

The works are situated at the junction of East Bridge-street and the Laganbank-road, within about 150 yards of the river. The advantage of this is that ample water can be obtained for condensing purposes, and coal can be delivered by barge, the intention being at a future date to erect an overhead tramway between the riverside and the

The new buildings, which are only a part of a much larger scheme, occupy a little over one-quarter of the space available. The total power which can be placed on the site eventually will be about 20,000 h.p., and the present

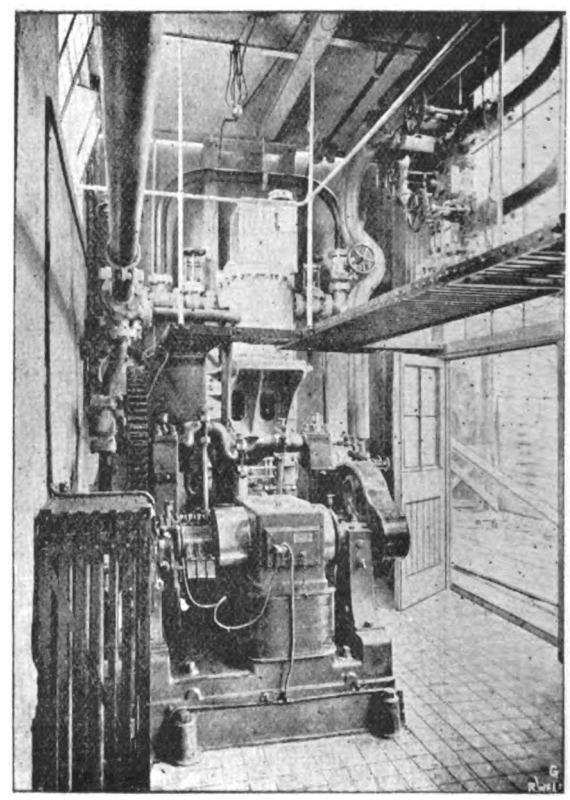

FIG. 4.—View of the Pump-Room, showing Electrical Feed Pump.

arrangements are such that they will harmonise with this large plant.

BUILDINGS.

The total space covered by the buildings is considerably over half an acre. The ground floor is occupied by the engine-house, boiler-house, with space for economisers, coal bunkers, pump-house, etc., battery-room, men's messroom,

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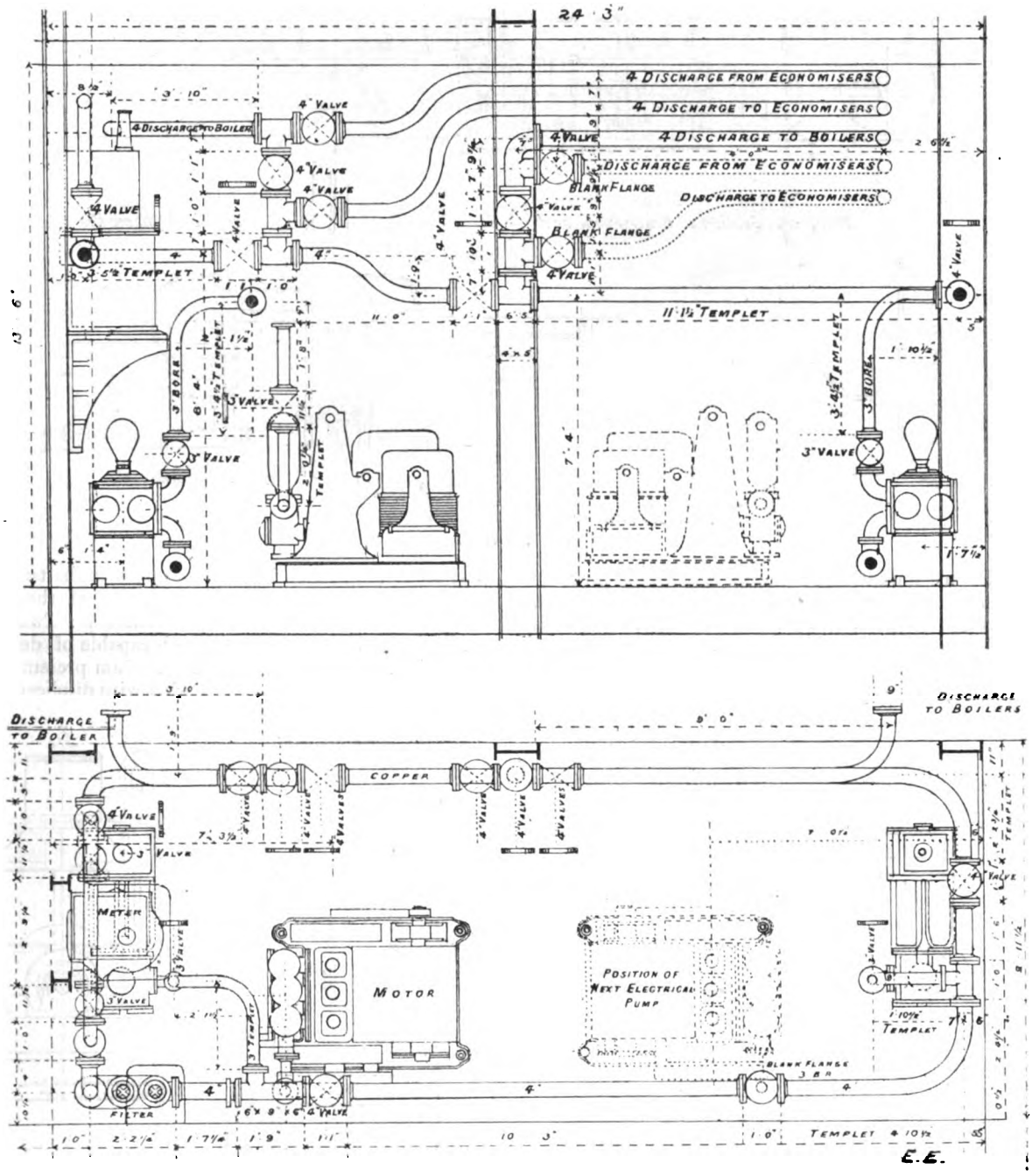
timekeeper's room, and sanitary accommodation. The engine-house (Fig. 1) is very spacious and lofty, being 200ft. by 40ft., and has its walls lined throughout with coloured glazed bricks, which present quite a picturesque appearance. The boiler-house is of similar length by 64ft. broad. On the first floor over the battery-room are the drawing, general, and private offices for the various officials, with strong-room, engineer's room, storeroom, meter testing and meter storerooms, main superintendent's room, and lavatory accommodation. The second floor is arranged as a residential flat for the engineer-in-charge. This is a large suite of bed and sitting rooms, with bathroom, kitchen, etc., and porter's apartments. The building throughout is of fireproof construction, the floors being of concrete and steel, on the principle of Messrs. Mark, Fawcett, and Co. The paving of the battery-room floor is of vitrified tiles bedded in cement, the joints being afterwards run with pitch, the object being to withstand the chemical action of the acids used in the batteries. The foundation, owing to the nature of the soil, had to be very extensively piled, the piles being framed together with steel beams bedded in concrete. The total number of piles driven in the course of the operation was about 1,200, the number under the chimney alone being 154. The distribution of the various departments of the building is so arranged that they can be duplicated at any future time to meet any demand that may be made on the establishment for increasing the machinery and plant, when accommodation for further boilers, engines, economisers, batteries, etc., could be easily and expeditiously arranged. The principal façade, which is towards East Bridge-street, along which it extends for about 225ft., is effectively treated in red brick and Giffnock stone in the style of the English Renaissance. It may be stated that the principal entrance, which is not yet completed, will be from East Bridge-street—the entrance for coal, machinery, etc., being from Laganbank-road. The chimney stack is a novelty in tall chimney construction, and is of quite an ornamental character, the red brick being judiciously relieved with courses of artificial stone, while a cornice and mouldings of the same material has been introduced in an effective manner, the whole being surmounted by a cast-iron cap to which four lightning conductors have been fixed. The height of the structure is 175ft., and the diameter at the base is 25ft., the internal diameter of the flue being 13ft. The architects were Messrs. Graeme-Watt and Tulloch, and the clerk of the works was Mr. Moore. The contractors for the buildings were Messrs. J. and W. Stewart, of Belfast.



FIGS. 5 AND 6.—Plan and Elevation of the Pump-Room at Belfast.

STEAM GENERATING PLANT.

The boiler-house (Fig. 2) is arranged to take 10 Lancashire boilers, 30ft. by 8ft., four of which are at present

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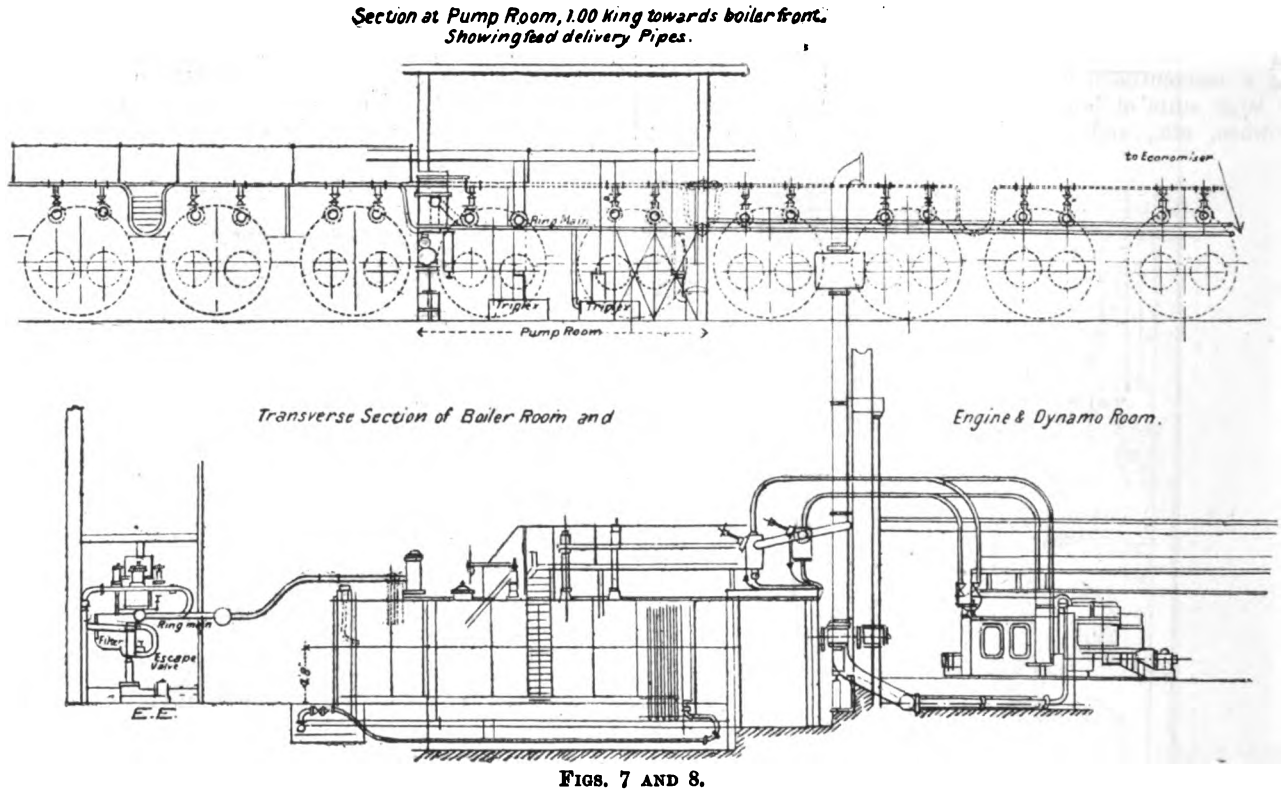
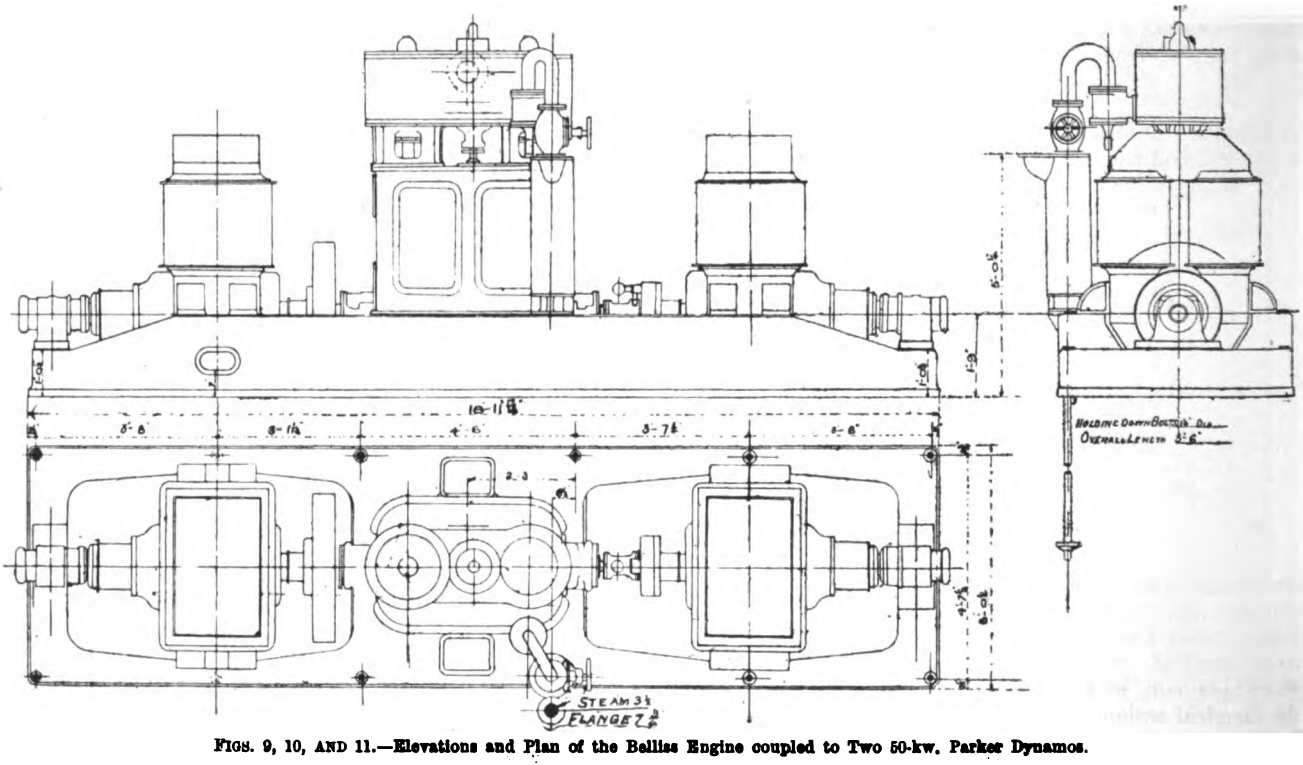
erected and working at a pressure of 160lb. per square inch. These boilers were manufactured and supplied by Messrs. Victor Coates and Co., of the Lagan Foundry, Belfast. The boilers are constructed for a working pressure of 180lb. per square inch, and have been tested to 275lb. per square inch by hydraulic pressure. They are fitted with Hopkinson's mountings, made for a working pressure of 200lb. per square inch. One is arranged for hand firing, and the others are fitted with mechanical stokers of the "sprinkler" type, as shown in Fig. 3. They are also provided with steam-jet. The stokers, as can be seen in the illustration, are rope-geared to a countershaft fixed overhead and driven by an electric motor. A Green's economiser of 216 tubes is erected at the end of the house next the chimney, provision being made to increase this number to 864 tubes as required. The scrapers are driven by an electric motor. The coal bunkers extend the whole length of the range of boilers, and are provided with doors opening on to an elevated roadway, from which carts can be unloaded with a minimum amount of labour. Plant to convey the coal from the bunkers to the stoker hopper will be installed at a future date, and provision has been made for an overhead tramway from the riverside when the building is extended.



FIGS. 7 AND 8.

The feed-pump room is situated opposite the two centre boilers of the range, occupying a portion of the bunker space. It contains the following machinery: Two sets of horizontal duplex steam-pumps, each capable of delivering to the boiler, against a head of 180lb. steam pressure, 4,000 gallons per hour. These are provided with duplicate steam supply. One three-throw electric pump of the same duty as the steam-pumps, and provided with by-pass and regulating resistance for varying the rate of feed. The pump was supplied by Messrs. Crompton and Co., and can be seen in the foreground of Fig. 4. The general arrangement of these pumps and their pipe connections can be seen in



FIGS. 9, 10, AND 11.—Elevations and Plan of the Belliss Engine coupled to Two 50-kw. Parker Dynamos.

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Figs. 5 and 6. There are also in the pump-room a feed-water oil-extracting filter, and a Kennedy water-meter, each capable of passing 10,000 gallons of water per hour. The latter is provided with a recording arrangement. A relief valve is fixed in each pump delivery and arranged to return all waste water to the feed tanks.

A ring feed main is fixed round the pump-room, to which is connected the deliveries from the pumps and economisers, and the duplicate feeds to the boilers. The pipes are solid-drawn copper throughout, and the necessary valves are Hopkinson's own make. Each pump is connected to two sets of tanks. The tanks are built below the stoking floor, and have a capacity of 20,000 gallons. There are also two distinct supplies from the city water-mains.

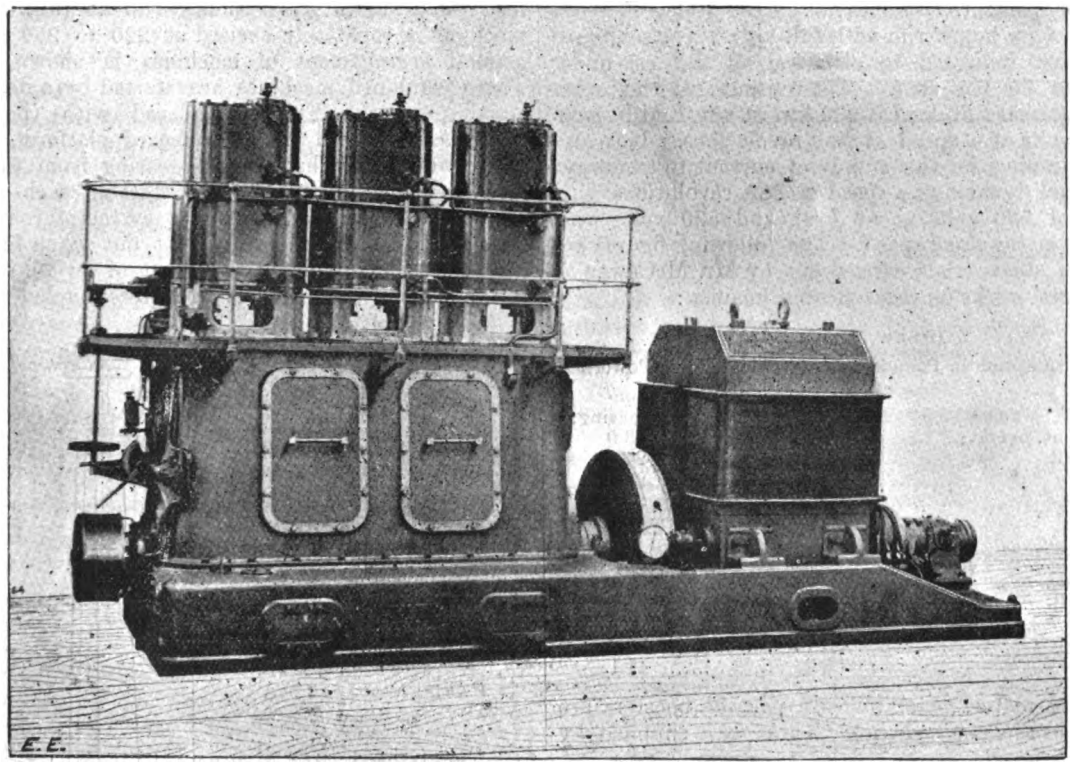

FIG. 12.—View of the Belliss-Parker 200-kw. Steam Dynamo.

STEAM-PIPES.

A complete duplicate system of steam-pipes is provided between the engines and the boilers (as is shown in Fig. 2). The two main steam-pipes are placed in the boiler-house (Fig. 7), being slung by rods from brackets fixed on the wall and from the roof irons. A branch pipe from each main connects to each engine through a Y-piece provided with valves fixed on the steam receiver. The boilers have two junction valves, with a 5in. branch to each main. The main steam-pipes are lap-welded mild steel, with wrought-steel flanges screwed and brazed on. Copper expansion bends connect the two ranges at the ends, and valves are fixed in suitable positions for dividing up the mains, one range only being in use at times of light load. The branch pipes to the engines and boilers are solid-drawn copper, and the T-pieces cast iron. The valves throughout are Hopkinson's patent parallel slide valves. Drains and steam-traps are provided where necessary. The whole of the pipework was tested by hydraulic pressure to 300lb. per square inch when erected and jointed. The exhaust-pipes are placed in trenches below the engine-room floor level. The main pipe, which runs parallel to and next the division wall, is brought into the boiler-house at one end and through the roof for use when the engines are running non-condensing. This is provided with a stop valve and a silencer (Fig. 8). The main pipes are cast iron, the branches to the engines being copper. A system of drain-pipes is arranged for engine and boiler house, and deliver into tanks. The drains are 3in. and the blow-off 4in. cast iron. The boilers are connected to the latter through isolating valves by copper bends. The whole of the steam and exhaust pipework was also supplied by Messrs. Victor Coates and Co., Limited, of Belfast.

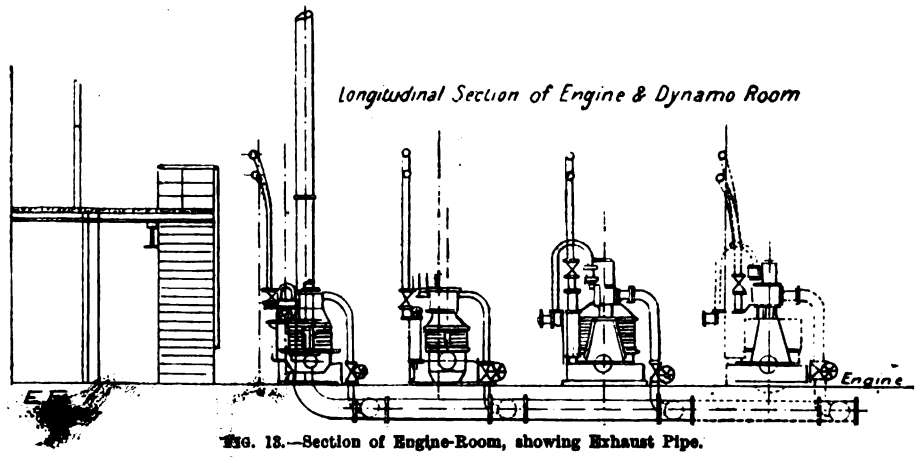

FIG. 13.—Section of Engine-Room, showing Exhaust Pipe.

ENGINE-HOUSE PLANT.

In the engine-house there are at present three sets of Belliss-Parker steam dynamos—two 100-kw., one 200-kw., and another 200-kw., in course of erection. The small sets consist of a two-crank compound engine (shown in

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Figs. 9, 10, and 11) with a 50-kw. dynamo coupled to each end of the crankshaft. When running at a speed of 380 revolutions per minute, these sets give their output at a voltage which may be varied from 220 to 350 volts by altering the resistance of the field. The higher voltage is required for battery-charging. The 200-kw. sets (Fig. 12) are coupled to 350-h.p. engines, which are three-crank compounds. The output of one dynamo is 440 to 500 volts with 455 to 400 amperes, at a speed of 360 revolutions per minute. Temperature rise does not exceed 70deg. F. above the air after a six hours' run with full load. The combined efficiency, from indicated to electrical, of this set under pressure was 86 per cent. The output of the other dynamo at normal full load is 200 kw. at any E.M.F. from 440 to 500 volts at a speed of 360 revolutions. It is also capable of running for the supply of current to tramways as a compound dynamo at a speed of 360 revolutions with an E.M.F. of 500 volts at no load, and 550 volts with 365 amperes at the same speed. The following figures are the results of steam trials carried out by Mr. McCowen at the contractors' works on these steam dynamos:

100-KW. SET.

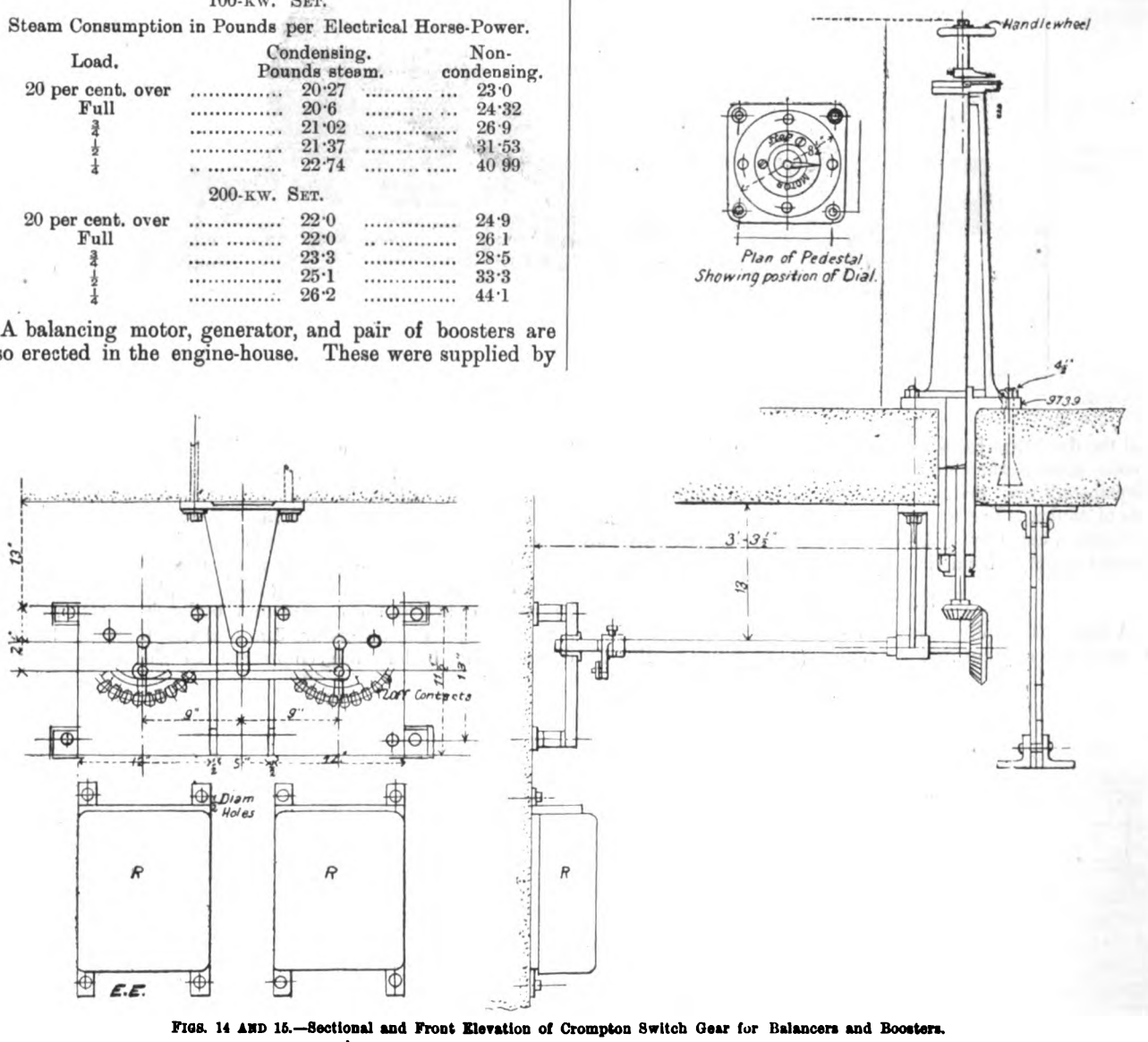
Steam Consumption in Pounds per Electrical Horse-Power.

Load.	Condensing. Pounds steam.	Non-condensing.
20 per cent. over	20·27	23·0
Full	20·6	24·32
¾	21·02	26·9
½	21·37	31·53
¼	22·74	40 99

200-KW. SET.

20 per cent. over	22·0	24·9
Full	22·0	26 1
¾	23·3	28·5
½	25·1	33·3
¼	26·2	44·1

A balancing motor, generator, and pair of boosters are also erected in the engine-house. These were supplied by Messrs. Crompton and Co., and consist of four separate armatures, coupled in line, each armature having its own field magnet. The two inner machines are similar, each being wound to give 12 kw. at 220 to 250 volts, and are capable of dealing with an out-of-balance current of 100 amperes in the middle wire. The two outer machines are the boosters, each having an output of 100 amperes at any voltage between 0 and 120 by altering the resistance of the fields. These machines are chiefly used for charging the end cells of the batteries (the main battery being always charged and discharged in parallel with the outside load). They can also be used for charging "hospital" cells, milking up portions of the battery, and supplying current for testing purposes, and, if necessary, for raising the voltage on a feeder. The speed of the combined set is 800 revolutions per minute. All the armatures are drum-wound, and having their spindles provided with couplings to admit of changing and repairing the armatures individually. The bearings are of ample size, and are self-lubricating, all the parts being designed for long continuous running, the temperature rise not exceeding 70deg. F. after six hours' run at full load. Each machine is separately excited at 220 to 250 volts. The general arrangement of machines is shown in Fig. 1. These combined machines are started by a double motor-starting switch (Fig. 14), placed with the necessary resistances beneath the switchboard platform, the switch being worked by hand-wheel gearing from the platform level, as shown in Fig. 15. On starting, each armature of the balancer is connected to the system through starting resistances, which are entirely cut out when full speed is reached. The double arrangement of switch is necessary, as the fields of the balancer are cross-coupled to opposite sides of the three-wire system to minimise the regulation by hand. The shunt regulating switch-gear, worked also from the switchboard platform, is provided for the adjustment of the booster and balancer fields.



FIGS. 14 AND 15.—Sectional and Front Elevation of Crompton Switch Gear for Balancers and Boosters.

ACCUMULATORS.

The battery-room, adjoining the switchboard end of the engine-room, is in a convenient position for working the battery regulating gear from the switchboard platform. Only about half of the available space is at present occupied by the two batteries, each consisting of 130 cells of the Faure-King type, having a capacity of 500 ampere-

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hours at a discharge rate of 100 amperes. They are also capable of discharging at 300 amperes for one hour. There are in addition eight hospital cells of the same capacity. The cells are placed in one tier at a convenient height on six parallel rows of stands, with a gangway between each pair of stands, and are suitably arranged for examination. Forty-five end cells on each battery are connected by solid copper rods to the battery regulating switches, which are placed in enclosed cases in the battery-room. The accumulators were supplied by the Electrical Power Storage Company.

Switchboard.

The switchboard (Fig. 16) is placed on a platform 13ft. above the floor-level at the west end of the engine-room, and is arranged for six feeders, eight dynamos, a motor-generator, the two "boosters," and battery regulators. The connections of the switchboard are arranged as shown in Fig. 17. There are at present erected five enamelled slate panels, 7ft. 6in. high, the width varying from 3ft. 3in. to 2ft. 8in., according to the amount of apparatus mounted on each. The framework carrying them is built up of H section steel, the joints between the slates being covered with a teak moulding. The centre panel carries the positive and negative battery and middle wire ammeters, battery emergency switches, and regulator hand-wheels and indicators, the feeder resistance switches, two large (Weston type) feeder voltmeters to show the pressure at the feeding points, three Kelvin electrostatic voltmeters for indicating the pressure between the middle wire and either side, and right across the system at the generating station end, the necessary apparatus and gear for two boosters, including ammeters, automatic switches, shunt-maker, and break switches, and plug bars for connecting the boosters in the various ways they can be used. The other four panels carry the feeder and dynamo bars and instruments, the two on the right of the centre panel being for the positive, and the two on the left for the negative sides of the system. The feeder and dynamo bars are placed vertically on the front of the panels, the four 'bus bars being fixed horizontally at the back. The panels adjoining the centre one have, in addition to the above, a charge and discharge battery bar, which can be plugged on to any one of the 'bus bars, a safety arrangement being provided so that it is not possible to plug both charge and discharge on to the same 'bus bar together. A double-pole throw-over switch is provided in the circuit of each of the 50-kw. dynamos, so that they may be run in parallel on either side of the system or in series across the outers. A switch is also provided for disconnecting them from the middle wire. Each machine has in circuit with it an ammeter, a "minimum automatic cut-out," a fuse on both poles, and a supply meter. Each feeder has in circuit on both poles an ammeter, duplex fuse, and switch. The feeder resistances consist of five back E.M.F. cells on each side, which can be switched in between the top and second or top and third 'bus bars if it should be found necessary to slightly lower the pressure on a lightly-loaded feeder. These are actuated by hand-wheels fixed on the centre panel. The battery regulating switches, which are fixed in the battery-room, are actuated from the switchboard through shaft and bevel gearing. Provision has also been made for working them direct in the battery-room in the event of anything going wrong with the gear. A reversible ampere-hour meter is in the circuit of each battery. The shunt regulating resistance and switches of the dynamos, motor-generators, and boosters, and the starting resistance and switch of the motor-generator are placed below the concrete floor of the switchboard platform, and are connected by suitable gear to handwheels supported on pedestals placed in a convenient position on the platform. The leads from the dynamos are brought through the foundation block in Doulton casings (Fig. 18), and cleated up to the back of the wall supporting the switchboard platform. The feeders are brought from the switchboard in the form of insulated cables. These are cleated on to the end wall behind the switchboard, and taken through Doulton casing to the outside. The switchboards were manufactured and fixed by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne.

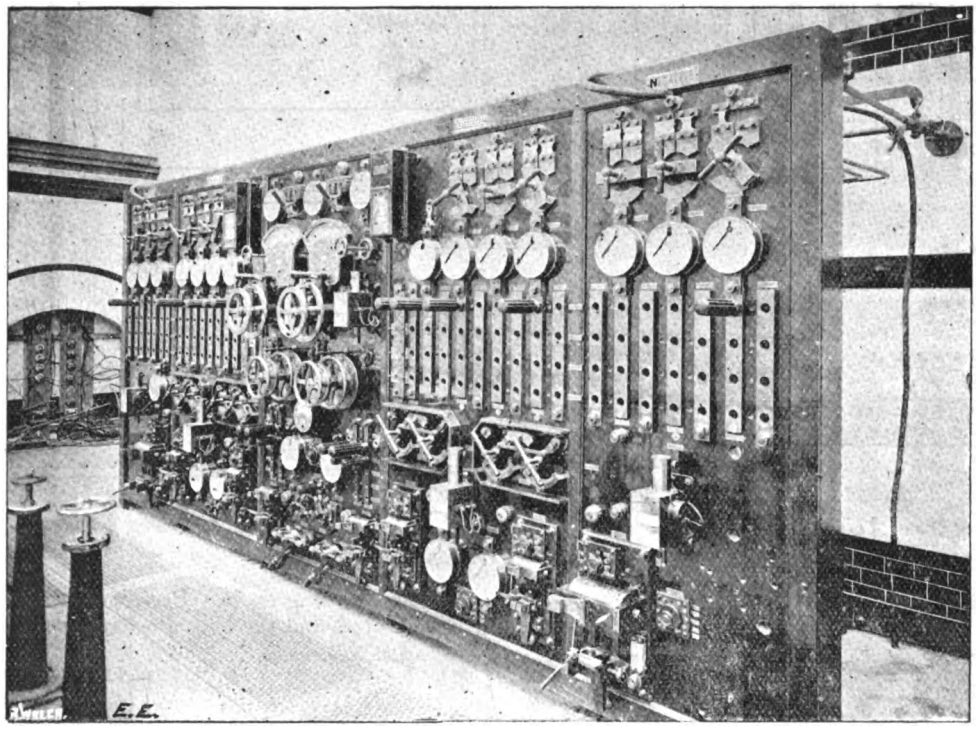

Fig. 16.—General View of the Belfast Switchboard, made by J. H. Holmes and Co.

Mains.

The system of distribution is the three-wire low-tension 440 volts between the outer wires, or 220 between either outer and the middle wire. The latter being the pressure current is delivered to consumers except in special cases, when a supply is given at 440 volts. The distributing mains are connected up in a network, and fed at several points by feeders from the generating stations. Pilot wires are connected from the feeding points to voltmeters on the station switchboard, so that the engineer in charge can see that the proper pressure is being maintained on the network. The mains consist of single-core cable insulated with vulcanised bitumen and drawn into Doulton earthenware casing when laid under footways, or into cast-iron pipes under roadways. Doulton conduits of the standard type, with either two, three, or six rectangular ways, each 2¼in.

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by 2¼in., have been laid to the extent of about 250,000ft. of single duct. The joints between the lengths have been made by means of cast-iron clamp collars in two portions bolted together. The interior of the collars is recessed and the upper piece is provided with an aperture, through which is poured a rapidly setting bituminous compound. This entirely surrounds the ends of the lengths, and is prevented from entering the ducts by Doulton's patent expanding joint mandrils, one of which is inserted into each duct while the joint is being made. Perfect continuity of the ducts is thus secured, and the bolted collars provide ample strength at the joints. In Fig. 19 are shown sections of the joint of three-way conduit before being filled in with bitumen. Branch cable connections are provided for in the following

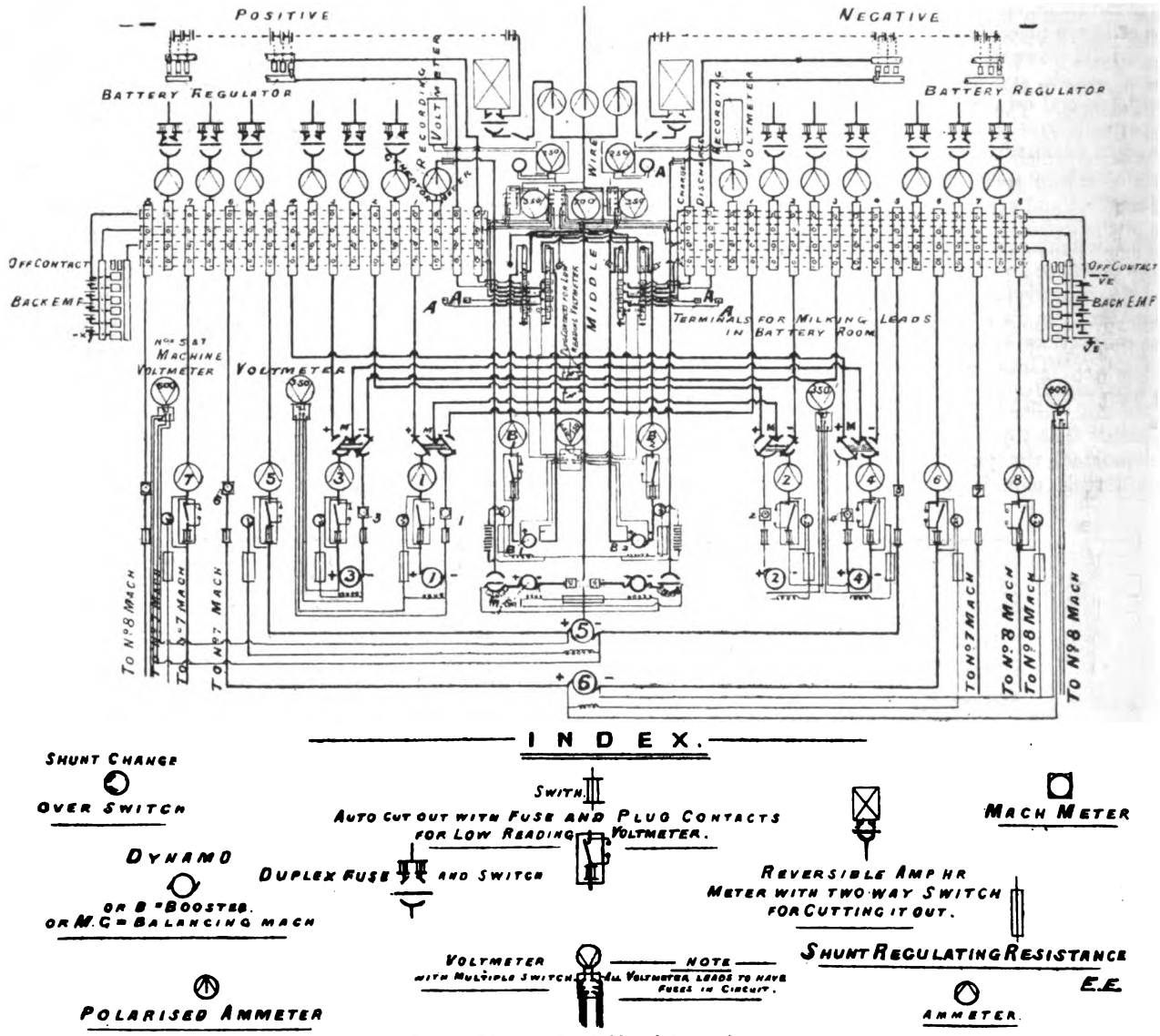

FIG. 17.—Diagram of Switchboard Connections.

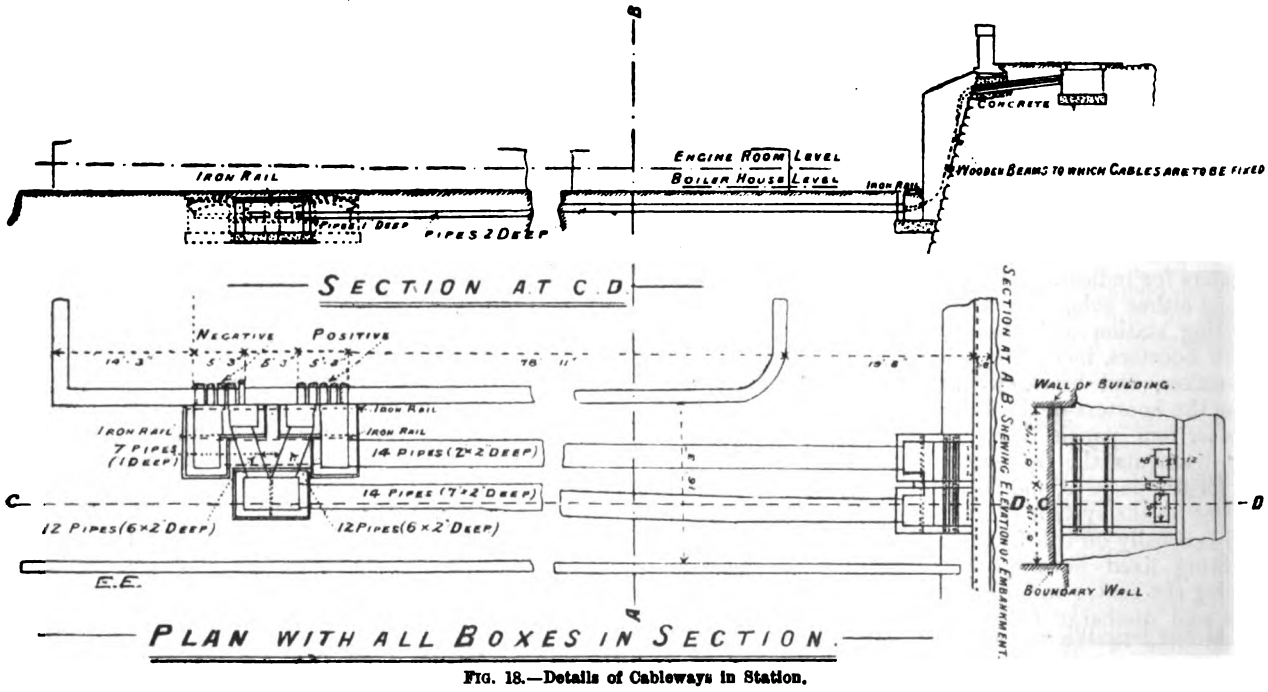

FIG. 18.—Details of Cableways in Station.

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manner. At suitable intervals in the line of conduits, special lengths are laid, which are grooved during manufacture in such a way that, while strength is preserved, a longitudinal division can be made by means of a chisel when desired. When a T connection is required, the upper portion of the split length is detached, giving access to the cables. The cable joints having been completed, a junction cover made for the purpose is substituted for the piece which has been detached. This cover is fitted with a cast-iron socket piece to take the service pipe. Lead-covered and armoured three-core cable is also used in some of the avenues in the residential district. The recent cable extensions and all the roadwork for them have been carried out by the Callender Cable and Construction Company, Limited. The most distant point supplied is about 2¼ miles from the generating station. There are at present an equivalent of 29,000 8-c.p. lamps connected to the mains, which include 150 h.p. in motors, and applications have been received for an equivalent of 8,000 8-c.p. lamps

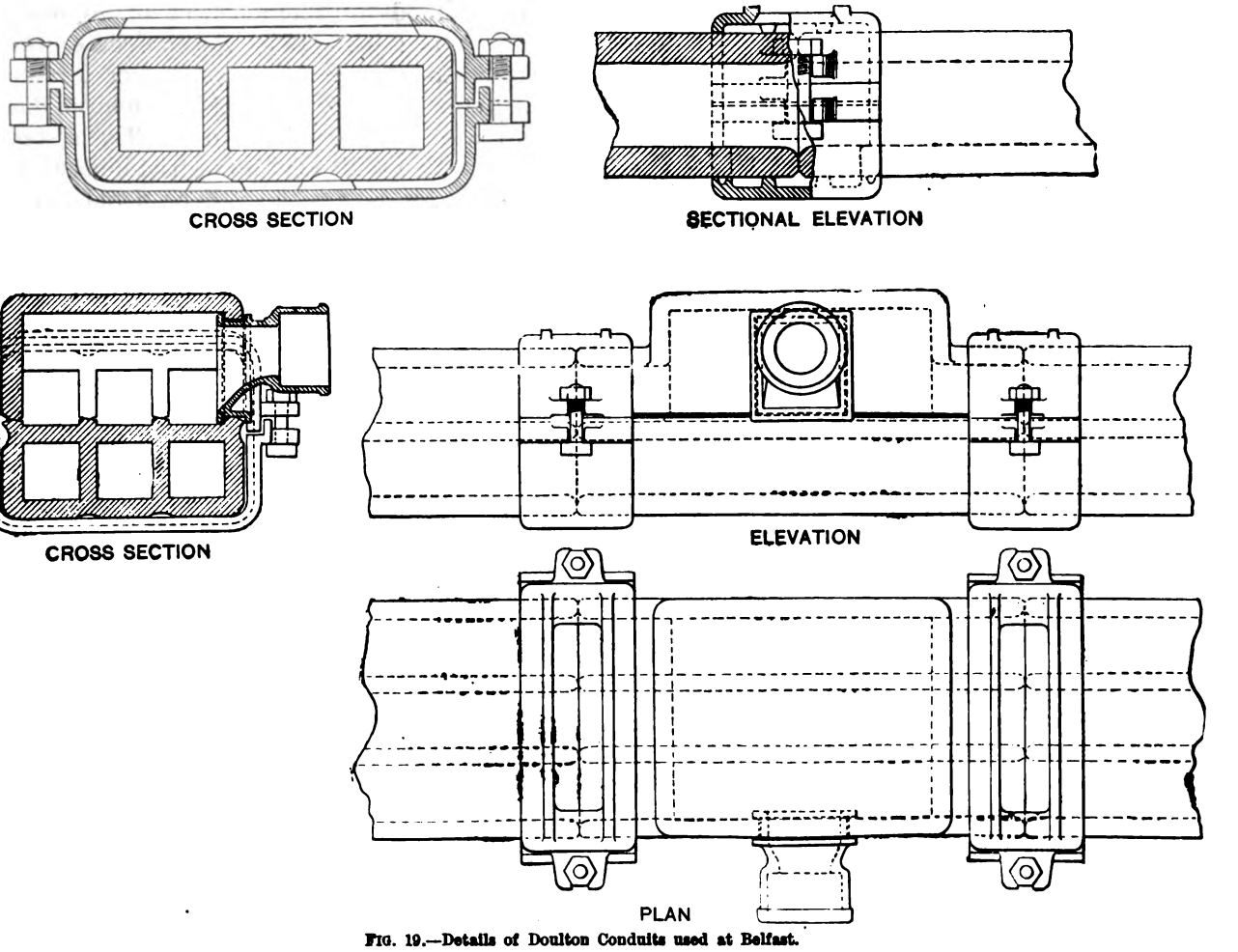

FIG. 19.—Details of Doulton Conduits used at Belfast.

in addition, so that it will be necessary to order further plant at an early date. The "Wright" system of charging has been in operation since July 1 last, and when the advantages of this become known the demand will no doubt increase still more rapidly.

THE OPENING CEREMONY.

The inauguration of the new works took place on Tuesday last, when elaborate preparations had been made for the reception of the Lord-Lieutenant of Ireland (Earl Cadogan), who subsequently declared the works open. The exterior of the extensive range of buildings had been gaily decorated with flags and bunting, and along a portion of East Bridge-street were placed rows of venetian masts with vari-coloured streamers flying merrily in the breeze. The interior of the building through which his Excellency was to pass had also received attention at the hands of the decorator. The Lord Mayor and the other members of the Corporation preceded the Lord-Lieutenant by a few minutes from the new City Hall, so that they were in readiness to receive him upon his arrival at the electric station. Subsequently the Lady Mayoress, at the request of Mr. Stewart, presented a gold key to the Lord-Lieutenant as a memento of the occasion. The following inscription is engraved on the shield on the back of arms on the key: "To his Excellency Earl Cadogan, Lord-Lieutenant of Ireland, on his opening the electric lighting station, Belfast, by the contractors, J. and W. Stewart, 1898."

At the conclusion of this interesting little ceremony the Lord-Lieutenant, accompanied by the Lady Mayoress on the right and Councillor Andrews on the left, and followed by the Lord Mayor and Lady Cadogan and the members of the Corporation, proceeded up the room to the switchboard platform. Here Councillor ANDREWS asked the Lord-Lieutenant to declare the station open.

The LORD-LIEUTENANT, who was again received with loud applause, said: I have the greatest pleasure in responding to the invitation of Councillor Andrews to declare this station open. I need hardly say I wish every success to this building and to the labours which have been here carried out. I now declare the station open.

The chief engineer afterwards explained the different apparatus and plant to his Excellency, who seemed greatly pleased with what he saw and heard. The Lord-Lieutenant and party were then taken into the engineers' department, where they signed their names in the visitors' book.

Steel for Magnets.—The *American Journal of Science* gives the results of tests of a large number of magnets made of self-hardening steel, now in common use for lathe tools. The object of these tests was to search for a material for standard measuring magnets which would be as permanent as possible, and have a small temperature and induction coefficient. The experiments show that comparatively short seasoned magnets made of this steel have decidedly smaller induction coefficients than magnets of the same dimensions made of tool steel; the difference in the temperature coefficient is much less, but the advantage is still on the side of those made of self-hardening steel; the temperature and induction coefficients of long magnets of the two kinds of steel do not seem to be very different.

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THE LONDON COUNTY COUNCIL AND TRAMWAYS.

The London County Council has, we believe, decided to make a start in working tramways at the beginning of the New Year. We have had our say as to this policy, and have nothing further to add upon the facts accomplished. The discussion upon Mr. J. C. Robinson's communications at the last meeting of the Council brings up other matters. If our readers will turn to pp. 439-440 of our issue of Sept. 30, they will see that Mr. C. J. Robinson, on behalf of the London United Tramways Company, suggested certain agreements and offered to make certain arrangements, and either to give or remove them in 1908, when the Council might undertake the control of these tramlines. Mr. Robinson says practically, Certain methods of traction will be to our convenience now; if in 1908 you purchase, we will undertake to remove these systems or leave them without cost to the Council. Mr. Robinson desired to introduce the overhead or trolley system of electric traction. Nor did he restrict himself to the continuance of such system, but offered to change for any other system "proving more efficient, economical, or acceptable." The Highways Committee of the Council reported on Mr. Robinson's letters, and the report, after summarising his views, says:

"We are still of the opinion which we have previously expressed that the overhead trolley system of electrical traction is unsuitable for the more crowded of the London thoroughfares. As, however, the company is desirous of making an experiment, and has offered to make concessions which will probably be of considerable benefit to the Council should the experiment ultimately prove successful, and has further expressed its willingness to adopt any other system which may be proved superior after further experience shall have been gained, we think that the Council might give provisional consent to the application being made by the company for authority to use the overhead trolley system of electrical traction, but so far only as regards that part of the company's tramways between the Askew Arms public-house and the Uxbridge-road railway station, and on condition that, in consideration of this concession, the company reconstructs, according to an underground system of electrical traction, the other two lines of tramway specified in Mr. Robinson's letter. This arrangement, if carried out, will afford the company an opportunity for a full and satisfactory trial of both methods of electrical traction upon roads quite at the outskirts of the county; and the Council will be able to ascertain whether the overhead trolley system proves successful in the Uxbridge-road, and is or is not a source of inconvenience, and also whether underground conduit and overhead trolley systems can be successfully worked, as we have been assured they can, in conjunction with each other. We recommend that Mr. J. C. Robinson, managing director and engineer of the London United Tramways, Limited, be informed that the Council will, on the terms stated in his letter dated Sept. 27, 1898, consent to application being made by the company to the Board of Trade for power to reconstruct, in accordance with the overhead trolley system of electrical traction, the tramways in that part of Uxbridge-road between the Askew Arms public-house and the

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railway station, on condition that the company do also, and on the same terms, reconstruct, according to an underground system of electrical traction, the tramways (*a*) from Uxbridge-road railway station by Goldhawk-road to Young's-corner, and (*b*) from Young's-corner to Hammersmith-broadway, and do submit for the Council's approval full plans, details, and other particulars of the works referred to."

After some discussion, and the moving of amendments, this recommendation was carried. In our opinion the recommendation is a proof of the crass stupidity of the Council. It may be possible, it may be convenient, it may even be commercially profitable to have breaks of system in short lines, but, upon the face of it, such breaks are neither desirable nor progressive. Perhaps the London County Council argues that breaks of system exist in going from horse to cable system, hence there is no objection to carrying such breaks into electrical systems. Surely the committee have decided the recommendation upon other than business grounds. The company's offer is understandable; the committee's recommendation possesses no glimmer of light. Why suggest a mixture of systems? Is it to obtain information on both systems at the expense of the company? Is it to tie the company rigidly to horse traction to 1908, and then to point out how behind the times is the system in use? All over the country there is a straining for progress in matters of traction, but the London County Council seems to be the stumbling block to all progress. We could understand all conduit, or all trolley, but we cannot understand the mixture. The people most interested in the question—the citizens of Hammersmith—decide by the vote of their Vestry in favour of Mr. Robinson's proposals—the overhead system. Every inducement is offered by the company to give it a fair trial, as the London County Council is safeguarded in every direction. If the overhead wire proved such an eyesore and nuisance as is represented, it could, by the terms of the offer, be removed after a year's notice. The gain sanitarily, as well as with regard to street surface, would be very great to the vestries interested; but the London County Council does not consider the indirect benefits—it only seems to consider "politics."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ARC LIGHT DYNAMO.

SIR,—Might I ask your opinion of the cause of the following trouble? I am employed in charge of series-wound machines (500 volts 20 amperes), used for arc lighting, 11 lamps in series. Ever since the erection of the plant six years ago, we have had constant trouble through small holes forming in the insulation of commutator bars, either close to insulating washer or at the heel of the bar, which continue to develop until a permanent short is established from bar to bar. There is no earth on the circuits, nor have I ever met with this trouble on any other installation.—Yours, etc., ICONOCLAST.

[In this case it is not possible to give a definite answer, as our correspondent has not supplied us with details of the dynamo. Still, from what is given as to the gradual piercing of the insulation, we gather that it is due to a self-induction effect setting up a high voltage just after the point of commutation due to the sudden changes in the current.—ED. *E. E.*]

PERSONAL.

SIR,—In your issue of Oct. 14, in an article referring to certain bankruptcy proceedings, mention is made of the Randall Telephone Patents Enterprise and of the Randall Telephone Company, Limited. That there may be no misunderstanding by the many readers of your journal in regard to these statements likely to place me in a false position, I wish to state that although the Randall Telephone Patents Syndicate, and also a company under the name of the Improved Telephone Patents, Limited, have been registered, I was not a party to either, and both were registered without my knowledge or consent, and I have never received or even seen any of the alleged shares or bonds, neither had I any knowledge of the bill transactions referred to, nor any acquaintance with the gentleman named in your article as the debtor. Neither of these registered companies have any rights under or claims upon my patents or either of them.—Yours, etc.,

C. ADAMS-RANDALL.

London, W.C., Oct. 17, 1898.

THE SHOREDITCH DUST DESTRUCTOR.

The following letter appeared in the last issue of the *Contract Journal*:

SIR,—So many conflicting statements have been made respecting the financial success of the Shoreditch dust destructor for generating steam for the electric lighting, that a copy of the authorised and duly-audited Vestry accounts showing what I take to be the true version of the facts will be welcome to those who are interested in this municipal problem, which undoubtedly has yet to be satisfactorily solved.

I notice that the statements of the vestry clerk in his report on p. 2 of the volume are not borne out by the figures in the authorised accounts, and are consequently misleading and calculated to do municipal government considerable injury.

The vestry clerk states "that 18,842 tons of refuse have been destroyed (the surveyor states 18,378, p. 188) in nine months, and the heat produced therefrom and from an expenditure of coal costing £279 (?) has thus produced all the steam required for the generation of 491,107 Board of Trade units of electricity." He also states that "the chief electrical engineer makes the total cost of the destruction amount to £2,837, including repayment and interest on capital, whereas under the old system of barging it would have cost £2,904 to have disposed of such refuse," and, he further states, "after allowing therefore out of electricity profits £2,192 for repayment of interest and capital, and £500 for the cost of steam, there is a net profit, including the saving of previous expenditure on the joint schemes for the first nine months of working, of £1,268."

I have carefully examined the audited accounts and find the following quite different statements occur. Query, which are correct? I prefer the latter.

The value and quantity of fuel delivered to the destructor is (taking the vestry clerk's figure) 18,842 tons of refuse.

Page 350, coal 315 tons	£278	19	8
Page 323, coal 54 tons	46	16	0
Page 323, coke 33 chaldrons	14	17	0
	£340	12	8

against the vestry's clerk's £279.

I now come to the financial results of the working (March 25, 1896, to March 25, 1898) of the electricity works, with the repayment and interest of capital, which show a loss of £1,281. 19s. 4d. (p. 363) from March, 1896, of which £1,255. 8s. 2d. was paid out of the rates; but after paying all charges at March 25, 1898, and allowing for the repayment of £1,255. 8s. 2d. to the general rate account, there is a *net loss* of £474. 7s. 2d., thus showing as an electricity supply the authority have a valuable undertaking, but this does not appear to be the case when the dust destructor is taken with it as a joint scheme.

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The dust destructor maintenance cost (p. 328) shows a total of	£4,202	4	5
Less a credit of revenue of	249	15	0
Total net cost	3,952	9	5
Barging saved per the vestry clerk, 18,842 tons	2,904	0	0
Total cost of disposal (exceeding the old system by)	1,048	9	5
But the electricity accounts show a loss of	474	7	2
Leaving a total loss on the joint scheme of	£1,522	16	7

The vestry clerk states a profit of £1,268. 17s. 9d. (p. 2). Who is correct?

But another curious feature presents itself—viz., the average of the total cost of the Dusting and Scavenging Committee's accounts for 1894 and 1895, 1895 and 1896, 1896 and 1897 was £18,563 (see p. 401), whereas in 1897-98, with the dust destructor, it was £22,388; this increase of £3,825 requires a careful investigation by the ratepayers. Again, I note that the street-lighting in 1896 and 1897 was £6,379, but with the electric lighting in 1897 and 1898 it was £7,916, showing an increase of £1,537, which would make the electricity works into a heavy loss, an increase of light in the streets being the only advantage gained for this extravagant burden.

Taking the destructor accounts, I find that a guaranteed statement was made by the contractors (see engineers' printed report on tenders) that the labour and maintenance for the destruction of 20,000 tons of refuse per annum would be £1,700. The stokers' wages alone (see p. 323) exceed this amount of £2,093 by £393 for 18,842 tons, and taking the total cost of maintenance at £3,952. 9s. 5d., it exceeds 4s. 2d. per ton disposal, including barging, or, without barging of clinkers, 3s. 9d. per ton.

I am aware that there is an initial expenditure in these amounts which will not recur, but I note also no amount for depreciation is allowed in either case.

I have left the engineering side of the matter to be discussed in some other way and season, but the figures in the costs show clearly the leakage, and this is particularly seen in the units generated, as out of the total of 491,107 no less than 156,725 are used on the works and 50,087 (see p. 366) are not accounted for, which means that only three-fifths of the energy generated produce any revenue.

Although these are the results from this individual plant, I do not infer or wish to be understood that all destructors are and will be financial failures. Far from it. I believe that this object lesson shows glaringly the faults which may be remedied, and that 1s. 6d. per ton for disposal without clinkers may be achieved. St. Pancras are near this now, thanks to Mr. Morley.

I notice that some remarks have been made as to the results of 12 months' working—June, 1897, to June, 1898. These figures are not published, therefore I cannot deal with them. Being a vestryman of St. Marylebone I have analysed these figures, as being of special interest and instruction in view of the possibility of this Vestry also embarking on a similar project.

To sum up the results as set forth in the accounts, I am of opinion that the extra lighting in the streets is not worth £1,537, therefore the charge per unit to that department is much too heavy, and fully two-thirds should be surcharged the electricity accounts and some of the dust destructor. Maintenance—as coal stoking—and the carting of all clinkers and the barging of 4,712 tons of clinkers, etc. (p. 323), should also be charged to the electricity accounts *in contra* for the heat supplied as well as an absolute value, when something like a real cost of working of the joint scheme could be arrived at.—Yours, etc.,

T. W. BAKER.

Broad-street House, E.C., Oct. 17, 1898.

ASSOCIATION OF MUNICIPAL CORPORATIONS.

The autumn general meeting of the Association of Municipal Corporations was held at the Westminster Palace Hotel on the 19th inst., and the principal topic of discussion was the action of the House of Lords in assenting to the General Electrical Power Distributing Company's Bill. Sir A. K. Rollit, M.P., occupied the chair, and there was a large attendance, including the Lord Mayor of Manchester, the Lord Mayor of Sheffield, and the Mayor of Nottingham. We extract from the *Times* as follows:

SUPPLY OF ELECTRICAL POWER.

The MAYOR of NOTTINGHAM moved: "That this association affirms the principle that where local authorities have, with the sanction of Parliament, established, or are in the course of establishing undertakings for public benefit, and have not failed in the performance of their duties, it is not right or expedient that powers should be granted to companies to compete with such local authorities." He said that nothing had tended in a greater degree to the well-being of the inhabitants of the municipalities of the country than the action taken by the different corporations, under the direct sanction and authority of Parliament, to acquire gas and water undertakings. As to electrical undertakings, corporations had naturally understood that Parliament would follow the same policy adopted in respect to gas and water undertakings. That policy was that local authorities should have no competitors. The practice established by Parliament in regard to gas and water was followed by the Board of Trade in the matter of electrical undertakings—namely, that no concession should be granted to a public company until the corporation or the local authority of the district concerned had first had an opportunity of deciding whether the community themselves desired to undertake the supply. Under such circumstances the various corporations must have been startled when they found that the Bill of the General Power Distributing Company had been lodged in Parliament, and still more startled when they saw that it had received the sanction of the House of Lords, an Assembly on which many were inclined to rely for the protection of the rights of property. The Bill contained most revolutionary proposals. At present it applied to a large district in the Midlands, including the cities of Lincoln and Sheffield and the town of Nottingham, and provided that the company promoting it should be permitted to enter the district and compete with the corporation or other authorities in the distribution of electricity. In a short time the Nottingham Corporation will have spent close on half a million sterling on electrical undertakings. The association could imagine their dismay when they learned that by means of a private Bill they were to be subjected to the competition of a company working for a profit. At present Nottingham and Sheffield were threatened, but if the Bill passed it would soon be found that Liverpool and Manchester and other places were threatened. As corporations they could not sit tamely by under such circumstances, and he appealed to them to pass his resolution in the interest of self-preservation.

The LORD MAYOR of SHEFFIELD, in seconding the motion, said that Sheffield had just taken over an electric lighting undertaking at a premium of £125,000. If this Bill became law, the whole of the money would have been thrown away. Sheffield asked their colleagues to help them in the fight against this company.

The TOWN CLERK of LIVERPOOL said that an important point involved was whether or not it was desirable that the council of any town should supply electricity at less than cost price at the expense of the general body of ratepayers. He understood that the Nottingham ratepayers had decided to supply electric light, but to supply it at the cheapest possible cost consistently with not throwing any charge on the rates. A company now suggested that if they were only authorised to go into Nottingham and break up the streets and lay down mains, they would be able to supply electricity at a price which must force the Corporation so to reduce their charges as to throw a considerable burden on the rates of the town.

The LORD MAYOR of MANCHESTER maintained that the case of Nottingham and Sheffield was unanswered. He did not believe the House of Commons would ever pass such an iniquitous Bill.

The TOWN CLERK of DONCASTER, a REPRESENTATIVE of LEEDS, the TOWN CLERK of EASTBOURNE, the TOWN CLERK of ILKESTON, the TOWN CLERK of DEWSBURY, the TOWN CLERK of SOUTHPORT, and the MAYOR of CREWE having supported the motion, it was adopted unanimously.

A further resolution requesting the council of the association to organise an opposition to the Bill was agreed to.

TELEPHONES.

The DEPUTY TOWN CLERK of HUDDERSFIELD moved: "That the association represent to the Local Government Board, the Postmaster-General, and the Treasury the expediency of legislation being so framed that the Postmaster-General be empowered to grant licenses which shall be self-contained, and confer all necessary and incidental powers for the supply of telephony by local authorities, including borrowing powers." He pointed out that under the present system there must be delay in the spread of telephony. Before local authorities could be fully invested with the powers to undertake the installation of tele-

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phones two parliamentary sessions must elapse; there must be one session for the Bill empowering the Post Office to grant a provisional order, and another session for the Bill confirming the provisional order granted by the Post Office.

The TOWN CLERK of FOLKESTONE seconded the resolution.

The TOWN CLERK of LIVERPOOL regarded the proposal as premature, and trusted it would not be accepted. The principle involved in the proposition was absolutely contrary to the line adopted throughout by the association in regard to telephones. They, as an association, had always taken the view that it was the duty of the Postmaster-General to supply telephones, and only as a subsidiary matter had they ever suggested that municipalities should be allowed to supply telephones within their own areas.—After discussion the motion was rejected.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE III.

We saw in the last lecture that when a motor is connected to a line of constant tension, it speeds up from rest according to a definite law, and that if the resistance of the motor is unchanged in the process, the rate of speeding up—that is to say, the acceleration—has a certain definite initial value that can be easily calculated, and then gradually diminishes, the time required to attain full speed depending chiefly upon the moment of inertia of the mass that has to be set in motion. We saw also that if we are able to vary the resistance in the circuit, by means of a rheostat in series with the armature of the motor, we can keep the acceleration constant for a considerable period, for so long, in fact, as we can keep any resistance in circuit, and that when the rheostat is "all out" the acceleration begins to diminish, as it does in the case already considered where the resistance is constant. We have now to see how the principles that have been shown to hold when a motor is speeding up from rest may be applied to the practical case of controlling the action of a motor or motors.

Before taking up the question of control in its practical aspects, let us devote a few minutes to considering two important ways in which the curves of acceleration and current may assist our future discussion. Referring to the diagram given in Fig. 12, and confining our attention for the present to the curve of acceleration with variable resistance, let us suppose that we draw a line parallel to the speed axis—that is to say, a vertical line, cutting the acceleration curve at any point. Now, vertical distances represent speed in feet per second, and horizontal distances represent time in seconds, hence any area enclosed between the curve and such a vertical line as we have drawn will represent the product of feet per second and seconds—that is to say, feet. It follows that when we have the curve of acceleration representing the way in which a car or train speeds up from rest, we can find the distance in feet that will have been covered in any given number of seconds from the moment of starting, by drawing a vertical line through the point in the time base corresponding to the given time, and finding the area included between that line, the curve, and the time base. For instance, if we have to compare the distance travelled in so many seconds from the moment of starting by the two methods of constant and variable acceleration, as shown by the acceleration curves in Fig. 12, we can do so at once by drawing a vertical line at the proper point on the time base, and comparing the areas included between this line and the two acceleration curves. A simple inspection shows us that the distance covered by the constant acceleration method is greater than that of the variable acceleration. If we draw a number of vertical lines at different times, and find by this method the distance travelled at each time, and set off a vertical length along the line previously drawn on some suitable scale, we shall get a curve giving us the distance travelled at each time. Such a curve has been drawn in Fig. 15, giving the performance of the motors on the City and South London Railway. This new curve turns up rapidly after full speed has been attained. It is easy to see that so long as the acceleration is constant, the distance travelled increases as the square of the time, the distance curve, therefore, being a parabola, and that directly the acceleration ceases, and full speed is attained, the distance covered increases simply as the time, so that the distance curve becomes a straight line.

Turning our attention now to the current curve, we have have seen that while horizontal distances represent seconds, as in the acceleration curve, the vertical axis measures current in amperes. Hence the area of the current curve represents the product of amperes and seconds. Now, the tension of the line is constant, therefore the area of the current curve represents ampere-seconds multiplied by volts—that is to say, watt-seconds, or, more simply, work done. If, then, we have the current curve giving the variations of the current used in starting a car or train, we can find out how much work has been done in starting, by drawing a vertical line through the given point on the time base, and finding the area of the current curve included between this line and the current curve, expressed in watt-seconds or foot-pounds, or any other convenient unit of work. We shall find that we often have occasion to compare the work done in covering a given distance, or in getting up a given speed, by different methods of control, and we shall be able to effect our comparison most conveniently by comparing the areas of the current curves.

Let us now consider the simplest case of motor control—namely, that where there is one motor only. First of all, we are met by the difficulty that if we suddenly switch on a motor at rest to a line of any considerable tension, we shall have so large a current passing through the armature that we shall inevitably blow the fuse inserted in circuit to protect the motor from injury. It is obvious, therefore, that we must either make the resistance of the motor sufficiently large, so that when thrown on the line the current, as given by Ohm's law, does not exceed the safe limit, or else we must have a rheostat in series with the armature, which may be gradually removed as the motor speeds up. The question then arises, "Would it not be simpler to do away with the rheostat, and have all the resistance in the motor itself?" There are serious objections to such a method. In the first place, the $C^2 R$ losses, which are so large a part of the losses incurred in starting, are increased directly in proportion to the resistance in the circuit. I think we should be all ready to admit that from the point of view of economy of running a high internal resistance is objectionable.

There is, however, another reason why a high internal resistance should be avoided. The speed of a motor may be expressed by the equation $n = \frac{E - CR}{M}$, where C is the current required to balance the load on the motor. Now, if the speed at full load is fixed, a motor with a high internal resistance must have a proportionally small induction factor. Hence the torque for any given current will be smaller for the motor with the higher internal resistance, so that at the moment of starting the torque available for acceleration will be less. Now, I am not bringing this point to your notice simply for the sake of the theoretic interest involved. It is a matter of distinct practical importance. By way of illustration I may quote the case of the motors which were designed to run on the Liverpool Overhead Railway. The first motors that were designed for this railway were made with very high internal resistance, as much as 1·04 ohms, including the armature and the magnets, the motors being series wound. The object of making the resistance so high was stated to be to get as much as possible of the starting resistance in the form of convolutions on the armature, for then, it was said, the resistance, that would otherwise have to take the form of a rheostat, might be made use of to get a greater torque at the moment of starting. Now, these motors had to comply with a certain specification, which stipulated that they should give a definite horizontal pull at a given speed.

(To be continued.)

* Cantor lectures, delivered before the Society of Arts.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

108. Should accumulators for traction purposes be tested at constant current or by keeping the charging E.M.F. constant? Does this make any difference in the results?—J. C. R.

109. In a transmission of power scheme what considerations should determine the permissible loss in the line wires?—P. T.

ANSWERS.

Question No. 102.—In laying-out the plant on a direct-current three-wire system, which of the following makes the best and most economical arrangement: (*a*) one steam dynamo of 200 kw. and balancing transformer; (*b*) two steam dynamos, each of 100 kw.; (*c*) one steam-engine to give 200 kw., and two dynamos of 100 kw., each coupled to engine?

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Best Answer to No. 102 (*awarded* 10*s.*).—In considering the superiority of any one of the three alternatives suggested above, we must look at the matter chiefly from the following standpoints: that of (1) efficiency; (2) capital outlay; (3) repairs and maintenance.

Now as regards (1) we can fairly expect to get the following:

	a.	*b.*	*c.*
Full load.....	86 per cent.	83 per cent.	84 per cent.
Half load.....	77 per cent.	73 per cent.	75 per cent.
Quarter load ...	62 per cent.	59 per cent.	60 per cent.

from which it will be seen that (*a*) takes the lead in every case, (*c*) coming next, and (*b*) last. The efficiency of (*a*) has been considered without the loss occurring in the balancer. Taking an average efficiency in the latter of 80 per cent. and an output for it of, say, 20 kw., which would be a usual figure for the size of dynamo mentioned above, it reduces the total efficiency of (*a*) by an amount varying in ordinary cases from 4 to ½ per cent.; the former is the worst possible case—that is, when the dynamo is running almost light and the balancer fully loaded—but seeing that in an ideal three-wire system the load on each side is equal—that is, the balancer is running light—then we shall be well within the mark if we take an average reduction in efficiency of the combination of 1 per cent., thus making the minimum for (*a*) at full, half, and quarter load 85, 76, and 61 per cent., thus still giving it the lead over the other two. Neither (*b*) nor (*c*) offer any advantage over (*a*) as regards subdivision of plant, for in any of the cases, whether they are fully loaded or not, all the machines will still have to be kept running, and there will be a loss in the case of (*b*) in two engines and two machines, in (*c*) in one engine and two machines, whereas in (*a*), owing to its higher efficiency, there will be a reduced loss in only one engine and one machine, and a comparatively negligible loss in the balancer.

2. Now with regard to the capital outlay, the following will give a good idea of the relative cost of the three systems:

(*a*) One 200-kw. steam-engine	£1,502
One 200-kw. dynamo.....	1,148
One 20-kw. balancer	250
Total	2,900
(*b*) Two 100-kw. engines at £805	1,610
Two 100-kw. dynamos at £745.....	1,490
Total	3,300
(*c*) One 200-kw. engine, with extended base	1,510
Two 100-kw. dynamos at £745.....	1,490
Total	£3,000

Thus the saving effected by adopting (*a*) instead of (*c*) is £100, and instead of (*b*), which is the most expensive of the three, about £300. The saving of (*a*) or (*c*) over (*b*) will be still greater than this if the cost of foundations and erection are considered. The switch gear will be almost identical with (*b*) and (*c*), while (*a*) will perhaps be slightly more expensive, but the actual difference in cost will be quite negligible.

3. As far as repairs and maintenance are concerned, there is little to choose between (*a*) and (*c*); possibly (*c*) may be less on account of the smaller number of commutators which it involves; (*b*) will be the heaviest of the three, owing to the increased consumption of oil, etc., in the two engines, the greater number of spare parts required, and the generally increased repairs bill.

In attention the whole three systems are practically the same. For immunity from breakdown (*a*) offers the most advantages, for it will stand overloading to a greater extent without danger than either of the other two. (B) is slightly more flexible than (*a*) or (*c*), for with it it is possible to run one machine for any specific purpose, such as battery charging, etc. From this it will be seen that, taking into consideration the principal points—viz., efficiency, capital outlay, etc., their order of merit is—

(*a*) One 200-kw. steam dynamo and balancer.
(*c*) One 200-kw. engine and two 100-kw. dynamos.
(*b*) Two 100-kw. steam dynamos.

Of course, it is difficult to lay down any hard-and-fast rule, local conditions often playing an important part in considerations of this sort. For instance, the disposition of two small machines might be much easier than one big one, as (*a*) or (*c*), but in ordinary cases their respective merits will be somewhat as above.—H. B.

Answer to No. 102 (*awarded* 5*s.*).—In order to clearly show the different arrangements in the three cases a reference to the following diagrams will be useful.

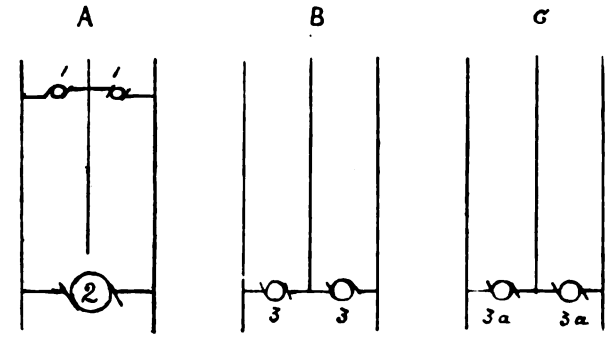

Diagram A shows the best arrangement for least steam consumption, or highest combined efficiency of dynamo and engine at all *total* outputs. It must be noted that this system is limited by the amount of difference in the loads on the two sides, which difference must not be excessive. This arrangement requires least switch gear and space, while the initial cost and maintenance expense is reduced to a minimum.

Diagram B is best suited where the difference in the loads on the two sides is excessive. These differences can be compensated for by means of engine speed, and, further, by speed regulation. The combined efficiency is good, and near maximum output approaches that of A, but at lower outputs is much less, excepting the case when only one side of the system is in commission, requiring only one dynamo and one engine. The initial expense is greater than of A, as the total unit is split into halves. This expense, however, is not in exact proportion, for since smaller machines are used a higher speed is permissible, which reduces the apparently increased expense. The cost of maintenance is greater, the space occupied much greater, and the switch gear is more elaborate than A. A balancer is useless when only one side of the system is in commission.

Diagram C is a compromise between the two foregoing systems, and is similar in action to B, excepting that such wide range in difference of load between the two sides cannot be so readily and efficiently dealt with, for since the three machines are rigidly coupled the speed throughout is the same, so that the variation would be compensated by field regulation. The combined efficiency is not equal to A, but is much better than B, since all the machines are working nearer to their fullest capacity. It is especially better than B when average difference of loads takes place between the two sides. Generally speaking, for the conditions met with in general practice, system C has practically the leading advantages, though the initial cost, maintenance, and switch complexity are greater than A, but are less than B.

If the engine for system C be designed so that 200 kw. may be regarded as an overload, the efficiency of the combination at the lighter loads is improved. Improvement in regulation can be made by adding a balancer, as in A.—KILOWATT.

Question No. 103.—In designing an electric light installation, show how you would calculate the size of the mains to allow for a given "drop" at the farthest lamp.

Best Answer to No. 103 (*awarded* 10*s.*).—Answering the question by a concrete example, we will suppose we are designing an installation of 100 lamps taking a total current of 60 amperes.

Let L_1 = total length in feet (go and return) of cable from the point of supply (the supply company's fuses) to the main switch of the house installation.

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Let L_2 = length from main switches to the distribution board.

Let L_3 = length from distribution board to the farthest lamp (measured on the circuit for which the product L_3 into C_3, the current in the circuit, is a maximum).

Let C_1, C_2, C_3 be the currents in respective circuits with all lamps alight.

These may be computed on the basis of four watts per candle-power.

Let S = section in square inches of conductor under consideration carrying current C.

Then the drop of volts in a length L is given by the formula—

$$V = \frac{8LC}{S \times 10^6}.$$

We will now suppose that the maximum drop allowed at farthest lamp with all alight is one volt. A larger drop is often allowed for cheapness, but it is not good economy, as the candle-power of a lamp varies approximately as the sixth power of the volts, and hence any small drop in pressure, say 1 per cent., will make about 6 per cent. difference in the light emitted.

Beginning at the lamp end of the circuit, let the maximum current on any one of the distribution circuits be 15 amperes, and we will suppose the farthest lamp 75ft. distant. Then $L_3 = 150$ $C_3 = 15$.

At 1,000 amperes per square inch the section would be ·015 square inch, but this is too small for mechanical reasons, and no wire less than 18 gauge, or if stranded than $^3/_{20}$, should be used.

Section of No. 18 = ·048 = S_3.

Hence, $$V_3 = \frac{8 \times 150 \times 15}{\cdot 048 \times 10^6} = \cdot 4 \text{ volt.}$$

Let $L_2 = 200$;

$C_2 = 60$, being the whole current;

and suppose $L_1 = 100$ft.

Then we have to select a cable which gives a drop of less than ·6 volt with 60 amperes in 300ft.:

$$V_1 + V_2 = \cdot 6 = \frac{8 \times 300 \times 60}{S \times 10^6};$$

or S = ·24 square inch section.

Consulting wire tables, we find $^7/_{14}$ cable has exactly this section, and this will be the cable to use.

This gives a current density of 250 amperes per square inch. Six hundred or 700 amperes per square inch would be more economical generally, but if we used a smaller main cable, we should have to put in larger wires in each circuit to lamps, and it is always advisable to have the main cable large enough to allow for extensions.

In cases where more than one distribution board is used, C_1 will not = C_2, and we shall have to determine the drop in each portion separately, but the following equation will hold:

$$V = V_1 + V_2 + V_3 = \frac{1}{10^6}\left(\frac{8\,L_1\,C_1}{S_1} + \frac{8\,L_2\,C_2}{S_2} + \frac{8\,L_3\,C_3}{S_3}\right),$$

where V = permissible drop at farthest lamps.—E. M.

Answer to No. 103 (*awarded* 5*s.*).—For the purpose of calculating the size of mains to allow for a given drop in the voltage at the farthest lamp in the circuit, the rule is: multiply the current by the length of cable in feet, and divide result by loss of volts allowable; call this result x. Opposite the value of x which is nearest to this in the following table, is the size of the conductor to be employed, and the current it will carry at 1,000 amperes per square inch.

$$x = \frac{C \times l}{V};$$

where C = current in amperes to pass along the conductor;

l = length of cable (lead and return) in feet;

V = permissible loss in volts at farthest lamp.

Example.—Current, 30 amperes; length of cable, 450ft.; loss in volts, 5. Find cable necessary to carry given current at a loss of not more than given volts.

$$x = \frac{C \times l}{V} = 30 \times 90 = 2{,}700.$$

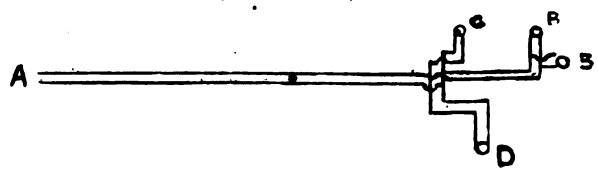
The size of cable when $x = 2{,}700$ is found to be $^7/_{16}$'s.

In designing an electric light installation, the size of mains for all the circuits should be calculated as above. The following wire table is calculated for copper 98 per cent. conductivity.

S.W.G.	Area of conductor in square inches.	Resistance per foot in ohms.	Current at 1,000 amperes per square inch	x.
20	·00102	·008007	1·02	122
19	00126	·00648	1·26	151
18	·00181	·00451	1·81	217
3/22	·00186	004417	1·86	223
7/25	·00217	·003716	1·87	260
17	·00246	·003319	2·46	295
7/24	·00266	·003070	2·66	319
7/23	00315	·002579	3·15	378
16	·00322	·002536	3·22	386
15	00407	·002007	4 07	488
7/22	·00434	·001894	4·34	521
14	·00503	·001624	5·03	604
7/21	·00560	·001451	5 60	672
13	·00665	·001228	6·65	798
7/20	·00714	·001144	7 14	857
12	·00849	·000962	8·49	1,019
11	0106	·000771	10·6	1,272
7/18	·0127	·000645	12·7	1,524
10	·0129	·000633	12·9	1,548
9	·0163	·000501	16 3	1.956
19/20	·0194	·000402	19·4	2,328
8	·0201	·000406	20 1	2,412
7/16	·0225	000362	22·5	2 700
19/19	0239	·000341	23·9	2,868
7	·0243	·000336	24·3	2 916
6	·029	·000282	29·0	3.480
19/18	·0344	·000237	34·4	4,128
19/17	·0467	·000174	46·7	5,604
19/16	·0612	·0001336	61·2	7,344
19/15	·0703	·0001056	77 3	9,276
19/14	·0953	·0000855	95·6	11,472
37/16	·119	·0000686	119	14,280
19/13	·126	·0000647	126	15,120
37/15	·151	·0000543	151	18,120
19/12	·161	·0000507	161	19,320
37/14	186	·0000475	186	22,320
37/13	·246	·0000332	246	29,520
37/12	·314	·0000260	314	37,680
—	·5	·0000163	500	60,000
—	·8	·0000102	800	96,000
—	1 0	·00000817	1,000	120,000

The resistance and the permissible current at 1,000 amperes per square inch may be found for any other material by multiplying the values in the respective columns by $^{98}/_m$ and $^m/_{98}$ respectively, where m is the percentage conductivity referred to pure copper. If the figure in the last column but one is greater than the current to be transmitted, the current density is less than 1,000 amperes per square inch. If the figure be less, more than 1,000 amperes per square inch are being transmitted.—R. B. B.

Answer to No. 103 (*awarded* 5*s.*).—



Let A be the position of the generator;

B be the position of the *most distant* lamp or group of lamps;

C and D be the position of the other groups;

b be the current required by lamps at B;

r be the resistance of cables from distributing points to B;

l be the *length* (in yards) *of route* of cables from distributing points to B.

It is advisable that the mains carrying current for the whole of the lamps be brought to a position as central as possible so that the distances to the various groups of lamps may be as small and as nearly equal as possible. The drop of volts between the distributing point and the most distant lamp is then kept down to a small percentage (about 2 per cent.) of the total P.D. Let this "drop" be v volts.

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Then $\frac{v}{b} = r$;

$\frac{r}{2l}$ = resistance per yard of cable to and from B;

$\therefore \frac{v}{2bl} = R$ = resistance per yard of cable to and from B.

The size of cable having this resistance per yard can then be read off in any cable maker's list. It can, however, be calculated from the expression

$$a = \frac{\rho}{R} \times \frac{91{\cdot}44}{6{\cdot}45},$$

where ρ is the specific resistance (c.m.) of the copper used, and a is the area of cross-section of cable; a may then be split up into 7, 19, etc., wires, as may be convenient.

In a cross-section of a cable the sections of the individual wires are elliptical, and therefore of slightly greater area than their circular cross-sections, but it is hardly safe to rely upon this increase of section per wire, as the contact between wire and wire is rarely good enough for it to be thoroughly utilised. This settles the cables for group B, but if it is found desirable to feed another group, B_1, from the same sub-main, at some point, J, intermediate between B and the distributing point, the cable up to the point J must have a sectional area of $\frac{a\ (b+b_1)}{b}$ square inches, where b_1 is the current in amperes required for group B_1.

Then if v_2 = loss of volts up to point J;
l_2 = length of route up to point J;
r_2 = resistance per yard of joint main up to point J;

$$v_2 = (b + b_1)\ r_2\ 2\ l_2.$$

$(v_1 - v_2)$ is the drop allowable between J and B_1, and can be treated in the same way as that given for B.

Similarly, any other groups, C, D, can be provided for. The nearer the lamps are to the distributing point the higher will be the current density which can be allowed in their cable connections, but, of course, in no case must the safe heating limit of current density be exceeded. The drop between the generator and distributing point, not being a matter of regulation at the lamps, hardly comes within the question. The size of cable would be given directly by Thomson's law of economy.—F. O. H.

BRADFORD TRAMWAY ACCIDENT.

The following is a complete report of the evidence given at the enquiry held by Major Cardew on behalf of the Board of Trade in reference to the fatal accident on the Great Horton electric tramway. For the report we are indebted to the *Bradford Observer*:

Major Cardew, R.E., opened the official enquiry in the Council-chamber at the Bradford Town Hall on the 22nd ult., but it had to be adjourned till last week to enable the driver and conductor to give evidence. The Corporation were represented by the deputy town clerk (Mr. F. Stevens); Mr. T. Lawrence Atkinson appeared on behalf of the relatives of Albert Drake, of Queensbury, who died from injuries received in the accident; Mr. H. Waddington watched the proceedings for the relatives of Joshua Walton Penny, also deceased; and Mr. W. E. Tetley and Mr. J. Elliot represented other persons who also sustained injuries.

Major Cardew said he understood that there had been some comment with regard to his appointment by the Board of Trade because he was the official who inspected the tramway before the opening was sanctioned. He presumed from the comment which had been made that there was some question as to whether the tramway should have been passed. The reason for his inspection was to determine whether the tramway had been properly executed, the whole of the particulars of the construction having previously been decided in the Act of Parliament. That was not a matter with which he was concerned at all. The inspection was for the purpose of determining whether the work had been properly executed, and whether the lines were safe for traffic. If, therefore, it appeared to any gentlemen present that the lines were not safe for traffic he would be glad to hear any evidence which might be offered on the point, and they might be sure that if any mistake had been made he would not be afraid to say so. He thought that his name was pretty well known outside the city of Bradford, and he intended to make his report utterly regardless of whether it involved any blame upon him or anyone else.

The first witness was **Edwin Edwards**, inspector of the Great Horton tramway, who produced the following report to the manager upon the occurrence of Monday last: "All cars were examined and found in good running order. The cars left the depôt at the proper times—five o'clock, 5.15, 5.30, and 5.45 a.m., there being a 15 minutes' service until 8 a.m., when, owing to there being an excess of traffic, I sent out some special cars. The cars ran very satisfactorily until about 10.30 a.m., when I received information that a serious accident had happened to car No. 16 at the corner of Grange-road. I at once went there, and found that the car had left the rails, and had turned over on its side, and that a number of the passengers had been injured, some of them seriously. Owing to the driver and conductor having been injured and taken away, I could not get any reliable information as to how the accident had occurred. I examined the car, and found that the wheels were badly flatted, as though they had been skidding some distance. The hand-brake was in good working order; also the sand-valve gearing. The sand-box was empty, but this had evidently been caused by the car going over, as there was a large quantity of sand about the inside of the car. There were also two bags of sand, which had been kept in reserve under the car seat. I also examined the rails which the car went over, and found them in places completely filled up with sand. Steps were at once taken to clear the car away, but some considerably delay was caused owing to the police authorities wishing to have the car photographed. The running of the other cars was seriously interrupted until about three o'clock, when a 10 minutes' service was again commenced. Driver Clarkson reports his car running over the end of the line at Morley-street terminus at 2.15 p.m., his explanation being that a street watering cart had made the rails greasy, causing the car wheels to skid. He was delayed about 10 minutes. Driver Pickles, No. 8 car, met with an accident owing to the trolley coming off the wire near the Crown Inn, and getting bent it had to be taken to the depôt."

Witness stated, in reply to Major Cardew, that two extra cars were put on about eight o'clock, and in both instances the wheels were examined in the shed before being sent out. The driver of the car to which the accident occurred had been at work since the line was opened, commencing as a conductor.

Mr. Atkinson: What experience had he had on electric tramways?—**Witness**: I could not say.

Did you put him on to this work?—No, he was put on by the manager to learn before he was sent out as a driver.

Major Cardew: How long had the driver in charge of this car been driving?—**Witness**: He had been driving about a fortnight.

Does that include the time he was supposed to be learning?—No.

Mr. Atkinson: Do you mean that he had been a conductor on this line?—Yes, sir.

Mr. Waddington: When you went over the line did you find any evidence of the sand having been used?—**Witness**: Yes, I found sand all over the rails.

Major Cardew: What was the condition of the rails?—**Witness**: They were very bad at the time.

On account of the weather?—Yes, it was very bad at the time. It had just started to rain, and they were very wet and slippery.

Mr. Atkinson: In what distance can you pull up a tram travelling down hill?—**Witness**: It should be stopped within 10 or 12 yards on a gradient.

Whether the line is greasy or not?—Yes.

That is to say, an experienced driver would be able to pull it up?—Yes.

How do you account for these cars jumping?—I can only put it down to the action of the electric brake.

Not to the inexperience of the driver?—I have tried the same thing myself, but I cannot always avoid it.

Mr. Waddington: Have you had any reports of a driver going at a high speed?—**Witness**: Only what I have seen in the papers.

There have been no official complaints?—No, sir.

Mr. Atkinson: Have any drivers complained of the inadequacy of the brakes?—No, not since the first day when they overran the line.

It has been suggested that you should have a slipper brake?—Yes.

In your opinion would that make it safer—you know that they have the slipper brake at Halifax, and no serious accident has happened there?—Yes.

Mr. Stevens: Do you know whether the Halifax Corporation have the electric brake for their new trams?—**Witness**: No, they have not.

And if they had no electric brake at Halifax they would want a slipper brake?—Yes.

Mr. Bucknill: Do you consider the brake power on the trams perfectly adequate?—**Witness**: Yes, sir; I consider the hand-brake very satisfactory.

Major Cardew: Do you consider the brake power adequate—not only the hand-brake, but the electric brake?—**Witness**: On the ordinary line I consider it is, but not on the greasy line.

What do you find fault with?—The skidding of the wheels.

That can easily be avoided, cannot it?—I don't think so.

Suppose you had the hand-brake on and found the wheels skidded, what would you do?—I should take off the brake and put it on again.

Would that stop it at once?—It might do so.

Mr. Waddington: Could not this accident have been avoided if the electric brake had been used?—**Witness**: I believe the electric brake was being used.

Mr. Atkinson: Ought not the curve leading into All Saints'-road to be slightly raised on the outside?—**Witness**: I believe that they are.

But I mean more so than at present?—I don't know. I have worked on curves quite as severe as this without having any trouble.

You know it is a fact that the outer rail ought to be raised?—They generally are.

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And in your opinion these are raised quite sufficiently?—Yes, I think any car coming down at a proper speed would be in no danger of coming off the rails.

Mr. Bucknill: If the electric brake had been used could these flatted spots have been found on the wheels?—**Witness**: Yes, I think they could. If any brake is used to lock the wheels the electric brake is rendered quite inoperative.

Major Cardew: What were the orders given to the drivers with regard to speed?—**Witness**: The instructions are that they shall not descend any gradient at the rate of more than six miles an hour, and there are certain places on the road where they are ordered to bring their cars to a standstill.

What about the curves?—The rate must not exceed two miles an hour.

Are these instructions carried out?—Yes, sir. I have had no occasion to find fault with any of the men for doing wrong in that respect.

What time do they occupy on the journey?—The drivers are allowed half an hour up to noon, and after that 35 minutes.

But there is no such restriction on the speed going up?—No, sir; we don't consider it necessary.

And the length of the line is nearly three miles?—Yes.

In reply to further questions, witness stated that some portions of the line were nearly level, and the drivers would run the car up to eight miles an hour. The maximum speed specified in the Act was 10 miles an hour.

Mr. Waddington: Is it not a fact that drivers place too much reliance on the hand-brake?—**Witness**: I have not received any such complaints.

Do you know that any such complaint has been received by anybody connected with the management?—I don't know.

Do you mean to say that you don't know whether any fresh instructions have been given to the drivers that they have to make more use of the electric brake?—Instructions are in the books supplied to the men. They have been specially instructed to read the rules and adhere to them.

Why "specially" instructed?—So we can get them carried out more efficiently.

You are quite certain that no person has lodged a complaint of this character?—I have not heard of any.

Mr. Bucknill: What experience have you had?—**Witness**: I have had about six years' experience as an electric tram driver in Staffordshire and at Halifax.

I believe that Bradford is one of the first places where this additional brake has been brought into use?—Yes. In other places they have the reversing brake for emergency instead.

Mr. Elliot: Is it not a fact that when the tram started from Horton Bank Top there was no sand in the box?—**Witness**: I believe the driver got a fresh supply before he left the shed.

I suppose that, if the supply of sand became exhausted, this would be an important factor in bringing about an accident?—Oh, yes.

Major Cardew, after perusing the book of rules for the drivers and conductors, said that the regulations did not appear to state that the electric brake should be used in descending the hill. All that was said on the subject was that, when the electric brake was used, the hand-brake must be off. Addressing the witness, he asked if, as a matter of fact, instructions were given that the electric brake must be applied downhill, and a reply was given in the affirmative, witness stating, in reply to a further enquiry, that the notch was varied according to the gradient.

The electric brake, of course, is dependent for its power upon the speed at which the car is running?—Yes.

What do you consider is the speed sufficient to cause the brake to act?—About four or five miles an hour.

By **Mr. Waddington**: On a greasy line he did not consider that the car could be controlled so easily with the electric brake as with the hand-brake.

Mr. Waddington: Have you given your employés the benefit of that advice?—**Witness**: I have expressed that opinion.

To whom?—Merely as my own opinion as a practical man.

I ask you, to whom have you expressed that opinion?—To our men.

When?—Some time ago. I simply gave it as my opinion. I am speaking of my preference as if I were a driver.

How long is it since you came to that conclusion—since the accident, I suppose?—Yes.

James Speight, a fitter employed at the Great Horton tram-shed, gave evidence to the effect that on the morning of the accident he examined the wheels of all the outgoing cars, and found them all in perfect order, without flats. The car No. 16, which was overturned, was one of the best cars in the shed. The cars were not, as a rule, returned to the shed with flats on the wheels. After the accident the car was brought back to the shed, and he found that the wheels were flatted, due apparently to skidding. The wheels were locked with the hand-brake. Evidently the car had skidded for a considerable distance. Both boxes of sand were full and in working order when the car left the shed, and there was a supply of four bags besides, which were placed under the seat. The lines had been greasy most of the morning, and a good deal of sand had been used.

Mr. Atkinson: Do you think it proper for a conductor of no experience whatever to be allowed to take charge of one of these cars?—Witness: That is not for me to say.

Major Cardew: Do you consider the brake power sufficient?—**Witness**: Yes, if it is used in time.

C. J. Spencer (manager of the Corporation tramways) said that on the morning in question he found that traffic on the Great Horton section was very heavy, and he directed that two extra cars should be brought into service. After carefully examining the sand-brakes and other parts of the car No. 16, he personally took charge of it on the journey towards Bradford. On the way down he saw Mungovin, a driver who was off duty, who undertook the work. Witness instructed him to be very careful.

Major Cardew: Did he require it?—**Witness**: Well, not particularly, but I said that it was a greasy morning, and he would have to be very careful. I was simply giving him a general caution. It was on the next journey down that the accident occurred.

In describing the scene immediately after the car overturned, witness said that he examined the car, and found the sanding gear in perfect order. There was a large quantity of sand scattered about the inside compartment, as if it had been thrown out of the boxes, and there was a spare bag under the seat. The rails were very greasy, but they had evidently been well sanded up to Park-avenue. Other cars ran along the line both before and after the accident, and there was no difficulty in negotiating the corner. His instructions to the drivers with regard to the speed at which the cars were to be driven down hill was that it should not exceed the rate of six miles an hour, and not more than two miles an hour round the curves. Printed rules to this effect had been brought before the notice of the men.

Mr. Waddington: Who engages the drivers and conductors?—**Witness**: The Tramways Committee.

Do they make the appointments upon your recommendation or upon their own responsibility?—Upon their own responsibility.

Does that not strike you as rather an extraordinary proceeding after you have become general manager, and to assume most of the responsibility? You know the committee are not practical men?—That is not for me to say.

Do these men apply to you in the first instance?—No, they apply direct to the Tramways Committee.

Who is the responsible person to judge of the personal fitness or otherwise of the applicants?—I suppose that I am.

Did you make any recommendations?—I gave no special recommendations. I was at the meetings when they were appointed, and that was all.

By Major Cardew: It does not, in my opinion, require a very skilful man to drive a car.

In the course of further examination, witness said he considered that a man who had been accustomed to drive a steam tram would be able to manage an electric car after he had had a few days' training.

Mr. Tetley: Have you had any complaint as to the working of these cars?—**Witness**: From the general public or the officials?

Please answer my question. Have you had any complaints as to the working of the trams on this section of the line?—I have received no definite complaints.

Have you had any indefinite complaints?—None beyond what I have seen in the papers about the drivers going too fast.

Have you had any complaints as to the working of the brakes?—Yes, I have.

Who were the complaints from?—I have had complaints from passengers, but not many.

Has it been determined to put on new brakes?—Yes.

Why?—Because the committee considered that it would be an advantage. As manager I reported the matter to them, because I thought it was necessary to have another brake. I foresaw the difficulties which would arise on account of greasy line.

Did you report it because it had been found that the present brakes were not sufficient?—My experience told me that when the rails became greasy there would be a difficulty, and I reported to that effect; I thought it was urgent.

You saw that with a greasy rail an accident might happen any day. Do you deem it sufficient direction to the individuals who manage these cars to put them straight on the cars with practically no other instruction than a rule-book?—The conductor does not interfere with the technical part of the car. The driver manages the whole of the brakes.

Do you suggest that you can take a man who has had no previous experience of electric cars and put him on as conductor?—To collect fares, yes.

By Major Cardew: The instructions given to the drivers was to regulate the speed by the electric brake, and to stop the car with the hand-brake. The simultaneous use of both brakes was prohibited.

James Parker, of Great Horton, a former member of the City Council, volunteered to give evidence. He said he had been afraid for some time of the danger due to the excessive speed at which the cars were driven. On one occasion he travelled on a car which was set off by the driver at full speed, and they travelled through Great Horton at about the same pace as a runaway horse. Some ladies signalled to the driver, but he could not pull up. For his own safety witness jumped off the car. At another time he saw a driver leave his car whilst it was in motion, and go to the side of the road to see if the line was clear. This, of course, was a most dangerous practice.

J. H. Cox, the city surveyor, gave evidence with regard to some work which was undertaken last Sunday morning on the up line at the curve where the accident afterwards took place. He said that the work was simply the unscrewing of some tie-bars, and had nothing to do with the down line.

During the interval for lunch, Major Cardew, accompanied by several Corporation officials, visited the scene of the accident, and interviewed three residents who were eye-witnesses of the accident—Dr. Sergeant, Mrs. Hustler, and Mr. F. Greenwood. Dr. Sergeant estimated that the car was travelling at the rate of 12 miles an hour, and Mr. Greenwood compared the speed to that of an express train.

W. B. Bennett, of 13, Mount-pleasant, Queensbury, who was a

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passenger inside the car, but escaped with slight bruises, described the journey from Horton Bank Top.

Alderman J. Cowgill, chairman of the Tramways Committee, was next called as a witness. In reply to Mr. Atkinson, he said that he knew of all the instructions that were given by the manager, in whom he had full confidence.

Mr. Atkinson: He is supposed to know more about electricity and the working of the electric trams than members of the committee?—**Witness**: Most certainly.

How is it, then, that he has not had a free hand with regard to the engagement of the drivers?—The electric system in Bradford, as far as it has been worked by the municipality, was an entirely new thing. The committee advertised for drivers and conductors, and we had something like 650 applications. Mr. Spencer, the manager, was present at every meeting, and I think a body of men with their manager are perfectly capable of selecting the best men. We spent something like five or six nights at the work of getting every information we could about them. Since these original appointments the manager has consulted me, and it has been left to him to see whether applicants have been suitable or not. He has had an entirely free hand in regard to the appointments.

Has there been any influence brought to bear in their behalf?—Well, I don't know that there has.

Have you ever heard of one councillor boasting that he had got seven new appointments on this line?—No.

Have you ever given instructions to your manager that nobody outside of Bradford had to be appointed?—The instructions have not been given, but when the committee were going through the names they gave preference to Bradford men.

Although applications were made by men who had been at this work before in other districts?—I don't know that applications were made by anyone who had been at the work before.

With regard to the brakes, we have heard that they apply the slipper brake at Halifax, and that you have decided to put slipper brakes on the Bradford cars?—I believe that we have sufficient brake power at present.

Then why are you going into the extravagance of getting slipper brakes?—I don't call it extravagance when it only costs £8 or £10 per car. The main thing is to satisfy the public that you are doing everything possible for their safety.

In reply to Mr. Waddington, **Alderman Cowgill** said that he considered the men were paid sufficient wages. The committee could have got hundreds of suitable men for the work. Questioned with regard to the fact that the drivers and conductors had no facilities for getting their meals, witness said the conditions were practically the same on every tramway system.

By Mr. Tetley: He had heard a previous witness state that he considered conductors needed no previous experience of electric trams, a statement with which he agreed. The conductors' duties were simply to collect the fares, signal to the driver, and put on the hand-brake when requested by the driver, and he was a poor man who could not do a job like that without a long course of training. He was quite alive to the possibility of a driver being momentarily incapacitated, and with that in view the conductors received instructions in driving. He believed the conductors were made conversant with the operation of the brakes. He thought the system of electric tramways in Bradford was as good as any which was in existence if properly managed. The line had been carefully laid, and he did not think there was a better in the whole country. He was certainly of opinion that if the cars were properly worked the public were perfectly safe.

Mr. Tetley: Can you suggest a fundamental cause for the accident?—Witness: It is not for me to suggest at all.

If the cars are perfect, the line perfect, and an accident having happened, is it not attributable to management?—I don't think so. I don't think you can lay it on the management at all.

You don't suggest that any brakes or other safeguards with which this car was fitted had failed to do their duty?—I do not suggest anything.

Is there any indication that they had locked the wheels?—The conclusion I came to was that the wheels had been locked with the hand-brake.

That was all the brake could do?—Well, if I had been in charge of the car, I should have worked the electric brake.

And you would have managed it better than it has been managed?—I don't say so. I think the electric brake is superior to the hand-brake, because you can regulate the speed to almost any degree you wish.

In reply to Mr. Atkinson, **Alderman Cowgill** said that instructions had been given for the men to come more slowly down hill than up hill. It was a fact that the electric brake became quite useless directly the wheels were locked with the hand-brake.

Mr. Atkinson: From your experience, would you like to express an opinion as to whether an ordinary amount of skill has been used by this driver?—He is a very good man; he may have been going rather too quickly. I do not know.

Would you like to express an opinion as to whether a sufficient amount of skill has been used in the management of this car?—I should not like to express an opinion.

Have you already expressed an opinion that if the electric brake had been used this accident would not have happened?—No; I have not expressed an opinion. I have said that for braking purposes you can have nothing better than the electric brake.

Major Cardew: You are satisfied that the brake power is sufficient if properly used?—Yes.

Major Cardew remarked that this seemed to point to the belief that on this particular occasion the brake power should have proved sufficient.—**Witness**: I have so much confidence that I undertake to drive the car under any conditions.

Then, possessing such confidence, does it not follow that if a man had used this electric brake properly the accident would not have happened?—Well, that is the conclusion that it comes to in my mind. I might be wrong, but that is the opinion I hold.

Mr. Tetley: Have you heard any complaints as to the working of these cars?—**Witness**: My experience is that people will grumble under any conditions.

I mean complaints of cars going at nearly railway speed?—I have heard people grumble about the sudden shock when the car stopped.

Did your manager complain about the brake power?—He said that he would be better satisfied if we put the slipper brakes on; and, to satisfy the public and the manager, we decided to obtain slipper brakes.

Your manager is a man of experience and intelligence?—Yes, but my opinion is that there is sufficient brake power.

Mr. Tetley: Then if the cars failed to be checked by the brake power it can only be attributed to mismanagement or misjudgment.

R. W. Blackwell, engineer and contractor, said that his personal belief was that the apparent failure of the brakes was simply and solely a question of the human element. The essence of driving an electric car was perfect familiarity with the road. He was absolutely opposed to any idea that a driver or conductor needed to have anything like special skill. The less electrical or mechanical knowledge such men had the better it was for all concerned. No driver or conductor should ever tamper with any portion of the electrical apparatus under any conditions whatever. He attributed the accident in this case to the driver losing his head. Probably he was not very well acquainted with the line, and he let the car go a little too fast, checked it slightly with the hand-brake, and then lost all nerve. Then, as the speed still increased, instead of turning off one brake, and putting on the other, he would probably make the fatal mistake of screwing down the hand brake to greater pressure. That seemed to him to be the rational explanation of the accident. From the "flatted" state of the wheels he judged that the car must have attained a very considerable velocity, and skidded between a hundred feet and a hundred yards with the hand-brake hard on. There were dozens of instances where very much heavier gradients were negotiated with similar curves.

At this juncture **Major Cardew** remarked that it would be necessary to adjourn the enquiry to some future date, in order to obtain the evidence of the driver and conductor of the car, both of whom were still suffering from their injuries.

On the resumption of the enquiry on the 13th inst.:

John Mungovin, the driver of No. 16 car, was called, and in answer to questions put by Major Cardew, said: On Monday, Sept. 19, the day of the accident, my term of duty began at 10 minutes past 12 o'clock. I left home about 20 minutes to 9 o'clock to walk into town to see the procession of Barnum and Bailey's Show. All the cars were full going down, and I could not get a seat, so I took one up to the Horton terminus. The cars were not overcrowded; they were just full. When we arrived at the shed I saw Mr. Spencer in charge of a car. He was driving No. 16. I asked him if he were short of drivers. He asked me if I had anything particular to do. I said I was not doing anything—I was not on duty till 10 minutes past 12 o'clock. He asked me to go with him, and he continued to drive the car. I went with him. The car was full, but nobody was standing. The car went down all right. There was no difficulty with the brakes, but Mr. Spencer remarked that the car took some holding because the rails were greasy. I took charge at Bradford. I only waited about two minutes at the Bradford end. Before I took charge I examined the sand-boxes, and the one at the driving end down journey was nearly empty. The sand-box at the driving end up journey was about three parts full. There was a bag of sand by it. Going up I did not require to use the sand. It was a special car, and I did not take any notice of the time. At the Great Horton end, after going up, I waited about seven or eight minutes. I went into the shed and brought out four bags of sand. I filled the driving-box. I changed the trolley, and the conductor came out—he was a labourer in the shop. The acting conductor remarked to me it was very greasy, and said it was a pity conductors could not put sand down at the back. I said it would be of no use to me. I think he intended the remark for me, and not for the benefit of the line generally. I told him it would be of no use to me having the sand behind. We stopped about four times to the end of the penny stage. We were not full all the way. The penny stage is Southfield-lane. We picked up ten or a dozen passengers at that stage. This filled the car up inside, but not outside. A drizzling rain was falling at the time. I put on power to the first notch to start the car, let it run a few yards, and then put the handle of the electric brake on to the second notch. I ran like this to Paternoster-lane, and the brake held the car all right. The line takes a drop at Paternoster-lane to 1 in 19, and I then set myself to put the brake on to the third notch. The car kept under control till I got to Arctic-parade. I was applying sand all this time, as I consider it one of the worst bits of the line. I found at Arctic-parade that the car was leaving my control, so I put the brake on to the fourth notch, and then I put it to the fifth notch. I put it to the fifth notch about 30 yards before coming to the crossing place between Gaythorne-street and Shepherd-street. The brake appeared to have no effect; we seemed to gain speed. I let her run till we reached a point opposite the Fleece Inn. As we gained speed I shut the electric brake off about Cambridge-street, and put on the hand-brake. I released it slightly at intervals four or five times, as I judged from the motion of the car that the wheels were skidding. It was my impression that the wheels had been skidding all the way down

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from Arctic-parade. The hand-brake did not appear to be doing any good at all. I saw that something was going to happen, and as we neared the curve at All Saints'-road I glanced up to see if there was anybody on the top. I noticed that the trolley was off, and I thought it had come off with the speed. I had thought of reversing as a last resource, but then I saw it would be no use use with the trolley off. This would be about 80 yards above the curve. I rang my bell, and I don't know that there is anything more to tell. We nearly turned the curve before we left the rails, and then I was thrown off. About 200 yards before the curve a young man came out on the front, and I pushed him inside again. There was no one on the front. When the car left control she would be going about five miles an hour. I had the brake on to the third notch. I had been driving the cars on a half hour schedule, and had had no difficulty in keeping to the time-table. I had no fixed time this day. We drive the cars faster up than down. On any journey on which I had an unusual number of stoppages I should be late on the return journey. I should never make up time on the downward journey. I have never had any difficulty in keeping to the scheduled time. Our instructions were that we were not to exceed a rate of six miles going down and two miles at the curves. I really think I kept to that. I went up at about eight miles an hour.

Examined by the Town Clerk: I am positive that the reversing lever was in the forward position. I am as certain of that as I can be certain of anything.

The **Town Clerk**: I put the matter to you because two witnesses will say that when they saw it soon after the acident the reverse lever was in the backward position, and another witness, I should add, will make a statement to the contrary.

Examined by Mr. Waddington: I have been a tramway conductor for about seven years under the Bradford Tramways and Omnibus Company, Limited. I started on Aug. 27 under the Corporation. The Tramways Committee, before whom I went, appointed me. I applied as a conductor, and I was asked as to my experience as a conductor. I was engaged to be a conductor until there should be a driver's vacancy. Three days after appointment I began to drive. Mr. Spencer instructed me in driving. They were "off and on" instructions. I went with other drivers four to five days, and then I was given a car. I was instructed as to the use of electric brakes. I had a copy of the rules and regulations given to me.

By Mr. Tetley: Mr. Spencer gave me instructions as to the electric brake, and Mr. Requier also at odd times. Mr. Spencer drove down with me two or three times. I had four or five days' regular training. I was instructed to travel down on the second notch, and did so. On the worst spots on bad days I have travelled on the third notch. I did not use the hand-brake in addition to the electric brake, except to bring the car to a dead stop. When I checked the car with the electric brake I did not use the hand-brake. I think the wheels were locked by the electric brake. We had been told that the electric brake did not skid. I have heard that the trolley was taken off. I should call that a "soft trick" from my point of view.

By Mr. Wright: I am absolutely certain that I never altered the reversing lever. I am quite certain that when I started from Southfield-lane I effectually released the hand-brake. It is possible for the hand-brake to be worked from the rear of the car. The hand-brake can be put on from the conductor's end. I could not say whether the hand-brake had been put on in this case from the conductor's end.

By Mr. Elliott: I did not look particularly at the car after the accident. I went to get stitched up.

By Mr. Hammond: After the tuition I received I had every confidence in my power to drive.

The **Commissioner** said he thought the driver had given his evidence very well.

Mr. Waddington: I think we all feel that, sir, and that he stuck to his post like a man.

Major Cardew said that as soon as he arrived in Bradford on Wednesday afternoon he proceeded to Horton Bank Top, and witnessed some experiments which were conducted to test the new slipper brake. The trials were made with No. 16 car, and they took place on a gradient of 1 in 14·24, where other tests had been made by Mr. John Waugh. The car was first let go for a distance of 72 yards, and, roughly estimated, the speed attained would be about 18 miles an hour. This pace, of course, was distinctly dangerous, and very considerably beyond the rate at which it was contemplated the cars would travel. Applying the slipper brake only after this speed had been reached, the car was pulled up in the space between five poles, and, according to Mr. Dawson, the deputy surveyor, the distance was 179½ yards. Then the hand-brake alone was used, and the car was stopped in 64½ yards, and afterwards, by means of the electric brake, a stop was effected in 37 yards. The rails were quite dry. From these tests it would appear that the electric brake was by far the most powerful. Evidently the slipper brake, as at present applied, was certainly not very rapid in operation, and he thought that it was generally agreed that it should be made to act more quickly. All these brakes necessarily came into operation by utilising some proportion of the weight of the car to produce friction on the rails, and the use of one brake to some extent minimised the action of another. In the course of further tests the electric brake was used with the car running under normal conditions, the controller being placed on the second notch. The car was then pulled up within about half its length. He might also add that he certainly came to the conclusion that, at the second notch, the speed of the car exceeded six miles an hour, and, in fact, he was inclined to think that it was rather more than seven miles an hour, but in these cases it was very difficult to judge the exact speed. At any rate, it was absolutely impossible to keep pace with the car in walking. On the third notch the car gave a speed of about 4½ miles an hour, or about the rate of a smart walking pace.

Mr. Waddington: I believe the cars travel at the second notch.

Major Cardew: That appears to be the direction given to the drivers for working down the bad gradients.

Mr. Spencer: But you would naturally expect drivers to use their brakes in order to reduce the speed to six miles an hour.

Mr. Waddington: That imposes on the driver the impossible feat of finding out at what pace he is travelling.

Major Cardew: Yes. I wish someone would bring out an invention to indicate the speed in these cases. There would be a good deal of money in it. It would be impracticable to judge by the revolutions of the wheels, for directly they commenced to skid the appliances would be utterly unreliable.

Mr. Richardson: Is there anything to prevent the combined action of two brakes?

Major Cardew: They can certainly be operated together, but whatever weight is put upon the slipper brake in order to produce friction is taken from the wheels.

Mr. Waddington: Therefore, possibly the operation of the slipper brake would reduce the effect of the hand-brake if they were applied together?

Major Cardew: To a certain extent; but so long as the car is not allowed to exceed a speed of six miles an hour I do not think it can get beyond control. That is my own view. I tell you that openly now, although it is not my duty to report to you but to the Board of Trade. Still, it is a matter of public interest, and that is the conclusion I came to after seeing the experiments. You are bound to have control over it within that speed. The steeper the incline the more you call upon the brakes to do, and, of course, if you increase the velocity difficulties will arise.

John Gifford Ames, an electrical engineer of some years' experience, was called as a witness by the town clerk. He stated that he arrived on the scene shortly after the accident occurred, and he examined the overturned car. At that time the controlling handle was in the "off" position, and the reversing lever was reversed. Before removing the lever he called the attention of the tramways manager to its position. He did not think that in the concussion which the car received in the accident the position of the reversing lever would be altered. It would require a direct blow. Possibly it might have been interfered with when the passengers scrambled out.

In the course of examination by Mr. Tetley, witness said that he was in practice at 39, Victoria-street, Westminster, and he had undertaken most of the work in connection with the overhead wires upon both the Bolton-road and Great Horton routes for the sub-contractors. He had heard the driver's evidence, but he did not believe that the electric brake locked the wheels and made the car skid, as this was impossible. If the lever pointed to "reverse" on the indicator the electric brake could not be worked. If he had been driving the car in the circumstances under which the accident occurred he would have tried to reverse the motion of the wheels as a last resource.

By Mr. Waddington: It was very foolish and ignorant to remove the trolley from the wire.

Hugh Phillimore, an electrical engineer acting as assistant to the last witness, confirmed his statement to the effect that the controller was in the "off" position and the reversing lever was reversed. As a practical man he considered it extremely improbable that the lever could have been accidentally moved, and it could not have been moved at all whilst the brake was on, as the two arrangements interlocked.

C. J. Spencer, the tramways manager, was recalled at the request of the town clerk. He stated that, so far as he could remember, the reversing lever was in the "forward" position.

Ernest Peter Bailey, an inland revenue official, of 20, Spring-gardens, who witnessed the accident, estimated the speed at which the car was travelling at from 16 to 20 miles an hour. Both the driver and conductor were working at the hand-brakes, and there was a passenger assisting the conductor. At the conductor's request a passenger on the top of the car disconnected the trolley pole from the overhead wire.

Josiah Lee, a dentist, of 4, Hartley-terrace, who had volunteered to give evidence, described an incident which occurred on the line about a week before the accident. He said that the car on which he was travelling to Great Horton slipped back for 80 yards or 100 yards on a steep gradient. It was apparently beyond control. The car had previously been stopped for a passenger, and instead of proceeding forward it went down the incline at an alarmingly rapid rate. The driver had a conductor's badge on his cap, and witness remarked at the time that he did not believe the man understood how to manage the car. Witness said that he hurried down the steps, and he found another man, not in uniform, working at the controller. The indicator pointed to full power. The reversing lever was at "reverse." He said to the man, "For God's sake, man, put some resistance on this thing, or we shall all be at the devil in a minute." There was no doubt that the car was running away; it was like a "deadly slip." This occurred on a single line; there was a car ahead on a loop line, and another car from Bradford a short distance behind. Just as the car in which he was travelling reached the points it was brought to a stop. At this point many of the passengers, who had been very much frightened, left the car, and continued the journey on the car behind.

At the conclusion of the evidence the town clerk produced a letter from Dr. Waddington, who was attending the conductor of the car, Thomas Powers. He stated that Powers could only attend the enquiry providing that he was brought to the town hall in the

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ambulance, and not removed from the stretcher, and that he returned home very shortly afterwards.

Major Cardew said he would like to have the conductor's account of what took place if he were in a condition to make a statement, and he therefore proposed to visit Powers at his own home.

The enquiry was then closed, and Major Cardew intimated that his report would be presented to the Board of Trade in due course.

Thomas Powers was afterwards examined at his home by Major Cardew, and he made the following statement: "I was engaged by the Bradford Corporation as shedman at the Horton Bank Top depôt. On the morning of Sept. 19 last I acted as conductor of car No. 16 by instruction of the manager, Mr. Spencer. Mr. Spencer drove down, and at about 9.45 a.m. he handed the car over to Mungovin. Mungovin drove the car back to Bank Top, and started again on the down journey at about 10.20 to 10.25. All went well until we reached the crossing after leaving Southfield-lane, where we stopped to allow another car to pass. I then got off and walked to the front of the car. I saw the rails were greasy. It was drizzling. I said to Mungovin that it would be a good thing if the conductor could put on sand. He said 'Yes, but I have no sand in the (conductor's) box; it was all used last trip.' We then started, and I commenced collecting fares. I noticed the car was going too fast—I should say about 20 miles an hour, judging the proper speed to be eight miles. I saw the driver putting the brake on, and occasionally putting his foot on the sand-box lever. He turned round and made a motion as if for me to put the brake on, but the wheels were skidding then. I put on the brake and fastened it. Two gentlemen were on the platform, and I tried to get them inside. There were about 18 ladies and children inside the car. I begged them to sit down, and, looking after them, I jumped off too late. I did not see the driver bring out any bags of sand at the top. We were there eight to ten minutes. I went to the office to take in the money I had received in fares. When we were about in the middle of the steep incline I told one of the passengers who was on the roof to pull off the trolley. After the accident I was attended to at once."

FATAL ACCIDENT AT THE METROPOLITAN ELECTRIC LIGHT SUPPLY COMPANY'S WORKS.

We regret to have to note another death in an electricity works. The following report of the accident, as disclosed at the inquest, shows that no blame can be attached to the company in the matter.

An inquest was held on Wednesday by Dr. George Danford Thomas, coroner for Central London, at the Marylebone Coroner's Court into the circumstances attending the death of Henry Stagg, aged 32 years, an electric wireman and foreman in the employ of the Metropolitan Electric Light Supply Company, Limited, who was killed at the company's station, Black Horse-yard, Rathbone-place, Oxford-street, on Sunday afternoon, under the following circumstances.

Mr. Barlow (solicitor to the Metropolitan Electric Light Supply Company) watched the case on behalf of the company, whilst Mr. T. C. Butler (H.M. Inspector of Factories) was present on behalf of the Home Office authorities.

Mr. Barlow said that, on behalf of the company, he had to express their deep regret at this sad accident and their sympathy with the relatives. The company desired to lay every possible information before the Court to assist the jury in coming to a verdict.

William George Stagg (brother of the deceased) stated that he was a general foreman in the employ of the Metropolitan Electric Light Supply Company, and had been so for some 10 years, whilst the deceased (his brother) was in the same employ, he being an acting foreman. Deceased's principal work was outside, in laying customers' connection. On Sunday they were at work at the Black Horse-yard station, and the deceased went home to dinner with him, they returning together to the works about half-past two. Witness went to his work, and some 10 minutes' later he was called to the office, where he saw his brother lying in an insensible condition. He felt his pulse and heart, and could just feel them beating. A medical man was at once fetched, and he saw deceased expire.

In reply to the Coroner, **Witness** said that it would be the deceased's duty to go to the switchboard to see about some repairs.

Mr. Barlow said he might inform the Court that on the previous Friday there had been a slight accident at this station which necessitated some repairs being done to the switchboard.

William Henry Laycock, a wireman in the employ of the company, stated that on Sunday afternoon he was engaged at the switchboard in covering up some wires, and at that time at the portion of the board he was at work on the electric current was not on. Deceased came up behind him and asked him how he was getting on, and he answered him "All right," after which he turned round and went on with his work. Directly afterwards he heard a peculiar noise and his mate calling out, "Look at Harry." Witness turned round and saw that the deceased was in a semi-reclining position against the switchboard, his feet being in contact with the terminals on the floor underneath the switchboard. He called to his mate to pull deceased away, which he did do. With assistance they carried him into the office, and there everything was done to restore him, but he died directly afterwards.

In answer to Mr. Barlow, **Witness** stated that there was a "Danger" notice on the switchboard. There were rubber mats on the floor for the men's protection. The switchboard was a vertical switch one, and between that and the wall of the building was a passage, along which they could walk in safety.

By a Juror: It was not possible to put a rail in front of the switchboard, as that was what they had to work upon.

In reply to Mr. Butler, the **Witness** stated that there was only a part of the board that had not the current on. There was a pressure of 1,000 volts on at the time of the accident. He had never known rubber mats to be conductors of electricity.

In answer to the Coroner, the **Witness** further stated that the workmen had all the necessary appliances as to gloves, etc., to protect themselves. He had received slight shocks himself at the work.

The Coroner said that he believed that it was a fact that everyone who was connected with electricity work for any length of time had received a shock.

Peter Copsey, a wireman's labourer, stated that he was assisting the last witness when the deceased entered and asked them how they were getting on. Laycock replied to him, after which he saw deceased turn up his sleeves as if preparing for work. Witness went on with his work, and directly afterwards noticed deceased was in a sort of stooping position, as if he was about to commence work. He saw deceased was holding a piece of iron pipe that ran up by the side.

The Coroner asked what the deceased was standing on, and the **Witness** replied rubber mats, and that in such a position he would be in safety. The next moment he heard a slight cry out, such as "Oh, oh," and on turning round he saw the deceased lying down with his feet stretched out across the terminals. Witness called out to Laycock, "Oh! look at Harry," who told him to pull him off at once by his clothes, which he endeavoured to do. Laycock ran to his assistance, and they both got him off, and with other assistance carried him into the office.

Mr. Barlow wished to know in what position deceased's hands were when he saw him lying down, having received the electric shock. — The **Witness** replied that deceased had his hands across his chest.

Mr. Butler wished to know what the iron pipe was that deceased had hold of just before he saw him on the ground, and **Witness** said that it was an iron pipe that was near to the iron stanchion, but whether the iron pipe contained electric wires or not he could not state. They were working on that portion of the switchboard that was not charged.

Mr. Alfred Henry Walton, M.I.C.E., M.I.E.E., stated that he was the company's engineer, and had been so for the last four years, and had supreme control of the company's work. They had been working in the same way and method practically since the company first started in 1889.

The Coroner said that one knew that as time went on scientific advances were being made. He supposed they might take it that every endeavour was made by the company to keep well up-to-date.

Mr. Walton replied that was so.

The Coroner said that, whilst not doubting Mr. Walton's ability and experience, he wished to know at once whether he thought he would be able to give a full explanation of this occurrence without further help. He had had other accidents through electricity, and had to have expert opinions in regard to such; therefore he wished to know whether it would be necessary for the case to be adjourned so that expert evidence might be called.

Mr. Walton said that he thought that in this case he could fully explain everything, and that there would be no necessity whatever for expert evidence to be called.

The Coroner asked if he was at the works at the time of the accident, and **Mr. Walton** replied that he was not, but Mr. Dixon, the resident engineer of the works at this particular station, was, and directly the sad accident took place witness was sent for and went at once and found that the deceased was dead. He should like to explain that the origin of the repairs was the result of a small accident which took place on the previous Friday.

The Coroner asked what kind of an accident had occurred.

Mr. Walton said that a workman had made a wrong connection on the switchboard, and some wires had been burnt. The damage was temporarily attended to on Friday night, so that the work could go on. Witness gave instructions that the permanent work of repairs should commence on Saturday soon after midnight, because it could be more easily done, the demand upon them not being so great at time. He gave instructions that the portion of the board on which the work was to be done was to be "killed." That meant that there was not to be any current on. On his arrival at the works on Sunday afternoon he noticed on the sheet in front of the switchboard the word "Dangerous," and there was a notice stating which portion of the board was alive and which was dead. He found that the work of repairing the defect was nearly all completed—that, in fact, all would have been done easily within another hour. Behind the switchboard was an iron stanchion that supported the building above, and the iron pipe referred to by a previous witness that he saw deceased have his hand on was an iron rod which supported the platform on which the switchboard was carried. When the deceased met with his accident he was immediately under the notice marked "Dangerous."

The Coroner said he supposed that Mr. Walton on getting to the works made a full investigation?

Mr. Walton said that he did, and he learnt that deceased on returning to the works with his brother from dinner went to see how the men were getting on. Deceased would not have to do

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any work himself. He would only have to supervise except in a case of emergency. Then he would give his men help. After speaking to his men deceased seems to have gone round the stanchion and then seen to be in a stooping position, after which he was found lying out. It was evident that he had slipped, as he was observed with his back against the wall and his feet stretching out practically across the terminals of one of the machines, and thus he would receive its full pressure of about 1,000 volts. When found, the deceased was in a very rigid state, and Copsey was unable alone to pull him away.

The **Coroner** asked if Mr. Walton noticed the rubber mats.

Mr. Walton replied that he examined the mats, and found them absolutely as good as new.

The **Coroner** wished to know whether Mr. Walton had satisfied himself that there was no contact by deceased with the hands.

Mr. Walton replied that he had, and that was clearly shown by the witness Copsey, who noticed that deceased had his hands across his body. Had there been contact with the hands, then the hands would have been burnt. The deceased's rigidity after the accident had forced one of the terminals into the sole of his boot. He had never known a man killed at 1,000 volts pressure. Men had touched the terminals with their bare hands while at such a pressure, and been burned on the fingers. Deceased when he slipped must have touched both terminals, for had he only touched one terminal he would not have received any shock, as he was standing on the rubber mat. He noticed that the deceased's boots were very wet, and would therefore act as a conductor. The switchboard was really marble panels.

The **Coroner** asked if any fence could be erected at the back of the switchboard.

The **Witness** said that if such was done then the danger would be increased rather than diminished. Everything in the shape of wood was as much as possible being abolished in case of a fire.

The **Coroner** said that he believed that the Home Office in consequence of accidents had been making special enquires in regard to electric works.

Mr. Butler said that was so.

Mr. Walton said that the committee had visited the works, and he spent much time with them, but up to the present the Home Office had not issued any special instructions. The switchboard must be quite open to inspection, because it was necessary for a man to be engaged to walk round continually and inspect it, and if anything was detected to be wrong to at once report to the engineer. If it was covered up, then, there would be more risks of accidents, for a man in uncovering it to see if there was any defects might receive a shock. There was on this particular board 72 or 82 connections.

A **Juror** thought it was possible that some fencing or protection of some kind could be put up.

The **Coroner** said that in these cases, and the same in regard to railway accidents, he did not think that it was wise for juries, who were not possessed of an expert or practical knowledge, to suggest that this or that should be carried out, but rather leave it to the experts to carry out what they deemed most suitable for to prevent similar occurrences, because it might be that the very thing that they suggested was most impractical when adopted, and if it led to a sad accident then it would be said that they carried out what were recommended. He found that when such occurrences took place, companies most anxiously looked about to see what could be adopted with a view of preventing a similar accident in future, and he was sure that the same would be done in regard to this case.

Dr. John C. Matherson, of Soho-square, deposed that he was called to see the deceased, who died a few moments after his arrival. Death was due to asphyxia due to an electric shock.

The **Coroner** said that it would be the same as if a person had been struck by lightning, and **Dr. Matherson** said that was so.

The jury returned a verdict of accidental death, and expressed their sympathy with the relatives.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended June 30, to be submitted to the fiftieth ordinary general meeting to take place to-day, states that the revenue amounted to £103,689 and the working expenses to £21,474. A quarterly interim dividend, amounting to £19,500, has been paid, and £25,000 transferred to the reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £8,964 to be carried forward. The dividend and bonus will be payable on the 27th inst. The directors report that shareholders in the Western and Brazilian Telegraph Company, Limited, holding considerably more than three-fourths of the capital, have assented to the exchange of their shares in this Company. The former secretary, Mr. Richard Collett, having retired, Mr. W. H. Axworthy and Mr. E. S. Hodson have been appointed manager and secretary respectively.

EASTERN EXTENSION TELEGRAPH COMPANY, LIMITED.

The report of the directors for the half-year ended June 30 last, to be submitted to the general meeting on 26th inst., states that the gross receipts have amounted during that period to £277,283, against £290,749 for the corresponding half-year of 1897, £123,223 of which is the net profit for the half-year. The working expenses, including £29,877 for cost of repairs to cables and expenses of ships, absorb £102,874. Two quarterly interim dividends of 1½ per cent. each, amounting to £62,500, have been paid for the half-year, leaving £60,723, of which £50,000 has been transferred to the general reserve fund, and the balance of £10,723 is carried forward. Telegraphic communication with the Philippines was entirely suspended from May 2 until Aug. 21, both cables having been cut by the American forces besieging Manila. No attempt was made by the Company to restore communication until the peace preliminaries were signed. An arrangement was then arrived at with both the Spanish and American Governments for reopening the cables on a neutral basis, after which the Company's staff repaired the cables, and the Company is now working direct with the public at Manila, instead of through the medium of the Spanish officials as heretofore.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Ghent (Belgium).—The Corporation are advertising for tenders for public and private electric lighting on Oct. 27 and 29 respectively.

Paris.—Tenders are invited for 40,000 kilos. copper wire, in two lots. Particulars are to be obtained from and tenders addressed to Post and Telegraph Department by Oct. 27.

Bedford.—Tenders are invited by the Urban Sanitary Authority for the supply of petty stores for the electric light works. Full particulars can be obtained at the Works. Tenders by 24th inst.

Morley.—Tenders are invited by the Morley Industrial Co-operative Society for wiring, etc., new buildings, now erected in Queen-street, Morley. Particulars may be obtained by applying at the Office on or before 22nd inst. Tenders by 31st inst.

Knowle.—Tenders are invited for the supply and fixing of two engines and dynamos, equal to an output of 24,000 watts each, etc., for the County Lunatic Asylum, Knowle, near Fareham. Tenders by Nov. 10. Further particulars appear in our advertising columns.

Johannesburg.—Tenders for the supply of electrical plant, comprising engines, boilers, dynamos, condensing engines, etc., have been called for by the Johannesburg Town Council. Tenders are to be forwarded to the secretary, Mr. M. Adolfs, on or before the 28th inst.

Burnley.—Tenders are invited by the Electric Lighting Committee for steam-piping and mechanical stokers. Plans and specifications may be obtained on application to the borough electrical engineer, Mr. W. R. Wright, Aqueduct-street, Burnley, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Tenders by 25th inst.

Bury (Lancs.).—The Corporation invite tenders for the wiring of the public baths, St. Marie's-place, Bury. Specification and form of tender may be obtained on application to the Borough Engineer, Bank-street, Bury, on payment of 10s. 6d. Sealed tenders, endorsed "Wiring at Baths," to be delivered at the office of Mr. John Haslam, town clerk, Bank-street, Bury, by 26th inst.

Hanley (Staffs).—Tenders are invited for the erection of a refuse destructor. The building in which the destructor is to be placed, or the brick chimney shaft, is not included in the contract. Further particulars, together with copies of the plan of two suggested sites, may be obtained on application to Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley, by Nov. 15

Halifax.—The Guardians invite tenders for supplying and fixing at the new union hospital, Skircoat, Halifax, about 85 small electrical ventilating fans. Specifications and particulars can be obtained from Messrs. Shepherd and Watney, consulting engineers, 71, Albion-street, Leeds. Tenders to Mr. A. T. Longbotham, clerk, 4, Carlton-street, Halifax, in sealed envelope, endorsed "Electrical Fans," by 9 a.m. on 25th inst.

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of transformers and accessories. Specification, form of tender, and general conditions can be obtained at the offices of Mr. A. H. Preece, A.M.I.C.E., 29, Victoria-street, S.W. Tenders, sealed and endorsed "Tender for Transformers," must be delivered at the office of Mr. W. H. Whitfield, clerk, Council Offices, Wimbledon, by 5 p.m. on Nov. 7.

Warsaw.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Warsaw, stating that the Municipal Council of that city invite tenders for the exploitation of the tramways of Warsaw under municipal control. Horse traction is at present in use, but it is intended to introduce electricity as soon as possible. Information as to the conditions can be obtained from the Magistrat de la Ville de Varsovie, Varsovie, Russia.

London, W.—Tenders are invited by the Great Western Railway Company for the supply of the following, among other stores: indiarubber goods, telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, and incandescent electric lamps. Samples and patterns may be seen at Swindon from 12th to 21st inst. on application at the office of the Stores Superintendent, Swindon, where specifications and forms of tender may be obtained. Tenders by 24th inst.

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Potteries (Staffs.).—The British Electric Traction Company, Limited, Donington House, Norfolk-street, London, W.C., invite tenders for the overhead construction of the Potteries extension tramways. Specifications, quantities, and plans may be obtained from Mr. C. H. Gadsby, contract engineer, at the above address on payment of £5 per set. Sealed tenders, addressed to the Secretary of the Company, marked "Tender for Overhead Construction of Potteries Extension Tramways," must be delivered at above address by noon on 22nd inst.

London, N.—Tenders are invited by the Guardians of Edmonton Union for the supply and erection of the whole or part of the following: (1) engines and dynamos, condenser and pipework, including all engineering; (2) wiring for about 600 lamps, including switchboard and battery, etc. Specification, etc., may be obtained at the office of Mr. F. Shelton, solicitor and clerk, The Grange, White Hart-lane, Lower Tottenham, London, N., on payment of a deposit of £5 5s., which will be returned on receipt of a bona fide tender. Tenders by 25th inst.

Bilston.—Tenders are invited by the Bilston Urban District Council for the construction of a line of telephonic communication between the Bilston waterworks pumping station at the Bratch and the town hall at Bilston, with the necessary receiving and transmitting instruments, and also the setting up of electric recording apparatus in the reservoir at Goldthorn Hill, with communication wires from the recording apparatus to the pumping station at the Bratch, and also to the town hall, Bilston. Plans may be seen at the office of Mr. Baldwin Latham, M.I.C.E., engineer for the works, 13, Victoria-street, Westminster, S.W., and also at the office of Mr. John D. Wassell, clerk, Town Hall, Bilston, and the form of tender may be obtained on application to the Engineer or to the Clerk on deposit of £5, which will be returned to all persons making a bona fide tender. Tender by 29th inst.

Hull.—Tenders are invited by the Electric Lighting Committee for the supply and erection of certain plant in connection with their electric lighting works. Forms of tender and specifications for the following are now ready: (Contract 4) high and low tension mains, casings, trenchwork, etc.; (5) switchboards, continuous-current rotary transformers, motor-generator, etc.; (6) centrifugal pump, condenser (ejector type), steam-pipes, etc. Specifications for any one of the above three contracts may be obtained from Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Cheques or postal orders to be made payable to Thos. Geo. Milner, city treasurer. Tenders, endorsed respectively "Tender for Mains," "Tender for Transformers," "Tender for Steam-Pipes," to be delivered to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on Oct. 27.

RESULTS OF TENDERS.

Fulham.—The tender of the Horsfall Company, at £16,760, for destructor furnaces (equivalent to 12 cells) has been accepted.

Berkhampstead.—The Guardians have accepted the tender of Mr. Rawlins for the provision of electric bell communication in the house.

Liverpool.—The Corporation have accepted the tender of Messrs. Morrison and Sons, Wavertree, for erection of an electric power station at Pumpfields, Vauxhall-road.

Lake Vyrnwy.—The Liverpool Corporation have accepted the tender of Messrs. Christy Bros., Chelmsford, at £676, for carrying out works of electric lighting at Lake Vyrnwy.

Liverpool.—The Corporation have accepted the tender of Messrs. Tetlow Bros., Hollinwood, at £656 per boiler, for the supply of 14 steel Lancashire boilers for the electric power station at Pumpfields, Vauxhall-road.

Ilford.—The Urban District Council have instructed the Consolidated Telephone Construction and Manufacturing Company, Limited, to erect a private telephone wire from the Council offices and medical officer's house to their new hospital at Chadwell Heath, with telephones in each ward.

Buxton.—The Urban District Council have accepted the following tenders for various works in connection with the electric lighting station: Mather and Platt, Manchester, electrical plant, £4,236; Hornsby and Sons, Grantham, boilers, £1,659; J. White, Glasgow, switchboard, £1,353; J. Spencer, Limited, Wednesbury, steam exhaust and other pipes, £950; Tudor Accumulator Company, battery, £820.

King's Lynn.—The Corporation have received tenders for the following works in connection with the electric lighting of the borough: (1) buildings, etc.; (2) gas-producing plant; (3) gas-engines; (4) dynamos, switchboard, motor-transformer, electrical instruments, fittings, etc.; (5) accumulators; (6) armoured cables and other mains, pipes, culverts, fuse boxes, etc. Accepted tenders: Contract No. 1, Merredew and Wort, Stevenage, £2,683. 18s. 1d.; Contract No. 2, Fielding and Platt, Limited, Gloucester, £1,582. 16s.; Contract No. 3, Fielding and Platt, Limited, £3,237. 16s.; Contract No. 4, General Electric Company, Limited, London, £2,652. 6s. 7d.; Contract No. 5, Chloride Electrical Storage Syndicate, Limited, Manchester, £846. 9s. 6d.; Contract No. 6, Siemens Bros. and Co., Limited, London, £8,649. 13s. 11d.

Football.—The annual football match between the Robertson lampmakers and the Edison and Swan lampmakers was played at Ponder's End on Saturday last in the presence of a large crowd of spectators, resulting in a victory for the Robertson lampmakers.

BUSINESS NOTES.

Bexhill.—A loan of £20,000 for electric lighting has been sanctioned.

Ashton-under-Lyne.—Mr. W. H. Vincent, of Woolwich, has been appointed borough electrical engineer.

Hull.—It is stated that the promoters of the proposed tramway from Hull to Hessle have abandoned their scheme.

New Office.—Mr. Frederick Grover, M.I.M.E., A.M.I.C.E., consulting engineer, has opened an office in Greek-street Chambers, Leeds.

Kidderminster.—The sale to the British Electric Traction Company of the Kidderminster electric lighting order has been completed.

Clontarf.—The Commissioners will hold a statutory meeting to consider the question of obtaining a provisional order for the electric lighting of the district.

Newton.—The Urban District Council decided on Monday not to take in hand the matter of electric lighting at present, but to leave it to a private company.

Southampton.—Mr. J. H. Lee, the electrical engineer, having received an appointment in London, has resigned, and the Council will advertise at once for a successor at a salary of £250.

Removal.—Messrs. W. T. Glover and Co., Limited, have removed their London offices from 39, Victoria-street, S.W., to Dartmouth House, Queen Anne's-gate, Westminster, S.W.

Crewe.—The Town Council have entered into a provisional agreement with the Edleston Trustees for the purpose of securing a site at a price of £1,299. 7s. 6d. for the electric lighting generating station.

Wolverhampton.—The report of the Electric Lighting Committee, contained in our last issue, and involving an expenditure of £29,740 for electric lighting extensions, has been adopted by the Town Council.

Yarmouth.—The Corporation have decided to proceed to obtain parliamentary powers enabling them to construct and work, under their own control and management, or lease to others, a system of electric tramways in the borough.

Hastings.—On Tuesday, Mr. F. H. Tulloch, Local Government Board inspector, held an enquiry into the proposal of the Corporation to borrow £58,000 for the purpose of acquiring the electric light company's undertaking.

Heaton Norris.—An application has been made to the Board of Trade by the Urban District Council, under the Electric Lighting Acts, 1882 and 1888, for authority to supply electricity for public and private lighting within their district.

Radcliffe.—The District Council have declined to treat with the Electrical Power Distribution Company at present. The plans prepared by the surveyor have been submitted to Mr. Bennett, and will be forwarded to the Local Government Board.

Alloa.—The Burgh Commissioners have now passed the statutory formal resolution to the effect that the town clerk be authorised to instruct the parliamentary agents of the Commissioners to apply for a provisional order for the electric lighting of the town.

Whitehaven.—The lighting of Trinity Church by electricity was such a manifest improvement that the Presbyterians followed the example, and now the Congregational Church and schoolroom are to be similarly supplied. There will be altogether 225 lights.

Ramsey.—The Lieutenant-Governor (Lord Henniker) has sanctioned the closing of the electric tramway to Ramsey during the winter season owing to the necessity of constructing a double line near Ballaglass. The line has been very successful during the season.

Leamington.—The Town Council have resolved to apply to the Board of Trade for the grant of a provisional order under the Electric Lighting Act of 1882 and 1888, authorising them to supply electricity for public and private purposes within the borough.

Queensbury.—At the last meeting of the District Council a resolution was passed to the effect that the Council should take steps to construct a tramway from their district boundary at Scarlet Heights to New Dolphin. It is expected that the scheme will be carried out by next summer.

Bournemouth.—The Town Council have again discussed at some length a recommendation from the Roads Committee that the Corporation should apply for powers, under the Light Railways Act, to lay down and work tramlines in certain parts of the borough. The recommendation was again defeated.

Goole.—The Board of Trade have confirmed the provisional order granted by the Light Railway Commissioners for making a light railway by means of various branches connecting Epworth, Haxey, Crowle, Luddington, and Hatfield, and the Goole and Marshland line now in course of construction by a junction at Swinfleet.

Limerick.—With regard to the application of the Limerick Electric Tramways Company for powers to lay down tramways in certain of the principal streets, a committee of the whole Council has been formed for the purpose of examining the tramway scheme and arranging under what terms tramways are to be worked in the city of Limerick.

Glasgow.—An augmented service of nine electric cars is now running on the new electric route from Mitchell-street to Springburn. A number of horse cars are also still in use, but as the number of the electric cars will be gradually increased, it is

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expected that by the middle of next week the horse cars will have entirely disappeared from the route.

Cardiff.—The Cardiff Guardians have adopted a recommendation of the Building Committee affirming the desirability of lighting the workhouse by electricity, produced by the Guardians' own plant on the premises. The committee has been authorised to employ an expert electrical engineer to consult with themselves and the architect and report upon the whole question.

Newark.—A special meeting of the Urban District Council will be held on Nov. 14 to consider an application of the Electrical Power Distribution Company, Limited, for the consent of the Council to their application to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the borough of Newark, and to order thereon.

Lord Kelvin's Electric Instruments.—We are informed that, for the convenience of London clients, Mr. James White has opened a branch at 66, Victoria-street, Westminster, S.W., under the management of Mr. Patrick Hamilton, B.Sc. There are now over 300 hands employed at the firm's works in Glasgow, and we hear that the machines, new additions notwithstanding, are being kept fully employed.

Islington.—At the Vestry meeting to-day it will be proposed, "That it be an instruction to the Electric Lighting Committee to report to the Vestry the cost of providing the electric light from Highbury-corner along Canonbury-road and the New North-road in order that the Islington installation may meet the electric lighting system being at present carried out by the Vestry of Shoreditch as far as the boundary of that parish."

Electricity in Colliery Districts.—We understand that Messrs. O'Gorman and Cozens-Hardy have been asked to advise the Bridgewater Trustees as to the most economical methods of remodelling the whole telephone system in their large colliery district. Also, that the new locomotive and timber works on the estate will be made the centre for distributing electrical energy, the existing plant being removed from one of the pit-mouths to the new works.

Poplar.—At a meeting of the Board of Works on Friday last, convened to discuss a series of notices of motion relative to the proposal of the Board to erect a electric light station on a site of ground adjacent to the Board's depôt in Glaucus-street, a resolution, "That in the purchase of the land abutting on Glaucus-street and Violet-road, Mr. Forbes, solicitor, of Addington-row, Bow, be directed and instructed to act for the Board," was carried.

Verity's, Limited.—This firm has lately opened a branch at 55, Mitchell-street, Glasgow, exclusively for their business with firms in Scotland. The branch is under the charge of Mr. Sydney Andrews. For the North of England clients, the headquarters are 29, Princess-street, Manchester; the Midlands are served from Aston, and the London district and the South of England as heretofore, from the London wholesale office, at 31, King-street, Covent Garden.

Bootle.—During a discussion at a recent Town Council meeting, a hope having been expressed that the General Purposes Committee would try to prevent the introduction of the overhead system of electric wires in connection with the electrical cars in Bootle, as the system seemed to be a most unsuitable one, the Chairman of the Tramways Committee said they were in the hands of the Liverpool Corporation. For his own part he would like to see the system done away with.

Marylebone.—The Vestry have agreed to give formal notice to the Metropolitan Electric Supply Company, Limited, of the Vestry's intention to proceed for a provisional order for the public and private lighting of the parish by electricity. It is stated that notwithstanding the fact that the Vestry failed to obtain parliamentary powers conferring the provisional order granted by the Board of Trade last year, it should go on and endeavour again to obtain such powers.

Huddersfield.—The Corporation have instructed the borough engineer, the waterworks manager, the electrical engineer, and the tramways manager to report upon the practicability of utilising the water of the Corporation works in the Wessenden Valley, seven miles from Huddersfield, for the purpose of generating electricity for traction or lighting purposes. They have given these officials power to obtain such expert opinions as they, in consultation with the Mayor and town clerk, may deem necessary.

Loughborough. — The Loughborough Town Council have adopted a report of the Gas and Electric Lighting Sub Committee advising the promotion of a Bill for the purposes of authorising the Corporation to purchase, either by agreement or compulsorily, the undertaking of the Loughborough Gas Company, and to authorise the Corporation to generate and supply electricity for public and private lighting purposes, and for motive power, and to establish the necessary undertaking and works for that purpose, etc.

Manchester.—The Special Tramways Committee of the Corporation have decided to recommend the City Council to promote in the next session of Parliament a Bill to enable the Corporation to obtain powers to purchase the whole of the Manchester Carriage and Tramway Company's system of tramways in the city, and also the tramways in connection with the system outside the city, and to work the whole of these tramways. The Electricity Committee will undertake the whole of the work relating to the electric equipment of the lines.

Brentwood.—At an extraordinary general meeting of the Brentwood Gas and Coke Company resolutions were confirmed providing for the voluntary winding-up of the company and its reconstruction as a new company, to be named the Brentwood Gas, Coke, and Light Company, Limited, with a memorandum and articles of association already approved by the directors. The liquidator is Mr. C. A. Fielder, secretary of the company. The new articles of association provide for powers for electric lighting in the company's district.

Personal.—Mr. Herbert E. McKrell (late London representative of Messrs. Johnson and Phillips) has been appointed London manager for T. Frankenburg, of the Greengate Rubber and Cable Works, Salford, Manchester.—We are informed by Mr. James L. Owen, C.E., M.I.E.E., M.E., that, having severed his connection with Messrs. Alfred Dickinson and Co., consulting, civil, mechanical, and electrical engineers, he has taken offices at Temple-courts, Temple-row, Birmingham, for the purpose of practising as an engineer

Ayr.—Application is being made for an order to construct a light railway from Ayr to Monkton by the Drake and Gorham Electric Light and Traction Company, Limited, of London. It is proposed to work the cars on the overhead trolley system, the current to be supplied from a generating station to be erected by the company. The cars are to be seated for about 50 passengers, and will be lighted with electric lamps. A single line, with a 15 minutes' service from each end, is proposed. The District Committee of the County Council have approved generally of the scheme.

Fulham.—With reference to various applications of private persons to supply electricity within the district, the Vestry's solicitor has expressed an opinion to the effect that if the Vestry consider it desirable to allow electricity other than their own to be supplied within the parish, they should arrange themselves, if possible, to acquire the necessary current from the Hammersmith Vestry, and that they should arrange to supply it to the various applicants at a cost to be agreed. If the Vestry could make such arrangements they would not be committing any act which would forfeit their provisional order.

Dudley.—On Friday last, Colonel Sir Francis Marindin (Board of Trade inspector) made an inspection of the plant of the Dudley, Sedgley, and Wolverhampton Tramway Company, who have applied for the renewal of their license to use steam power. During the course of the proceedings, Mr. J. Fell (the chairman of the company) stated that one of the main difficulties with which the company had to contend was the fact that the engines were originally of an old type, and of little use for traction on a line like that. He desired to introduce the electric system, and hoped soon to indicate to the local authorities exactly what the company proposed to do.

Carlisle.—It is expected that the maximum price to be charged for current will be 5d., and the minimum 4d. per unit for large consumers. The Town Council have appointed Mr. C. D. Burnett, who is at present engaged as Prof. Kennedy's assistant, as resident electrical engineer. The General Purposes Committee have under consideration a proposal of the promoters of the tramways for the employment of electricity, on the overhead system, as the power for working the tramways. There are several kinds of traction which might be employed—namely, horse propulsion, steam, cable, gas, electric conduit, and electric overhead traction.

Huddersfield.—At the monthly meeting of the Town Council on the 19th inst., the following letter was read: "I am directed by the Postmaster-General to acquaint you for the information of the Corporation of Huddersfield that on the necessary powers to enable the Corporation to work an exchange system being granted by Parliament, his Grace will be prepared to give the Corporation a license for a telephone exchange." Afterwards a resolution was passed to memorialise the proper authorities that the Postmaster-General should be authorised to grant self-contained licenses to corporations to work telephone exchanges, and that such licenses should confer all necessary and incidental powers, including borrowing powers.

Lowestoft.—The Great Eastern Railway Company have written to the Town Council stating that the company would be willing to take the electric light at the same price as they can now obtain gas, but pointing out that in the near future, when a new station would be erected at Lowestoft, the company's requirements may become so great that they may provide an installation of their own. The Council have replied that they will be able to supply the company with electric light at the same, or even a less, rate than they are now paying for gas. The scheme for the proposed East Anglian Light Railway (Electric) from Yarmouth to Lowestoft, and thence to Southwold, is now before a committee appointed to confer with the promoters as to the construction of the line within the borough boundary, the fares to be charged, etc.

Watford.—At a meeting of the Urban District Council on the 13th inst. the matter of the proposed electric railway was fully discussed, and a deputation from the Tradesmen's Association waited upon the Council, and asked that the Council would not favour the scheme, which could not be carried out without a surrender of public rights, for which no corresponding advantages would be secured. The Chairman thought that if the line would benefit anybody it would be the tradesmen of the town. The money the line would cost approached £100,000—a speculation which the Council could not undertake themselves. If the streets were not wide enough for a company's tramway, they would not be wide enough for a corporation tramway. An amendment, "That it is undesirable that the Council should support the scheme now submitted for an electric light railway through the streets of Watford," was lost, and the whole matter was then referred to the next meeting. The electric light is making rapid progress. In several instances firms are manufacturing their own light rather than wait until the Urban District Council's plant has been laid down.

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Edmonton.—At the last meeting of the District Council, the committee in charge of the matter reported that, owing to other things, they could not recommend the Council to proceed with the promotion of a provisional order for electric lighting this session, but the committee thought that the Council should join the other local authorities in opposing any private company seeking such powers in the district. Mr. Barrass enquired if they were to understand from the paragraph in regard to electric lighting that the Council intended to apply for a provisional order next year, because if not he should oppose the recommendation. The Clerk said the Board of Trade had been informed that it was the intention of the Council to apply for a provisional order, but it was not stated when that would be. It would be for the Council to fix the time next year, or postpone the date for another year. Mr. Williams said they could not pledge the Council of next year to any course, but it was generally understood they were going for a provisional order.

Ludlow.—The Public Lighting Committee, with a view to the application for a provisional order for electric lighting, have recommended the Town Council to adopt Lower Broad-street, Broad-street, King-street, Bull Ring, Corve-street, Lower Corve-street, Castle-street, Dinham, Mill-street from Castle-street to Bell-lane, Old-street from Bull Ring to Brand-lane, Tower-street to Galdeford, and Galdeford from Tower-street to Market-street as the places in which they would be prepared to supply electric light within two years. They have also recommended the Council to guarantee to supply, within 18 months from the confirmation of the order, electric light mains in any street on the requisition of six owners or occupiers who would undertake to use enough light for three years to produce 20 per cent. on the outlay, and find surety. Further, they have advised the Council to name £6,500 as the capital to be expended, repayable in 30 years, and to adopt certain other formal provisions. It is proposed to light the Guildhall and Council-chamber with electricity. It is stated that if the Council could get sanction for a 30 years' loan and borrow at 3 per cent., the annual repayment would be £353. 8s. 9d. less than they were paying for gas. The report has been adopted.

Liverpool.—The Tramways Committee of the City Council at its last meeting received a report from the city engineer on the reconstruction of existing lines and the construction of new lines authorised by the tramways order of 1898 for electric traction. The committee decided to recommend that the Council should authorise the carrying out during the year 1899 of the reconstruction of the old lines and the construction of the new lines mentioned in the engineer's report, at a total estimated cost of £143,060. As to the extension of the experimental line along Aigburth-road, a report of the city electrical engineer and the city engineer was received. On the motion that the engineers be instructed to prepare plans and specification for carrying out the work, it was moved as an amendment, which was lost, that Messrs. Mather and Platt, Mr. R. W. Blackwell, and the British Thomson-Houston Company, Limited, be requested to submit plans, specifications, and estimates for carrying out the proposed extension. The committee will ask the Council to authorise them to carry out the construction of a double line of electric traction from the Dingle to Aigburth Vale with the overhead trolley system, at a cost not exceeding £25,000, and that the city engineer be authorised to obtain tenders for the supply of rails and paving materials for the extension.

Limehurst.—At the fortnightly meeting of the Urban District Council it was reported that a conference had taken place between the representatives of the Ashton Corporation and the representatives of authorities in the surrounding neighbourhood, including the Limehurst District Council. It appeared that the Ashton Corporation were willing to put a Bill through Parliament to empower them to supply the authorities adjoining their boundaries with electrical energy in bulk, providing those authorities would each procure a provisional order. They expected that the largely-populated townships of Dukinfield, Droylsden, and Denton would become their customers for electrical power, otherwise the matter would not be proceeded with. The Droylsden Council, however, were in communication with Manchester to supply them with electrical energy, not in bulk, but retail, and also lay down the mains necessary in Droyleden, at 5d. per unit. The cost of the provisional order for powers would be £240, and also it would take something like the large sum of £1,000 per mile to lay down the mains. The conditions on which they would supply the electricity to the authorities was 2d. per unit, and it would be distributed by the authorities at the price of 5d. per unit. After discussion it was resolved that the Limehurst District Council could not at present take up the question of electricity.

Southwark.—The Vestry have received a report of the Electric Lighting and Dust Disposal Committee with reference to a letter from the National Telephone Company, asking that the notice to remove the telephone lines in Marshalsea-road be withdrawn, and requesting permission to lay underground mains in the following roads in the parish — viz., Marshalsea-road, Old Kent-road, Borough-road, St. George's-circus, Waterloo-road, and Westminster Bridge-road. The committee recommend that the National Telephone Company be informed that the Vestry will be prepared to consider an offer from them on the same terms as those granted to the Vestry of St. Martin-in-the-Fields, subject to the following conditions—viz.: (*a*) that free telephones be provided from the depôt and stoneyard to the vestry hall and departmental offices; (*b*) that the work of laying mains be carried out under the superintendence of the Vestry's surveyor, the company to pay the cost of such superintendence; (*c*) that the manhole covers do not exceed in size four superficial feet, and that they be fixed at positions to be approved of by the Vestry's surveyor; (*d*) that the footways be reinstated by the Vestry's workmen to the satisfaction of the surveyor, and maintained at a period of six months at the company's expense; (*e*) that the company undertake not to interfere with, or in any way damage or cause any injury to the Vestry's trees.

Hales Owen.—At a meeting of ratepayers from the parishes of Hales Owen, Hasbury, Hawne, and Hill, held for the purpose of considering the terms required by the Hales Owen Gas Company for lighting the public lamps in the parishes named, Mr. William Green, chairman of the District Council, said the question of lighting the public lamps in Hales Owen and district had been a sore point for a number of years past. Three years ago the gas company made a reduction of 5s. per lamp, but the District Council were bound for a period of three years. In June last a deputation was appointed to meet the gas company, and, after discussion, the directors of the company said they would light the lamps at £3 per lamp for eight months, and £2. 15s. if they did not light when there was a full moon, which amounted to about five nights per month. The gas company did not carry out their promise, and the District Council decided to agree to the terms of £3 per lamp but refused to be bound by a three years' contract, and in consequence the town had been in darkness since Sept. 1. He did not think the District Council were justified in binding themselves to a two years' agreement in the face of an offer from an electric company to light the parishes from end to end at £2. 10s. per lamp. They had also an offer from a company in London to fix the lamps in the parishes, but he could not state at what price. The clerk to the District Council had been instructed to apply to the Board of Trade for a provisional order authorising the Council to supply electricity for lighting and other purposes within their district. Ultimately a resolution approving of the District Council's action in the matter was carried, with a number of dissentients.

Shrewsbury.—Mr. W. A. Ducat held an enquiry on Friday last into an application to borrow £35,800 for the purchase by the Corporation of the undertaking of the Shropshire Electric Light and Power Company and for the extension of the works. There was no opposition. The Town Clerk said the Shropshire Electric Lighting Company obtained a provisional order in 1894, under which they executed certain works in the town, but they had not carried out the whole. In 1897 the Corporation approached the company with a view of purchasing the undertaking. Messrs. Kincaid, Waller, and Manville, of Westminster, were called in to value it. In February last a provisional undertaking was entered into with the company, agreeing to pay £21,500 for the undertaking and goodwill, but in addition was to be the cost of certain works, which would have to be carried out before the purchase could be completed, and which would be valued by the engineer to the Corporation. In case of the works being extended, which they would at once have to be if purchased by the Corporation, it would be necessary to acquire some additional property adjoining the present works, and for this purpose £800 would be needed. Since it became known in the town that the Corporation was likely to take over the works, the number of electric lamps had increased from 2,833 to 5,006, an increase of 2,173 in 12 months. This fact spoke for itself, that the public approved of the purchase. The sum to be paid the company was £21,500, besides which would be the cost of other works which had been carried out since the provisional agreement was signed, and also the cost of extending the mains along Abbey Foregate and to some other places, and £3,000 was set down for contingencies. The ratable value of the borough was £140,000, and the debt under the Public Health Act £65,900, the population in 1891 being 26,900.

Bristol.—Many circumstances, says the *Bristol Times and Mirror*, have caused delay on the part of the Bristol Tramways and Carriage Company in deciding upon a definite plan for carrying out in regular and consecutive order the great scheme of extensions and the reconstruction of existing horse lines for electrical traction, for which they obtained powers in their new Act. Plans of the whole of the works have been sent in to the city authorities, and when their views regarding them are known the directors will decide how to proceed, and the work will be pushed on vigorously. In the meantime the considerable body of men in the company's employ are kept going, making sectional extensions in one place or another, and renewing certain links. The latest piece of the existing track taken in hand is that between Old Market-street and Victoria-street, which was commenced last Friday. When this is finished, probably the whole scheme of work will be settled, and the reconstruction of the Victoria-street line between Temple-meads and Bristol Bridge and the tramways centre will follow, and will be probably worked by electricity from the St. George's power station soon after it is completed. The relaying of the Redcliffe-street line will be the next section undertaken. This is all that can be said with any degree of certainty at present regarding the lines. A commencement has also been made on another important branch—namely, the power station at Counterslip—which is to be a huge establishment, and to be fitted up with the best possible electrical apparatus, and where also provision will probably be made for additional plant necessary to work other extensions which might hereafter be decided upon. The tramways company came into possession of the premises yesterday week, and on Friday morning Mr. C. A. Hayes, the contractor, commenced to demolish the old buildings and to clear the site in preparation for the new structure.

Newington.—At the last meeting of the Vestry, Mr. L. J. Dunham, the clerk, informed the members that, acting under the instructions of the Electric Lighting Committee, he had settled an agreement with the South London Electric Supply Corporation,

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Limited, for taking from them electrical energy, pending the opening of the Vestry's station in Penrose-street, up to a maximum of 100 kw., which was equal to 3,350 8-c.p. lamps. The greater portion of this amount of energy would be required at the Kennington Theatre. The Vestry's cable would shortly be laid from the corner of South-place down the Kennington Park-road and both sides of Newington-butts to the Elephant headway, and the object of the agreement was to secure a "live" main between these points to enable the Vestry to supply current to the Tabernacle and the new block of buildings at the Elephant, in addition to the theatre, prior to the opening of their own station. The agreement had been carefully settled from an engineering point of view by the Vestry's consulting engineer (Mr. Manville), and in other respects by himself (the clerk) and the solicitor of the company. Although the maximum of electrical energy had been fixed at 100 kw., no minimum was mentioned, so that if no more energy was taken than that required for the theatre, there would be no further liability upon the Vestry. As a matter of fact, the agreement was so drawn that the Vestry would only have to pay for the current consumed, as shown by meter. There would be no profit made or loss incurred under this agreement. The theatre company had agreed to pay to the Vestry the same price per unit as the Vestry agreed to pay to the Corporation, and any householder or shopkeeper desiring to connect up to the Vestry's cable would have to be placed under the same conditions. The agreement was most beneficial to the parish, inasmuch as it would enable the Vestry, by the time their own station was ready for opening, to switch on at once to the station such a number of lamps as would, with those required for the municipal buildings and street-lighting, secure from the outset the financial success of the undertaking. He advised the Vestry, therefore, to seal the agreement, and this course was adopted.

St. George's (Hanover-square).—At yesterday's meeting of the Vestry a report of the Electric Lighting Committee was received, recommending, with reference to a letter received from Mr. W. Marcus Wilkins, vestry clerk of the parish of St. Mary, Battersea, stating that they have had under consideration the Bill of the General Power Distributing Company before Parliament, and Bills of a similar nature, which seek to give power to companies to supply electrical energy in bulk over large areas in parts of which provisional orders have already been granted to local authorities, and for other purposes, and requesting that the Vestry would ask the local member to oppose the Bill, that the request made by the Vestry of St. Mary, Battersea, be acceded to, and the Right Hon. G. J. Goschen, M.P. for the borough, be asked to oppose the Bill accordingly. The report further states (1) that in accordance with the committee's instructions the vestry clerk has prepared and submitted a report with regard to previous action taken by the Vestry in the matter of electric lighting and also with regard to the provisional orders applicable to the parish, and obtained by the Westminster and London Electric Supply Corporations respectively, and the position generally of the Vestry, under the Electric Lighting Acts, 1882 and 1888, and that they have authorised the vestry clerk to have such report printed and copies thereof forwarded to the members of the committee, and also to obtain sufficient copies for subsequent circulation amongst the members of the Vestry; (2) that they have instructed the surveyor to prepare and submit to the committee at the earliest opportunity a scheme providing for the public lighting of the parish by electricity, with particulars of the estimated annual cost which the adoption of such scheme would entail in the event of the public lighting being carried out by the Vestry, or as an alternative by one or both of the existing companies, and, further, that the vestry clerk and the surveyor be and they are hereby instructed and authorised to confer with the representatives of the Westminster and London Electric Supply Corporations respectively, with a view to obtaining quotations upon alternative lines (*a*) for supplying electricity for public lighting, and (*b*) for providing and maintaining the necessary lamps and lamp columns and all other apparatus and appliances, in addition to the cost of supplying electricity for public lighting.

Twickenham.—At last week's meeting of the District Council the clerk presented a report on electric lighting, which contained statistical tables showing the population, acreage, ratable value, particulars of establishment, maintenance, and profit and loss of electric lighting of 60 municipal undertakings; a return of works in course of construction in 38 other centres; a return of electric lighting installed by public companies in 48 centres; and a return of works in progress by companies in 10 centres. Mr. Ruston says while it was impossible to judge with any degree of accuracy or certainty, as the characteristics of each place must be considered separately, still the tables would lead one to infer that something like £20,000 would have to be provided to carry out an electrical scheme at Twickenham. The report continues as follows: "If the Council purpose obtaining a provisional order this ensuing session of Parliament, the preliminary steps must be taken during the ensuing month, and a large mass of particulars and facts must be collected for insertion therein. If the Council intend, either during the session 1898-9, or 1899-1900, to obtain a provisional order, consent should not be given to the companies which have given notice of their intention to apply for provisional orders. Further, if an order were obtained then, there is the prospect of leasing or selling it to some company should the Council decide not to put it in force themselves, and possibly better terms might be made with a company than if a company obtained a provisional order, and entered into an agreement for sale to the Council after a term of years had expired." The report was received, and a vote of thanks accorded the clerk for it. The Clerk said that he had received a notice from the Electric and General Engineering Company, asking the Council to give or refuse assent to the company having a provisional order. Mr. Warden-Stevens wrote asking to be appointed electrical engineer to the Council, and Mr. Gripper, of Edmundsons' Electric Corporation, Limited, wrote forwarding a draft of order they should ask for, and also stating that if the Council intended to apply for an order they should not proceed. A resolution of the Lighting Committee was adopted stating that, having further considered letters received from companies proposing to apply for provisional orders to supply electricity to the parish, they had instructed the clerk to reply thereto to the effect that the Council did not intend to give consent to any application at present, as it was the intention of the Council to apply for powers when they had obtained the necessary particulars. The Drake and Gorham Electric Power and Traction Company have written to the District Council intimating an intention to apply for an order to construct a light railway from Hounslow through Twickenham to St. Margaret's, and asking for a conference with the Council as to terms. The letter was referred to the Highways Committee.

PROVISIONAL PATENTS, 1898.

OCTOBER 10.

21248. Improvements in and connected with the electro-deposition of metals. Sherard Osborn Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

21261. Improvements in electrical ignition apparatus for internal-combustion engines. Thomas Wardell, 62, St. Vincent-street, Glasgow.

21265. Improvements in certain drums for holding electric cables. Thomas Oxley, 18, St. Ann's-street, Manchester. (Complete specification.)

21307. Improvements in the production of incandescent materials suitable for use in electric lighting. Sydney Pitt, 24, Southampton-buildings, Chancery-lane, London. (The Pharmaceutisches Institut Ludwig Wilhelm Gans, Germany.)

21317. Improvements in magnetic separating apparatus. Alexander Melville Clark, 53, Chancery-lane, London. (Metallurgische Gesellschaft A. G., Germany.)

OCTOBER 11.

21359. Improvements in and connected with shades or reflectors for electric lamps. Samuel Leach Kilpin, 18, New Bridge-street, London.

21364. Improvements in battery solutions. Henry Blumenberg, jun., 78, Fleet-street, London.

21374. Improvements in rheostats or electric heaters. Edwin O. Raster, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21401. Improvements in step-by-step dial telegraphs with duplicate indicators to record the indications given and received in signalling. Richard Robert Harper, 166, Fleet-street, London.

21407. Improvements in dynamo-electric machines. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

21410. Improvements in controlling switches and apparatus for electric motors. Reese Hutchison, 322, High Holborn, London. (Complete specification.)

OCTOBER 12.

21467. An improved form of alternating-current transformer or economy coil. Verity's, Limited, and Louis John Steele, Plume Works, Aston, Birmingham.

21480. Improvements in or relating to channels, tubes, and wells for underground electric conductors and the like. Carl Axel Wilhelm Huttman, 322, High Holborn, London.

21492. Apparatus for generating and utilising electric energy. William Speirs Simpson, 166, Fleet-street, London.

21501. Improvements in coin-freed electrical apparatus. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (E. G. Lochmann und Cie., Germany.)

OCTOBER 13.

21505. Improved device for use in connection with apparatus for the electric haulage of vehicles. Fred Roberts, 17, Hanover-street, Keighley.

21524. Improvements in electromagnetic variable speed and clutch gearing. Henry Appleby Wallaston, of W. Pope and Son, and Rankin Kennedy, 89, Gathorne-terrace, Leeds.

21550. Improvements in systems of control for electric motors and railway trains. William B. Potter, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 17, 1898, being date of application in United States.) (Complete specification.)

21551. Improvements in controlling electric motors and electrically-propelled railway trains. Edwin W. Rice, jun., 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 26, 1898, being date of application in United States.) (Complete specification.)

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21573. Improvements in dynamo-electric generators, motors, and transformers. Courtenay William Thompson, 47, Lincoln's-inn-fields, London.

OCTOBER 14.

21633. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

21638. Improvements in arc lamps for projection and for laboratory or like purposes. John Stuart and John Henry Barton, 47, Lincoln's-inn-fields, London.

21652. An improved system of electric traction. Sydney Worthington and Richard Joseph Crowley, 18, Granville-place, Portman-square, London.

21669. Improvements in or connected with incandescent electric lamps. Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

OCTOBER 15.

21695. A circulating electric battery. Ernest Alfred Stokes, Edwin James Stokes, and Richard Joseph Crowley, 100, Drakefell-road, Nunhead, London.

21715. Improvements in automatic means of breaking electric circuits. James Ferguson and James White, 154, St. Vincent-street, Glasgow.

21716. Improvements in electric measuring instruments. William Thomson, Baron Kelvin of Largs, 154, St. Vincent-street, Glasgow.

21718. Improvements in electric arc lamps. English Industrials, Limited, 55, Chancery-lane, London. (Elektricitaets Aktiengesellschaft, Germany.)

21719. Improvements in hand vice and other strainers or stretchers for telegraph, telephone, and other wires. William Stewart Mackie, 100, Wellington-street, Glasgow.

21733. Tubes and fittings for electrical purposes. Harold Evelyn Dolphin, 10, St. Mary's-terrace, Crassendale, near Liverpool.

21752. Improvements in telescriptors or telegraphic transmitting and recording or receiving apparatus. The Telescriptor Syndicate, Limited, 55, Chancery-lane, London. (Bernhard Hoffmann, France.)

21755. Improvements in electric meters, parts of which are applicable to the reduction of friction of rotating shafts. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Roger Sherman White, United States.) (Complete specification.)

21758. Improvements in systems of train control for electric motors. Frank E. Case, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 12, 1898, being date of application in the United States.) (Complete specification.)

21759. Improvements in electric train systems. William B. Potter, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 31, 1898, being date of application in the United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

17316. Electric accumulators. Garcia.

24155. Joint-box for electric cables. Hatton and W. T. Henley's Telegraph Works Company, Limited.

24156. Joint-box for coupling underground and aerial electrical cables. Hatton and W. T. Henley's Telegraph Works Company, Limited.

24157. Clamp connection for electrical conductors. Nichols and W. T. Henley's Telegraph Works Company, Limited.

25246. Process for the electrolytic separation of metals. Von der Linde.

28382. Commutator brush carriers for electric machines. Lake (Compagnie de l'Industrie Electrique.)

1898.

5068. Carbon-feeding mechanism of electric arc lamps. Wood.

13210. Electric heaters. Lundell.

13399. Method of combined application of continuous and alternating currents for exciting magnetic fields and combination apparatus for producing by this method electrical energy and mechanical power. Déri.

14060. Means of lowering the load of cranes or hoists driven by electromotors. Royce and Claremont.

14732. Method for obtaining combined alternating and continuous currents and distributing the same for the electrical transmission of power, particularly for electrical traction. Déri.

15222. Electric accumulators. Lake. (Burns.)

16155. Globes of electric incandescent and similar lamps and lamp shades or chimneys. English Industrials, Limited, and Heyl-Dia.

16875. Electricity meters. Schattner.

17280. Electrically-driven fans or ventilating devices. Bergmann.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Oct. 15	3 876	3,644	+ 232	—	—
Blackpool and Fleetwood Tramroad	,, 15	394	—	—	12,438	—
Bristol Tramways and Carriage Co.	,, 14	2,664	2,543	+ 121	—	—
City and South London Railway	,, 16	1,002	960	+ 42	15,253	14,551
Dover Tramways	,, 15	182	129	+ 52	6,800	—
Dublin U.T., elec. cars	,, 14	412	†297	+ 135	8,378	5,881†
Dublin S.D. Electric Tramways	,, 14	885	469	+ 416	16,259	11,242
Halifax Corporation Tramways	,, 12	260	—	—	4,223	—
Liverpool Overhead Railway	,, 16	1,388	1 296	+ 92	—	—
South Staffordshire Tramways	,, 14	670	630	+ 40	25,921*	26,184*

* Receipts since Jan. 1. † Horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	14½-15½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10-10½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited. Ordinary, Nos. 1-30,000	10	16½-17½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Bush Electrical Engineering Limited, Ordinary	2	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	10-10½
——	6	6 6½
—— Pref. Half-Shares	1	1¼-1¼
—— " "	5	4½-5
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23-24½
—— 90,001-100,000	10	22½-23½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	00	70-72
—— Ordinary	3	2¾-3½
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12½-13½
—— " " " No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1½-2
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2½-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅜-½
Elmore's Wire Company	2	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22½-23½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13½-14½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7½-8
—— £4½ Shares, New	4½	6½-7
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2⅞-3¼
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	104-107
Telegraph Construction and Maintenance	12	39-43
—— 5 per cent. Bonds	100	100-103
Waterloo and City Railway, Ordinary	100	113-118
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Dundee Institute of Architecture, Science, and Art.—The council of the institute announces that the opening meeting of the session will take the form of a dinner, on or about Nov. 17 next. The probable dates of the other meetings of the session will be Jan. 12, Feb. 9, and April 20.

Electric Power on Monitors.—The four new monitors for the United States navy, for which bids were opened on Oct. 1, will be quite fully equipped with auxiliary electrical apparatus, electric motors being installed for the turret-turning gear, ammunition hoists, and ventilating apparatus.

Institution of Electrical Engineers.—We note that a meeting of the institution, for members only, is called for Thursday next, Nov. 3, at 4 p.m., to consider a resolution to authorise certain changes in the articles of association. The changes proposed are somewhat numerous, but we look upon the matter as private till after the meeting.

Institution of Electrical Engineers.—The opening meeting of the session will be held on Thursday, Nov. 10, when a paper will be read by Prof. Silvanus P. Thompson on "Rotatory Transformers. We also learn that the annual dinner will take place in the Grand Hall of the Hotel Cecil on Wednesday, Dec. 7, and that the invitations are likely to be issued during the coming week.

The Loss of the "Mohegan."—A local seafaring expert has put forward as the cause of the wreck of the "Mohegan" the theory that at the Manacles there occasionally exists a strong magnetic attraction, and that the ship thereby was gradually drawn towards the rocks. This theory is absurd. A much more likely theory would be that the compasses were affected and a wrong course steered. But if this were so, other ship-captains would have experienced the same thing, and it is unlikely that it would not have been reported.

Electricity on the Indian Border.—A suggestion was made recently that advance stations and certain outposts should be furnished with installations of the electric light for objective purposes. It was even proposed to use the labour concentrated in certain gaols for turning treadmills to generate the required power. However all that may be, we hear, says *Indian Engineering*, that it has been decided to depute Lieutenant C. O. Halliday, R.E., to Malakand to consider on the spot all the necessary details connected with the question of establishing an electric lighting installation at that place.

Engine-Room Lighting.—The mishap at the Brighton electricity works, which put out all the lights in the town for 20 minutes last week, was caused, it is said, by an armature burning out. The automatic switch which should have cut the machine out did not act, and hence the armature short-circuited the 'bus bars. If the cut-out had acted, the fault would have been immediately localised, but, as it was, all the station lights went out, and this added considerably to the length of time before the faulty machine could be cut out and the supply resumed. There is no doubt that the general lighting of the station should be independent of the supply 'bus bars.

Liverpool Engineering Society.—We have received the programme of the above society for its twenty-fifth session. This will be commenced by a presidential address from Mr. John A. Brodie, Wh.Sch., M.I.C.E., M.I.Mech.E., which will be delivered on Wednesday, Nov. 2, at 8 p.m. The following meetings, held at intervals of about a fortnight, have all been arranged for. Amongst the papers to be read we notice the following as likely to interest the majority of our readers: "Electricity at the General Post Office," by Mr. W. H. Preece, C.B., F.R.S.; "The Snowdon Mountain Railway," by Mr. G. C. Aitchison; and "Some Observations on the Rating of Machinery," by Mr. Oswald W. Young.

Telegraph to Dawson City.—According to the *Financial News*, it should not be long now before telegraphic communication with the Klondyke region is established, some sanguine people even predicting that it will be open in January, although this is very unlikely. The Canadian Parliament in the beginning of the year granted a charter to some English and Canadian investors empowering them to construct a telegraph line from the Alaska coast to Dawson City. Nothing was done, however, during the summer, and the charter has come into the possession of another body possessing greater energy. Amongst these are Mr. J. Roche, M.P., and Mr. J. D. Pender (?). The plan is to construct a double land line from Skaguay *vid* Lake Tagish and Fort Selkirk to the Klondyke. The work is to be begun immediately, and the line is expected to be in operation early next year.

The London County Council and Electric Lighting.—We notice from this week's agenda of the London County Council that the matter in dispute between the Council and the Blackheath and Greenwich Electric Light Company has been satisfactorily settled; in fact, the reference to it in the agenda shows that our remarks on the subject in a previous issue were quite justified. All that was required to remove the objection to the Council was a statement from the company that they were making arrangements for the erection of the generating station within their area. If the County Council engineers had read the prospectus of the company when it was issued, they would have known that this was to be so, and in any case a letter asking the question on Sept. 2 or 13 would have saved the company at least a month of the period allowed for the laying down of the mains in their scheduled streets.

Smoke Nuisance.—The Metropolitan Electric Supply Company were fined again last week by the magistrate at Paddington for nuisance caused by smoke in the early part of September. The reason given by the magistrate for this decision was that the smoke from the electric light works had increased in blackness since the previous judgment, in spite of the fact that the coal strike had ended. This, he said, showed that every care had not been taken. The company urged that the scarcity of Welsh coal was the cause of this nuisance, and that supplies of coal from the collieries which had been on strike were not available in London till some three weeks after the strike ended. Unfortunately, the holidays of Mr. Markby, the engineer of the Amberley-road station, began early in September and ended just at the time when the full supply of Welsh coal was available. The coincidence in dates was used to prove—very unfairly, we think—that due care had not been exercised in his absence. The nuisance had entirely ceased before the end of September.

Active Opposition to Tramways.—The London County Council have decided to advertise for a tramway manager and engineer to superintend, after Christmas, the large tramway systems which will then become their property. We are glad to note that the gentleman appointed is to receive a salary of £1,500 per annum. If he experiences the same difficulty in introducing an improved system of traction that outside tramway engineers have had to put up with from the Council, his salary will not be too high a remuneration for the labours involved. We regret to see that at Hastings the opposition to tramways of any kind is as active as ever. We know of no town where tramways

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are more needed than at Hastings, and, we may add, in no place is the opposition from those tradespeople whom the tramways would most directly benefit more unreasonable. A meeting of the guarantors has been held to select candidates for the forthcoming municipal elections who will oppose by every possible means the introduction of electric tramways in Hastings and St. Leonards.

Pilot Lamps.—Most electrical engineers are accustomed to use an incandescent lamp fixed to every dynamo in the electric light station to give the driver or engineer-in-charge a rough gauge as to the voltage of that individual machine. Such lamps are exceedingly useful in times of breakdown as giving optical indications of which dynamo is at fault. The engineer-in-charge of the electric light station being, as a rule, in the engine-room, has these lamps always before him. The resident engineer regards the lamps in his office as pilot lights in working the plant, and in most cases he has his private house connected to the mains for the same reason. In that case any flickering of the light promptly gives him warning of troubles occurring in the central station. We notice that at Morecambe the Town Council have had a heated discussion as to whether their resident engineer should be allowed to have his house lights free of cost. They did decide to do so, thus conforming to the usual practice. The value of the light so given is small against the time saved by the engineer in getting to the station should any occasion for his presence arise.

A New Secret Sounder.—The Manufacturers' and Inventors' Electric Company, of New York, are bringing out a novel and useful telegraphic instrument, which they call the "Morse watch." It is a Morse telegraph instrument, a key and sounder, mounted in an ordinary pocket watch case. The sound can be so regulated as to be either a loud click, like the ordinary telegraph sounder, or an almost inaudible tick, like that of a watch. In the latter case the receiver requires to be held close to the ear in reading the signals. It is provided with a head-band of hair to attach the watch to the head for secret work, or where there is so much noise as to drown the ordinary sound. Most high-speed telegraphers being in the habit of transcribing their work upon typewriters, it is necessary to provide in some way to neutralise the noise of those machines. This difficulty is claimed to be overcome by the Morse watch, and the operator is secured from disturbance from this cause. Also in brokers' offices, where secrecy may be imperative, this watch provides that only the operator hears the message. This instrument, for the same reason, would be useful for the military telegraph. The whole instrument, including conducting cords, head-band, and watch, weighs only 4½oz., and may be carried as an ordinary watch.

Asylum Lighting.—The governors of the Cork District Lunatic Asylum have been collecting a mass of useful information as to the general practice of asylum lighting throughout Great Britain and Ireland. The resident medical superintendent, Dr. Wood, addressed the following series of questions to all the asylums in question: (1) Is your asylum lighted with gas or electricity? (2) If by electricity, do you generate it on the asylum grounds or rent it from a company? If the former (3) Do you use steam or gas as motor power for engines? (4) Number of lights in use; units consumed annually? (5) Horse-power of engine required? (6) Cost per unit? (7) If you use gas, have you adopted incandescent burners, and if so, are they a success? (8) Which light do you recommend for asylum purposes? (9) Do you use fans for ventilating purposes; if so, what do you use as a motor power? From the replies received we see that electricity is used in a very large number of asylums, and that it is recommended practically everywhere as a better illuminant than gas. Thus Dr. Wood reports that of all the English asylums from which reports have been received, the superintendent of Kent Asylum alone prefers gas to electricity. Three superintendents are silent on the subject, and all others more or less strongly advocate electricity as being much safer, healthier, cleaner, and in some instances cheaper than gas. Incandescent burners are, on the whole, condemned for general use as being too fragile, only two superintendents recommending them.

Telegraphed Testimonials. — The opponents to electric traction, and specially to systems of electric traction in which an overhead wire is used, urge that the streets are spoiled by the electric lines, and that the property depreciates accordingly. The following are a few opinions from those who know, as ascertained by telegraph just before a recent enquiry before the Light Railway Commissioners. Thus the Town Clerk of Coventry telegraphed: "Your telegram just received. Impression quite mistaken; streets through which tramways run amongst the most progressive in the city. Two years' experience very satisfactory on scores of safety, health, and efficiency." The Town Clerk of Dover telegraphed: "Tramways. No justification, from our experience, for impression named. Electric cables no source of danger; great economy on all other traction, especially horses. Send critics here. All local opponents converted." The Town Clerk of Kingstown (Dublin) telegraphed: "Value of property along line of tramways here much appreciated, not depreciated, in value, and electric traction, so far as I can ascertain, is not more dangerous than horse traction; while on sanitary grounds, it is more advantageous." Town Clerk, Wednesbury, telegraphed: "No depreciation of property followed overhead system here; not one accident happened since introduction five years ago. On sanitary and economic grounds, much preferable to horse or steam traction. Mayor (as chairman of Highway Committee) endorses."

Electric Lighting in Brussels.—The installation recently opened for illuminating purposes in the Gare du Midi in Brussels has proved very satisfactory, and the company which performed the work has received a contract for a similar installation in the Gare du Midi of Ghent. When the city authorities of Brussels, a few years ago, proposed the question of lighting public places, such as railway stations, parks, etc., by electricity, and of supplying electricity to subscribers the same as gas, great opposition was experienced on the ground that it would ruin the gasworks and injuriously affect the communal exchequer. Recent statistics show that during the past year not only has the use of electricity increased, but that the profit from the sale of gas was considerably in excess of that of previous years. Deducting the amount expended for establishing plant, etc., the city derived a profit of £8,896. The most important installation recently made in Brussels is in the King's palace. When the work is finally completed there will be 7,500 lamps, of which a large number will be of 5 c.p., employed in the chandeliers illuminating the ball and reception rooms. There are, according to the United States Consul at Brussels, about 47,391 lamps reduced in units of 16 candles, in the city system, averaging 117 lamps per 100 running metres of canalised streets. This number includes 770 arc lamps and 28 electric motors, the latter varying from $\frac{1}{10}$ h.p. to 10 h.p. with a total of 105 h.p. In view of the increasing use of electricity in Belgium, the Consul is of opinion that there is an excellent opportunity for the introduction of electric apparatus of all kinds.

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The Telephone Users' Association.—We have received a letter from this association, which is startling both in its incorrect facts and in its idea of what is wanted. The letter reads as follows: "Dear Sir,—It is evident from the fact that licenses have been granted to Glasgow and Huddersfield that the Government do not intend to take over the telephones, but to grant licenses to municipalities or to companies under their control, in accordance with the terms of the Treasury minute of May, 1892. This will entail upon every corporation anxious to have the control of the telephone exchange the trouble and inconvenience of obtaining a special Act of Parliament for its own particular locality. What is wanted now is pressure to be brought upon the Government to bring in a general enabling Act, whereby municipalities will be able to immediately take up the telephone business and work it in suitable areas, the extent of which ought to be at once under the consideration of every municipal authority. The chief point that requires the consideration of each town is, What extent of area suits the surrounding neighbourhood?—Yours truly, the TELEPHONE USERS' ASSOCIATION, Norwich." In the first place, licenses have not been granted to Glasgow and Huddersfield. The intentions of the Government as regards telephones are not yet known, as the Postmaster-General is not the Government. Again, a general enabling Act would, in our opinion, be most harmful, as some towns would be induced to take up the telephone business which cannot possibly make it pay. The last sentence of the letter is, perhaps, the most interesting of all. The question of "what extent of area suits the surrounding neighbourhood" is certainly a burning one, from the fact that nobody knows what it means.

Underground Electric Traction.—The *Lancet* thinks there is a possibility of the underground electric railways becoming dangerous to life on account of bad ventilation. The evidence on which this is based is as follows: On the day that the Guards returned to London from Egypt, the resources of the Waterloo and City line were very much strained. The number of passengers who crowded on to one train was so much in excess of the regulation number that one of the carriages pressed its springs to such an extent that the brake guard fouled the third or conducting rail when going up the incline towards the City. This short-circuited the electrical machinery and blew the fuses. The stoppage thus caused was entirely due to the overcrowding. The common report that the motive power was insufficient to carry the load is wholly inaccurate. Still, we are told that the delay was sufficiently long to cause a marked sense of suffocation to be felt by the passengers. The *Lancet* goes on to say that "it is assumed, and correctly, that the advance of a train through a tube which it closely fits is sufficient to maintain an adequate change of air in the tunnels, in which case no extra provision for ventilation need be made, but in the event of a breakdown the supply of air would soon be exhausted, and the result might be disastrous and comparable with the awful historic tragedy of the Black Hole of Calcutta." We fancy the editor of the *Lancet* will find, after due consideration, that his assumptions point to the fact that it is impossible to construct such a subway, as the workmen in excavating would be working under much worse conditions than were the above-mentioned passengers. We can quite understand that the air in the trains might become vitiated by the large number of people crowded into them, but are quite sure that the air in the tunnel was not appreciably affected.

The Paris Exhibition of 1900.—We see from the current number of *L'Electricien* that the committee dealing with Section 25 in this exhibition has addressed a letter to the editor in which the electrical engineers of France are asked to make up their minds quickly as to what they are going to exhibit in 1900. Under the terms of the general regulations the latest date for the reception of applications for spaces is fixed for Feb. 1, 1899, but the committee hope that in view of the great prominence given to electric matters applications will be forwarded not later than Oct. 1, 1898. As the letter is published in our contemporary's issue for Oct. 22, the exhibitors will have to antedate their applications considerably. Amongst the articles to be shown in Class 25 are alternating and continuous current dynamos, arc lamps, regulators, lighting carbons, incandescent lamps, complete installations for electric workshops, public and private electric plant, electric appliances in connection with lighthouses, navigation, public works and military operations. Measuring instruments and meters, photometry and appliances for determining the distribution of light, and all other applications of electricity for special purposes will be welcomed. The committee go on to say that exhibitors from France will be strongly represented in this class, and express the hope that the French industry will be prepared to show conclusively the progress which it has made since 1889. The letter also announces that considerable reductions in cost of transport have been arranged for all goods being sent by rail or water to the exhibition. In conclusion, it is suggested that the section should organise a retrospect museum, in which old types of machinery, old documents, and drawings in connection with electrical engineering in its early stages will be exhibited.

Institution of Junior Engineers.—As announced in our last issue, Sir Wm. H. White, Assistant Controller of the Navy and Director of Naval Construction, gave the presidential address at the inaugural meeting of this institution on Friday last. After a vote of thanks to Mr. John A. F. Aspinall, the retiring president, who commented on the backward position of England as compared with Continental countries in regard to electrical traction and the provision of telephone communication, Sir Wm. White, the new president, said the present century had witnessed a wonderful growth and development of civil engineering. Apart from the aid of science, the engineer could not have solved many of the problems presented to him. He now welcomed the mathematician, the chemist, and the physicist as essential and valuable allies. Scientific method was becoming more and more established in engineering practice and in experimental research. There was no exclusion of engineers from the ranks of scientific men, and there were numerous instances of men distinguished no less as scientists than as engineers. One of the most brilliant examples of that combination of qualities, he regretted to say, had been lost to engineering through the tragic death of the past-president of the institution, Dr. John Hopkinson. Referring to the many instances in which research undertaken originally and simply for scientific purposes had largely influenced engineering practice or created new departments, the president said that, perhaps, no more striking examples could be found than those connected with the use of steam and electricity. But in every kind of engineering the influence of science was felt. After alluding to the many instances in connection with shipbuilding and other problems, of the close relation and inter-dependence of the many branches into which modern engineering had naturally divided itself, Sir Wm. White concluded with some remarks on the training of young engineers, observing that the ideal system was, perhaps, that which permitted an engineering pupil to

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continue his scholastic training side by side with the preliminary practical experience, as was done by the medical student attached to a hospital.

A New Arc Lamp.—The *Electrical World* describes an arc lamp recently patented in America by Mr. S. Bergmann, the patent for which is dated Oct. 4 of this year. We have very carefully read the information given, and fail to see where the invention differs from the old Pilsen-Joel lamp. In order that our readers may see how close is the resemblance, we give the following particulars: The armature or plunger of the controlling solenoid, which is in series with the arc, travels through the full range of carbon consumption, the plunger being rigidly attached to the carbon. To obtain a uniform vertical lift, equal to the weight of the holder and upper carbon, through the entire travel of the plunger, the solenoid is wound with an increasing number of layers towards its upper, and particularly towards its lower, end. As is well known, the pull of a uniformly-wound solenoid on a core equal to or greater than the solenoid in length is a maximum when one end of the core is about in a mid-position within the solenoid. By increasing the number of turns towards the ends of the solenoid, the pull of the end of the core near either end of the coil is increased, and a practical uniformity of pull obtained over a considerable travel. As noted in the patent, a similar effect can be obtained by winding the solenoid with a uniform number of layers throughout its length and varying the cross-section of the core, as was done in the Pilsen lamp, or the two methods may be combined. In the Bergmann lamp, the upper end of the hollow spool on which the core is wound is sealed, and the core, fitting tightly within the spool, acts as the plunger of its own dashpot. The spool is of metal, and the tightly fitting core also serves as a contact for the current. The series resistance is wound in a helical coil wrapped in an annular chamber around the controlling solenoid. The claims of the patent cover only the arrangement of this series resistance.

Systems of Charging for Electric Energy.—The *Electrical World* of New York in its current issue describes the system of varying rates adopted by the Edison Electric Illuminating Company of New York. This company assumes the equivalent load of the number of lamps actually installed, and gives the reduction after this load has been in use for an average of one hour per day. If the average use exceeds two hours a further reduction is given, and so on. The scale of charges in use at Manchester is also described. The editor's opinion is that comparing these methods with those now generally advocated—viz., the use of Wright-demand and two-rate meters—it is plain that they do not distinguish between consumers who draw heavily at the time of the peak of the station and those who do so at some other time. Thus two consumers, with the same number of lamps and with similar high peaks, one occurring late in the afternoon and the other in the forenoon, would be charged at the same rate, although one would be much more desirable than the other to the station. This disadvantage would not be remedied even by a Wright-demand meter, but would be by a two-rate meter system. The sliding scales obtained in this way are similar to those obtained with the Wright-demand meter, the only difference being that in the one case the maximum demand is estimated from the load connected, while in the other case it is measured by an instrument. If the demand were always proportional to the lamp capacity connected, the system would be a perfectly equitable one, but between, for example, a consumer who sometimes use all his lamps and another who never uses more than half, the systems given above would not distinguish, while the Wright-demand meter would. With many companies it would be a very hard matter to estimate the lamp capacity wired up, and consumers could easily obtain low rates by deceiving the inspectors regarding the load connected. Another grave defect of the system used by the Edison Company in New York is that it tends to prevent lamps being fixed in places where they will not be regularly used. In fact, the system in question has been tried in two or three English towns and abandoned, because it tended to keep down the number of lamps connected.

Electrical Plant for Bridge Construction.—The bridge which is in course of erection at Budapest, and which is interesting from the point that it consists of a single span of about 900ft. from shore to shore, may also be said to be erected entirely by the means of electricity. The first electrical machine used was a ram for driving the iron girders used as piles, which, driven in close to each other, formed a wall to keep the water out of the excavations at the riverside of the shore pillars. These excavations were about 300ft. square and 45ft. deep, and caissons could not be used on account of their size. The electric ram consisted of a hammer rising up to 34ft., with a velocity of 12ft. per second. In 24 hours, 40 of these iron piles were driven in 26ft. deep. A steam ram was at work at the same time, but only 30 piles could be driven with it during 24 hours. It was this comparison which induced the contractor to use electricity for his other machinery. After the above-mentioned machinery had completed its work, its electric windlass was used to lift the spoil out of the holes. There were seven centrifugal pumps working day and night. Of these pumps some were 5in. diameter driven by 10-h.p. motors, others 8in. driven by a 16-h.p. motor, and one 9in. diameter with a 20-h.p. motor. Mr. Sandor Bak says in the *Elektrotechnischer Anzeiger* that before the building commenced he experienced the utmost difficulty in inducing the contractor to accept his recommendation to use electric power, but later on, as the building progressed, the value of this advice became apparent. He thinks, as electricity has been proved to be of such advantage during the six months it has now been employed on this bridge, that in future electric motors only will be used for the purposes indicated. The pumps were driven by means of leather belts, because a direct drive between the centrifugal pump and the electric motor proved to be impracticable, for the reason that it is almost impossible to keep the latter dry. Another reason is that with that particular kind of work the demands upon the pumps vary. As the excavation proceeds, the number of revolutions has to be increased to provide the extra lift. To do this by means of resistances in the main circuit is neither convenient nor economical. In the present case small variations were obtained in this way, and then by changing the diameters of the belt pulleys larger changes of speed were obtained.

Coal Analysis.—The following is an abstract, prepared for the *Journal* of the Chemical Society, of a paper prepared for the American Chemical Society by Messrs. W. F. Hillebrand, C. B. Dudley, and W. A. Noyes. The paper is a preliminary report from a committee appointed by the American Chemical Society to devise uniform methods for the technical analysis of coal. Sampling is done in the usual manner, at least 5lb. of coal being employed. For the estimation of the moisture, 1 grm. of the powder is heated in an open porcelain or platinum crucible for one hour at 104deg. to 107deg., best in a double-walled bath containing pure toluene; it is then cooled in a desiccator and the crucible weighed covered. The process gives very concordant results, although higher and probably more correct results are obtained by drying

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in a vacuum over sulphuric acid; this, however, takes about 20 hours. In the case of bituminous coals, traces of volatile organic matters are driven off at 100deg., particularly if dried in a current of air, but this does not materially affect the method. To estimate the volatile combustible matter, 1 grm. of the undried sample is placed in a platinum crucible weighing 20 grm. to 30 grm., and having a tightly-fitting cover. This is then heated for seven minutes over the full flame of a Bunsen burner. The crucible should be supported on a platinum triangle with the bottom 6cm. to 8cm. above the top of the burner; the flame should be 20cm. to 25cm. high when burning free, and the experiment made in a place protected from draught. The upper surface of the cover should burn clear, but the under surface should remain covered with carbon. From the loss on ignition must be deducted the loss on drying. The amount of ash is estimated by incinerating the portion used for the estimation of the moisture, at first over a very low flame with the crucible open and inclined, until it is free from carbon. The fixed carbon is represented by the amount of coke less the ash. No particular scheme is, as yet, proposed for the estimation of the sulphur, but, as in the case of the other items, useful suggestions will be duly considered by the committee. As the result of 21 analyses of coals, the heating effect of which had been determined with the bomb calorimeter, the following rule is proposed for calculating the heating effect from the analytical data: "Subtract from 100 the percentages of moisture and ash, and one-half the percentage of sulphur, and multiply the remainder by 80·7. The product will be the heating effect of the coal burnt to vapour of water, expressed in calories."

The Photometry of the Enclosed Arc.—In a paper on this subject read by Messrs. C. P. Matthews, W. H. Thompson, and J. E. Hilbish, before the American Institute of Electrical Engineers at New York in September last, it was said that the difficulty arising in photometry from difference of colour is less troublesome in the case of the enclosed arc than in the open arc. In the enclosed arc, the inner opalescent globe absorbs the rays of short wave-length in greatest proportion, a fact which brings the colour of the arc nearer to that of the standard. When an outer globe of milky glass is used—the standard being an incandescent lamp maintained at its normal voltage—there is no annoyance from colour difference. The second obstacle in careful measurement is the variability of the quantity to be measured. These variations are due to the wandering condition of the arc—a peculiarity that is very noticeable in the open alternating arc and in both types of enclosed arc. A third source of trouble is the question as to what constitutes candle-power. In experiments carried out in the laboratory of Purdue University a Krüss-Bunsen photometer was used. A number of enclosed arc lamps in their commercial form were tested. With the best lamp, with 5·84 amperes and voltage 103·2, the true watts used were 407, the watts used in mechanism were 80, the watts in the arc 327, the power factor was 0·67, the mean spherical intensity in Hefner units was 110·5, the watts per mean spherical Hefner unit (0·88 c.p.) 3 68, and the watts in the arc per mean spherical Hefner unit 2 96. The lamp was intended for an E M.F. of 104 volts. Tests were also made with lamps having a bell-shaped reflector of milky glass, and with an outer spherical globe of milky glass, these varying considerably from the best lamp's performance. The conclusion the writers drew from these tests was that lamps of low economy could, by improvement in mechanism, be brought to as high an efficiency as the best lamp. All the lamps tested had, with one exception, the same brand of carbon and all had opalescent inner globes. The carbons and globes being similar, the difference in economy must be largely attributable to the mechanism. If the alternating arc is regarded apart from any regulating device, the reason for its poor lighting qualities is the lower temperature of the glowing points and smaller area of crater surface. In the direct-current arc there are two bright surfaces of unequal area and greatly different temperature. In the alternating-current arc there are two bright surfaces of the same area and temperature. The points of the alternating arc being as much positive as negative, it would be expected that the mean spherical intensity of the alternating arc would have a value intermediate between the values of mean hemispherical intensity for the upper and lower lobes of the distribution due to the direct-current arc. This was conclusively proved by these experiments.

Electric Dumb Waiters.—The fine new public library of the city of Chicago is equipped with a system of dumb waiters for delivering books from one department to another. These devices, which are described fully in our New York namesake, are operated by electric motors, and there are some interesting things about the installation to the electrical engineer. The system is that of the Burdett-Rowntree Manufacturing Company, of Chicago. Most of these waiters travel simply in a vertical direction like an elevator, though some have recently been put in that travel in a variety of angles. The vertical dumb waiters for transferring books from one floor to another are controlled from any floor by the movement of a pointer. At each floor is a pointer on a semi-circular dial. The pointers on all the floors are connected together mechanically, so that if one of them is moved, all move. These pointers are intended to be moved by hand. The dumb waiter will come to whatever floor the pointer is placed at. If an attendant on the fifth floor wants the waiter at his floor, he moves the pointer to 5, and if all is right the waiter comes to his floor. If he wants to send it to the first floor, he moves the pointer to 1, and so on. To avoid confusion and accidents, the controller of the waiter motor is always locked when any door to the waiter shaft is open, so that the waiter can never be started when an attendant has the door open and is not expecting the waiter to start. The most interesting electrical problem in connection with these waiters is the way the motors are arranged so as to avoid the necessity of counter-weights and at the same time insure a reasonably constant speed for the book trays. The motors used are series wound, about 1 h.p. in capacity, and run when at full speed at the rate of about 500 revolutions per minute. Being of such small power and low speed, no starting resistance is used with them, but the current is snapped on at full voltage. In order to prevent these series-wound motors from running away with the car going down heavily loaded, part of the current is shunted around the armature through a resistance. This, of course, has the effect of so increasing the field strength by the greater volume of current passing through the fields that the counter E.M.F. of the motor is very high for a given speed, and little current can flow through the motor. When the waiter is going up the connections are altered so that part of the current is shunted by a resistance around the fields, which has the effect of weakening the field strength of the motor, reducing the counter E.M.F. at a given speed, and permitting the motor to run faster than with full field strength. Of course, the resistance with which the armature is shunted is much higher than that used on the fields. The practical result of this electrical arrangement of the motor circuits is that the maximum variation in the time of ascent and descent of the waiter is only one second above or below an average of 17 seconds, or a variation between 16 and 18 seconds.

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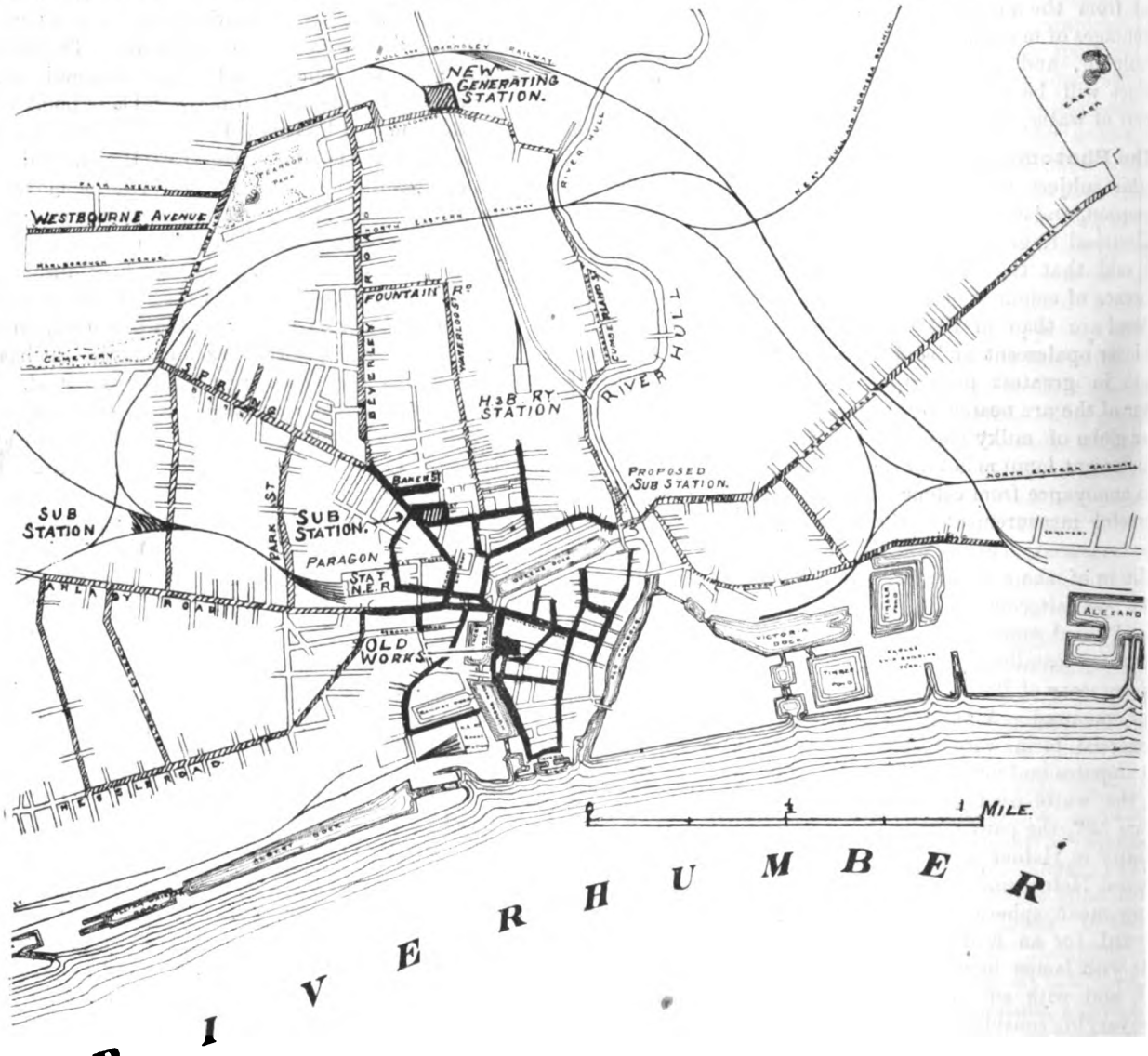
HULL NEW CENTRAL STATION.

ALDERMAN SKINNER.

MR. A. S. BARNARD.

Barnard, A. S., city electrical engineer of Hull, was born at Cheltenham in 1868. He was educated by his father, and also studied under Mr. H. Matthews, B.Sc., at the Cheltenham School of Science. He served an apprenticeship to Messrs. Gwynne and Barnett as an electrical engineer at Newcastle-on-Tyne, carrying out various contracts for electric lighting and transmission of power. He was then engaged by the Corlett Electrical Engineering Company, Limited, of



[Plan of the Mains at Hull. The black streets represent old mains, and the hatched streets show where new mains have been laid.

Messrs. S. F. Walker and Olliver, electrical engineers, of Cardiff, being afterwards retained for some time in their service. For about two years he traded in partnership with Wigan, for whom he superintended several large contracts in various parts of the country. In the summer of 1893 he was appointed borough electrical engineer at Lancaster, and in

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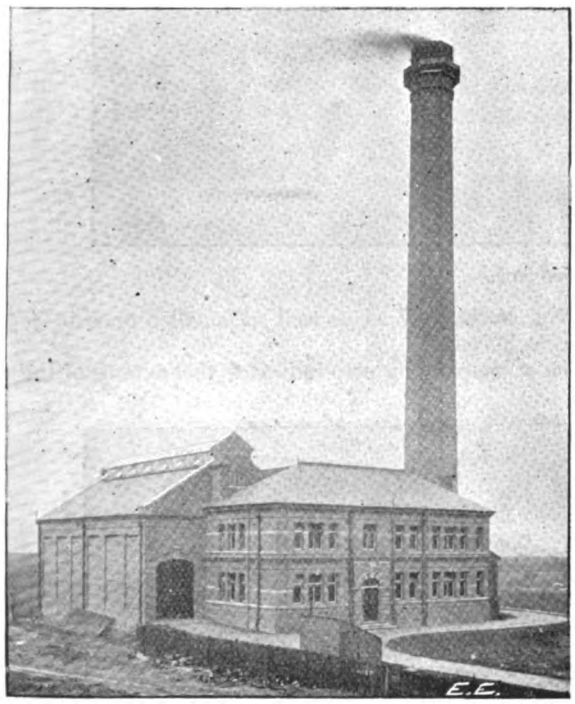
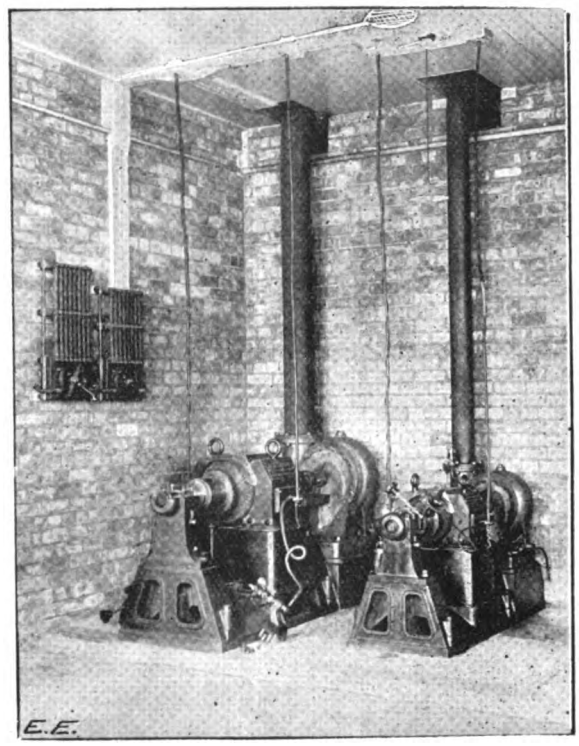
conjunction with Mr. Cook, the borough surveyor, superintended the installation of electric light in that town, afterwards taking charge of the works. Here, with his own staff, he carried out the greater part of the wiring on the private premises, as well as the street lighting by arcs and incandescents, and several large extensions of the mains. In October, 1895, he was appointed to his present position, and is now employed in extending the system of electric lighting in Hull, as well as, in conjunction with the city engineer, Mr. White, in superintending the installation of electric trams. He is a member of the Institution of Electrical Engineers, an associate member of the Institution of Civil Engineers, and a member of the Municipal Electrical Association.

On Monday last we witnessed the interesting ceremony at Hull of starting the machinery in the new central station. The capacity of the old station, opened in 1893, has long been too small for the demand—in fact, the demand is too great for the combined stations, and it is proposed not to increase the number of lamps wired till after Christmas, and to hurry on a still further increase in the plant. Any statement of fact of this kind is a conclusive proof of the success of the lighting in Hull. It was strikingly evident by the speeches after the ceremony, that the men who started as opponents have been converted by the pronounced success attained, and as converts are eager to go forward. This is a good and excellent sign that the necessary further extensions will not be delayed.



Sculcoates Station, Hull.

A brief recapitulation of the history of the work at Hull will not be out of place. The Electric Lighting Committee was formed on Nov. 21, 1889, Dr. Holder being elected chairman. On Aug. 4 in the following year the Hull electric lighting order was granted. In May, 1891, Mr. R. E. Crompton reported to the committee recommending a low-pressure scheme, with mains laid in the compulsory area (within the docks), at an estimated cost of £16,000. In April, Mr. F. Harman Lewis was appointed borough electrical engineer, and he immediately proceeded to carry out this scheme. The work included a generating station in Dagger-lane, with engines of 560 i.h.p. by Willans and Robinson; dynamos of 300 kw. by Siemens Bros. and Co.; boilers by Davey, Paxman, and Co.; accumulators by Crompton, Howell, and Co.; and mains, in about 2¼ miles of streets, by Crompton and Co. The site selected in Dagger-lane was unsuited for purposes of extension. On Jan. 16, 1893, these works were opened, and have ever since been continuously successful. At the date of opening there were connected to the mains 33 consumers, having the equivalent of about 600 lamps of 8 c.p. wired on their premises. In September of the same year Mr. Lewis left Hull to take up a similar post in Wolverhampton, and Mr. A. H. Gibbings was appointed borough electrical engineer in his stead. In the same month an extension of the mains (about three miles) was brought into use in the new town, west of the docks. These mains were laid by Messrs. Callender and Co., on the Callender-Webber system. In August, 1894, orders were placed with Messrs. Willans and Robinson and J. H. Holmes and Co. for a combined engine and dynamo (300 i.h.p. and 180 kw.). On Dec. 31 of that year the consumers connected numbered 271, with equivalent 8-c.p. lamps to the extent of 14,208. The profit on the year's working was £996, and the units sold during the year numbered 163,857. The next year—that is, in April, 1895—orders were placed with Messrs. Willans and Robinson and Messrs. J. H. Holmes and Co. for a second combined engine and dynamo (300 i.h.p., 180 kw.), and Messrs. Amos and Smith for a boiler (300 h.p.). In October Mr. Gibbings left, having been appointed electrical engineer to the city of Bradford, and Mr. A. S. Barnard was appointed in his stead. The annual report to Dec. 31 shows: consumers connected, 395, with equivalent 8-c.p. lamps to the extent of 20,584; and profit on year's working, £1,263, with units sold during year, 246,277. In January, 1896, Dr. Holder resigned his position as chairman of the Electric Lighting Committee, and Councillor J. T. Skinner was elected in his stead. In June the Electric Lighting Committee submitted a



Motors for Pumping Water.

large scheme of extensions (estimated cost, £42,000), which was rejected by the Town Council. In September Mr. Robert Hammond was asked to report to the committee on their scheme. In December the Electric Lighting Committee again submitted their scheme, with Mr. Hammond's report thereon, to the Council, but the scheme was again rejected. A fortnight later the scheme was submitted for the third time, and finally accepted by the Council, with the addition of £10,000 to the estimate for East Hull. There is a short history attached to this *volte-face* of the Council, in that Alderman Skinner put his foot down and made the vote a vote of confidence. The accounts to Dec. 31 show consumers connected, 520; equivalent of 8-c.p. lamps connected, 26,817; profit on year's working, £1,970; units sold, 340,439. To show how rapidly the capacity of the station was used up, we find in March, 1897, the number of consumers connected was 550; equivalent of 8-c.p. lamps, 28,524; profit on 15 months' working, £1,981; and the units sold during 15 months, 463,796. Owing to delay in starting the new works and the large number of applications for current, temporary works were laid down in North-street, which commenced generating current on Nov. 5, but were closed on March 5 following.

On March 31, 1898, the consumers connected numbered 737, with equivalent of 8-c.p. lamps connected 43,652.

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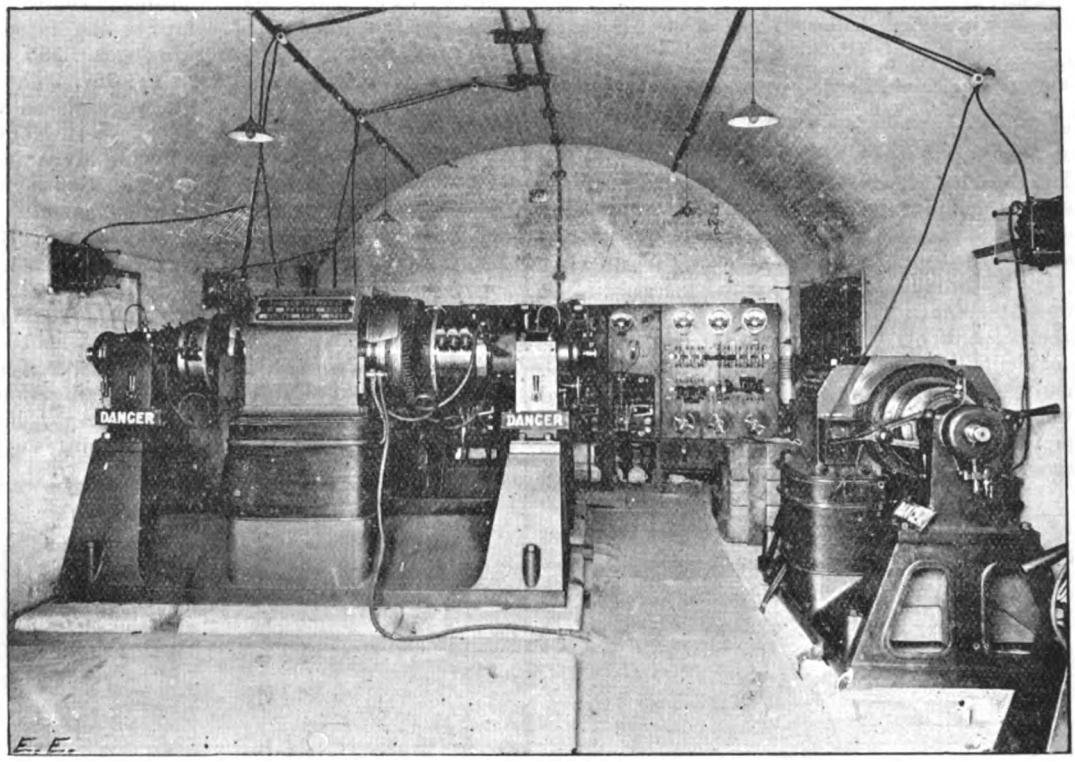
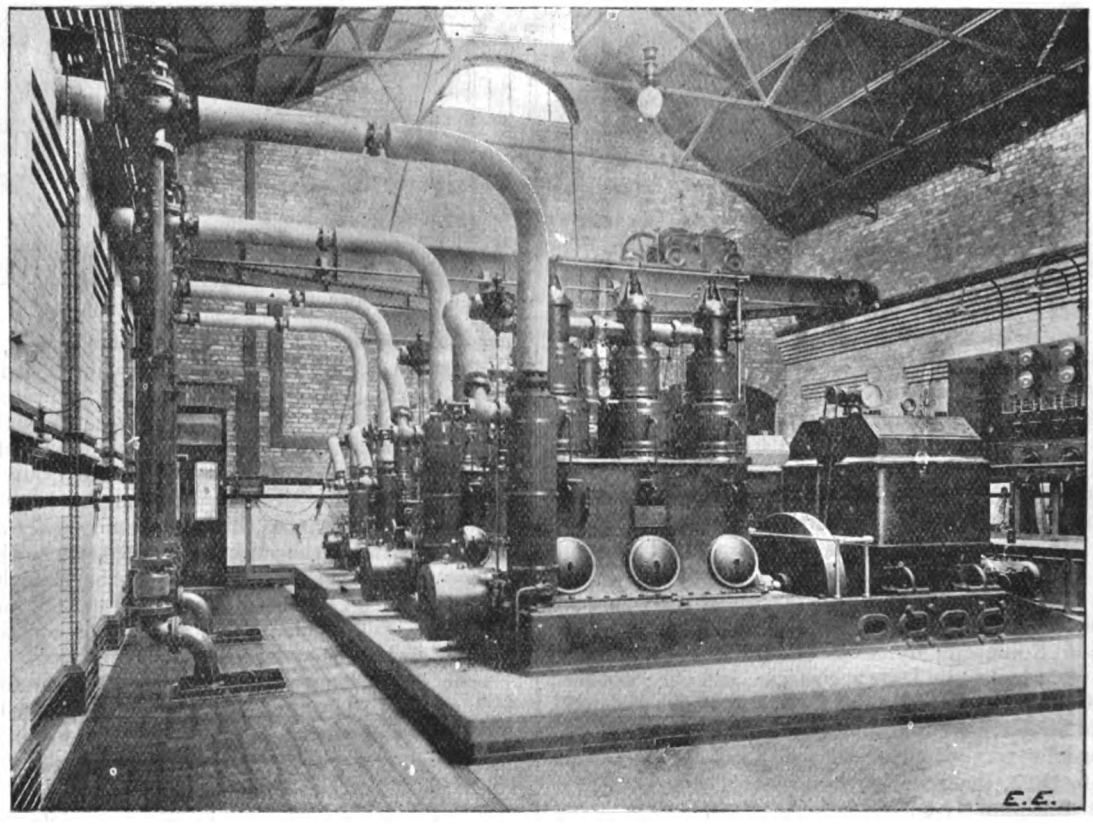
The profit on year's working was £2,039, and the units sold numbered 467,352. At the present time (October, 1898) the following figures show the state of things: Capacity of plant—Dagger-lane works: engines, 1,160 i.h.p.; dynamos, 660 kw. Sculcoates-lane works (formally opened on Monday), with sub-stations at Argyle-street and Albion-street: engines, 760 i.h.p.; dynamos, 456 kw. Extensions at present ordered: engine, 750 i.h.p.; dynamo, 450 kw.



Sub-Station Under Railway Arch.

The consumers connected to mains number 863, with an equivalent of 67,900 8-c.p. lamps. The streets in which mains have been laid measure—in the old town, 2¼ miles; in the new town (first extension), 3 miles; Sculcoates extension, 8 miles; and East Hull extension (about to be laid), 3¼ miles, making a total of 16½ miles. The customers include two theatres, three music halls, one circus, four large hotels, several schools, churches, many shops, and private houses. Motors are used in the printing of the *Eastern Morning News*, as well as smaller ones in several business houses.

The accompanying map indicates the extent of the new



Combined Sets—Willans Engines, Parker's Dynamos—Hull.

work, the contractors for which are: Messrs. Siemens, for the mains; Messrs. T. Parker and Co., for dynamos, transformers, switchboards, etc.; Willans and Robinson, for engines; Tinkers, Limited, and Babcock and Wilcox, for

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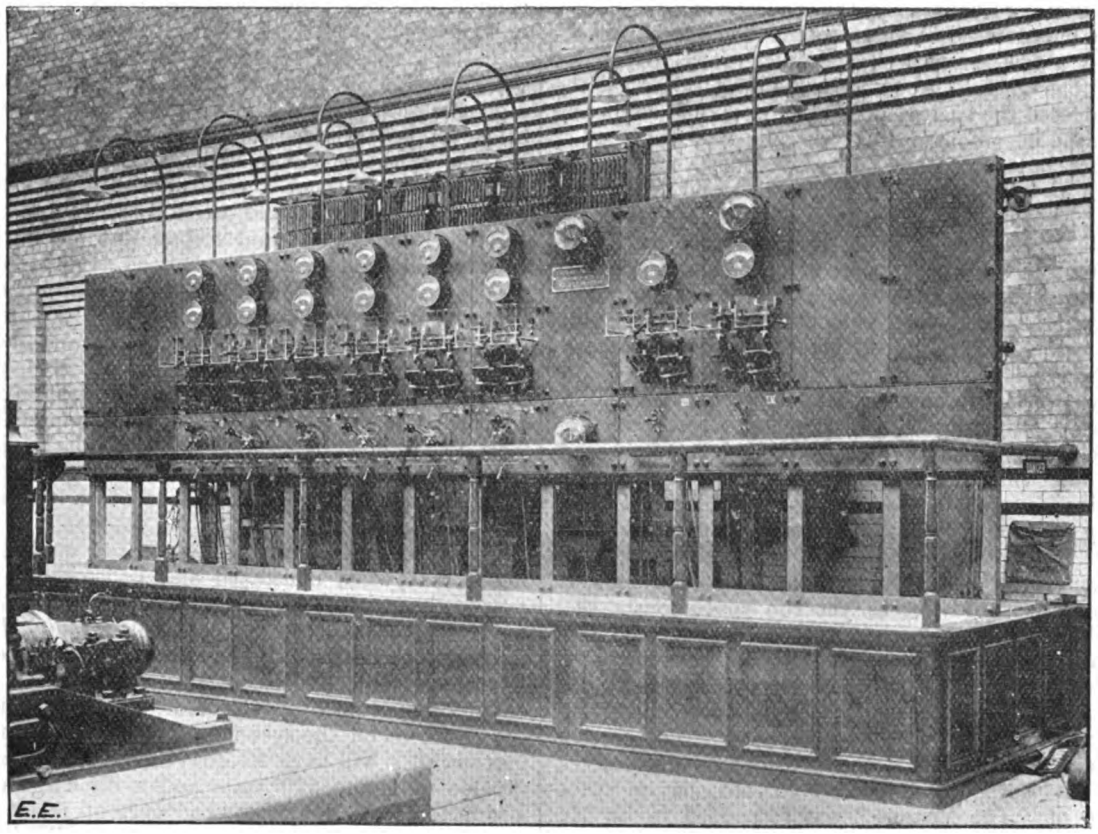
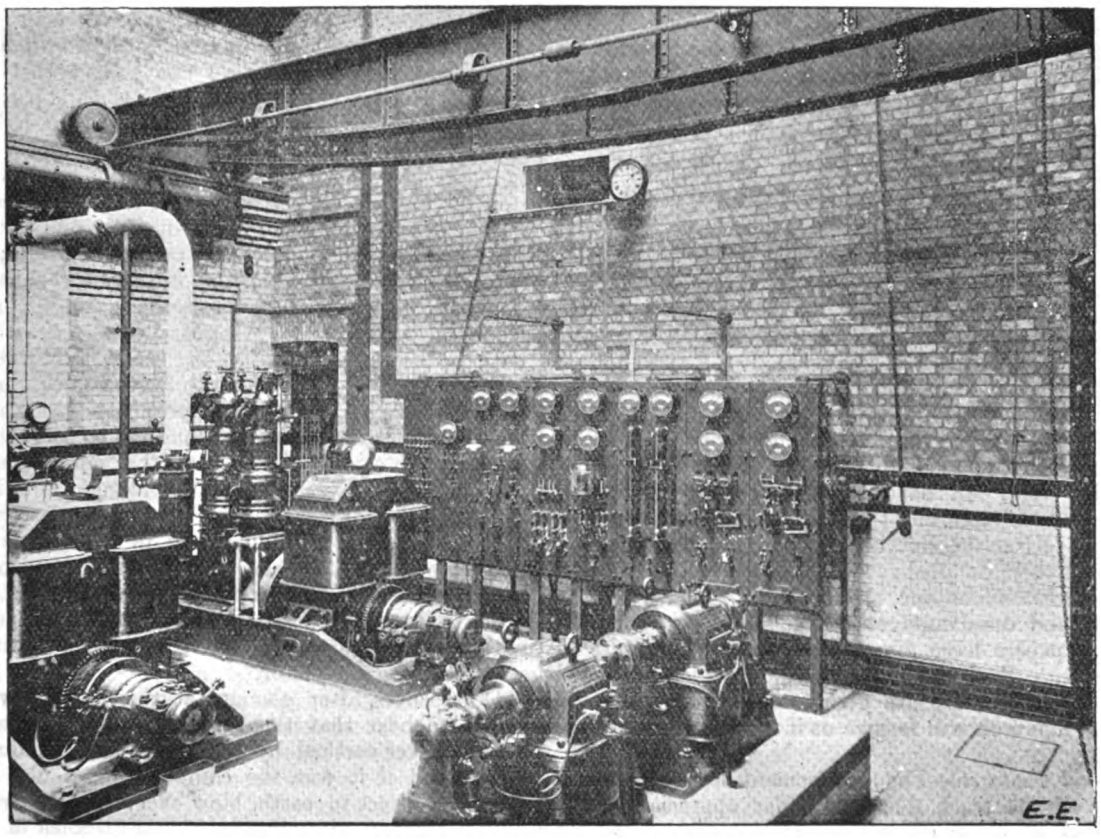
boilers; Pritchetts and Gold, for accumulators; Green and Son, for economiser; while the building, designed by Mr. White, the city engineer, was built by Messrs. Good and Sons, the sub-stations by Marsh and Co., and the crane was supplied by Spencer and Sons.



High-Pressure Switchboard.



Low-Pressure Plant and Switchboard.

Taking the events of the opening ceremony in their order—for the accompanying illustrations, from photographs by Messrs. Turner and Drinkwater, will tell their own tale — the dynamo-room was prettily decorated with flowers, evergreens, and flags, and had a temporary platform at the end whereon the notables gathered. Alderman Skinner gave the history of the undertaking much as we have given it above, and then Mr. Barnard described the work and apparatus without entering into technical details. The Mayor started one of the high pressure sets and Councillor Millington the other, after which a general round of the building was made. There are two high-pressure direct-current sets, 2,000 volts, trans-

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formed down at the sub-station by direct-current transformers—the system, in fact, as introduced by Mr. Parker at Oxford. A visit was made to the boiler-house to see the two Lancashire boilers and the Babcock-Wilcox boiler, and to the motors used to pump water. Then light refreshments and a few speeches claimed attention. After the toast of "The Queen," proposed by Alderman Skinner, the Mayor proposed the success of the undertaking, admitting that upon the inception of this work he had been one of the sceptics, but that since he had become a convert and believed in its future, and would do all he could to assist its progress. Alderman Skinner, in his reply, regretted the absence of Dr. Holder, to whom so much was due for his arduous work in the early stages of the undertaking. It had been said that when Dr. Holder retired no one would be found to take his place, but Alderman Skinner said, though knowing and feeling the great difficulty of the task, he had undertaken the duties, determined to try and bring the work to success. The toast of "The Engineers and Contractors" was proposed by Councillor Millington, to which Messrs. White, Barnard, and Parker, and the representative of Messrs. Willans and Robinson replied. So far as could be gathered, everything connected with the station had gone on satisfactorily. Two points only need to be referred to here. Mr. Parker called attention to the fact that central-station machinery did not as yet run continuously, that the possibilities of electricity were enormous, and that progress should be made in every direction in order to get a more constant load upon the plant. The representative of Messrs. Willans and Robinson congratulated Hull that it had not run to America or elsewhere abroad for the plant it required, but had trusted British manufacturers, and he felt sure the trust would not be in vain. The toast of "The Visitors" was responded to by Mr. Gibbings, who congratulated the town upon the completion of this extension. A visit was then made to a sub-station, where the motor-generators were shown to work automatically, being cut off or put on to the mains as required by the switchboard attendant at the central station. This ended the proceedings.

Mr. Barnard is to be congratulated upon the installation, which seems excellently designed and equipped. The necessary arrangements have been made for extensions, and, indeed, as we write, probably the Hull committee are considering a report as to the necessity of placing further orders for plant immediately and the getting of the funds for extensions.

THE THOMPSON-WALKER CONTACT SYSTEM.

The paper on contact systems of electric traction read by Prof. S. P. Thompson and Mr. Miles Walker at the British Association at Bristol serves as a fitting introduction to the above subject. We have, therefore, held back the paper till we should have had an opportunity of inspecting the line equipped by the authors in a private spot at Willesden. This we were able to see last Saturday, and a better day could not have been chosen for the experiment, as rain had fallen, and the whole track was saturated with water. After the description given in the foregoing paper, a further detailed account is not needed, and we shall here confine our attention to considering the advantages and disadvantages of the system. As certain untechnical papers have given badly-written accounts of interviews with Prof. S. P. Thompson, in which distorted views of the advantages are given to the public, we are sure Prof. Thompson will forgive us if we are rather critical in our judgment.

Mechanical Features.—The arrangement of the studs in the centre of the track does not differ appreciably from that advised by other experts in contact lines. We are assured by these gentlemen that a projection of $\frac{5}{8}$in. for the surface of the contacts over the level of the roadway gives ample allowance for the contact shoe. This we rather doubted, and we found on Saturday that 1$\frac{1}{2}$in. projection was allowed as a rule at Willesden. This is, in our opinion, the great objection to all contact systems, and the objection of course increases as the roadway wears down. This disadvantage has to be balanced against overhead wires with the trolley system, and against the open slot with the conduit, but we think that the open slot is much less objectionable.

Public Safety.—The arrangement of switch gear below the contact in the Thompson-Walker system gives decidedly a greater safety against leaving a contact alive than any other contact system we know of. This is obtained by the use of the magnetic effect of the iron contact shoe on the car. Without a mass of iron is over the contact the switch is not closed even if the normal current is flowing through the shunt coil of the operating solenoid. It is equally true that the core of the solenoid falls directly the iron shoe leaves it and thus breaks the circuit. In the event of the shoe not making contact with the point it is approaching, the whole circuit is broken and the car stops. With other contact systems a failure of the incoming contact also stops the car; but, as a rule, it runs on sufficiently far to leave a live contact exposed behind it. This live contact is bad, from the public's point of view, but it gives the tram driver a chance of getting his supply again, as he can do by hand that which the shoe under the car failed to do.

We experimented with a newspaper on Saturday, and found that when moistened and laid over a contact it several times held the shoe up for a sufficient length of time to break the circuit. We used a *Daily Mail* for the purpose, and pulled up the car three times out of five attempts. This experiment reveals a defect which will entail a somewhat expensive addition to the equipment of the cars run on the system. In order to re-establish connection, they will have to carry a battery of accumulators capable of giving 500 volts and a discharge of at least a quarter of an ampere. The current is not so much a difficulty, as the fact that about 250 small cells and their connections must be kept in order. These can, of course, be charged from the main circuit, but it will not do to leave them always in parallel with motors. When the contact is lost, as will somewhat frequently occur in streets which are not well swept, the controller handles will have to be brought back to open circuit before the small battery is put on to pick up the connection to the main.

The Switch Gear.—The present form of switch gear used is very ingenious, but we do not believe that it will be satisfactory in extended practice. In the first place, mercury contacts are used, and they appear to be light for the current required in starting. Mercury contacts have given great trouble, even where readily accessible, and we are sure the inventors are wrong to put them in buried switches. The next point is the shunt coil, in which 500 volts are used. This is a high voltage for the primary current; and as it is often made and broken, the insulation required must be good. Dry oil must be used in the vessel to prevent the insulation depreciating. We entirely disagree with the statement in the pamphlet describing the system, where it says: "The insulation for the winding of the magnet is most simple. It need only be of the most primitive kind, because the inner end of the winding is connected to the reel, and the outer end to earth." There is another mis-statement in the pamphlet. It says: "When the plunger falls, it 'earths' the stud and blows the feeder fuse in case the stud has not been disconnected, thus affording, in any such event, absolute security against accident. This method of earthing is believed to be more reliable than anything which has hitherto been proposed, because it is dependent upon nothing but the action of gravity and the continuity of a stout earthing conductor."

Our readers, after glancing at this extract, will be surprised to hear that the reliable action is a myth. The stud is never earthed by a stout earthing conductor, as is stated, and if it was, the contact shoe would, by putting 500 volts direct to earth, blow every fuse in circuit. The plug is earthed through the high resistance of the shunt coil, and the earth connection is not sufficiently good to give safety. This the inventors have endeavoured to provide in other ways by preventing leakage currents to the idle studs.

Comparison with Other Systems.—Comparisons between contact systems and the trolley system are useless, as

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where the overhead wire can be used neither the conduit nor the surface-contact system can compete on account of the much higher capital cost and of the greater cost of upkeep. Our comparisons must therefore be confined to the conduit system. Leaving the question of price till later, there is no doubt that the well-designed conduit is better from an engineering point of view. The contact systems (not Prof. Thompson's in particular) require a large number of automatic switches in the roadway, say some 300 per mile, and the failure of either of these disorganises the whole traffic for a few minutes at least, and piles up all the cars behind the fault. The next point is an electrical one. Prof. Thompson is represented by an evening paper of repute to say that his system will cause less electrolytic troubles to surrounding gas and water pipes than the conduit. This is quite incorrect, and we trust that

Feeders	4,000
	£8,200 to 9,000

II. *Open Conduit System.*

Cost of conduit under favourable conditions, including conductor rails, insulators, and drainage	£3,900
Permanent way and paving	3,500
Feeders	4,000
	£11,400

III. *Surface Contact System.*

180 to 360 boxes costing, say, £5 a-piece	£900 to 1,800
Permanent way and paving	3,500
Feeders and adjuncts	4,200
	£8,600 to £9,500

These last figures will not bear criticism. Thus, with the overhead system £300 is allowed for the trolley wire

General View of the Track at Willesden equipped with the Thompson-Walker System.

the reporter is to blame. All modern conduits are being constructed with insulated return conductor, so that earthed return through the rails need not be used. In this respect the Thompson-Walker system is no better than the trolley system, and the rails will have to be most carefully bonded and provided with return feeders to prevent trouble.

A comparison of first cost is made by the inventors, which reads as follows:

COST PER MILE OF SINGLE TRACK.

I. *Overhead Wire System.*

Trolley wire and adjuncts	£300
Poles	£400 to 1,200
Permanent way and paving	3,500

and adjuncts. On the surface-contact system this is reduced to £200, added on to the feeders. This small sum of £200 has to provide a mile of insulated conductors laid and jointed. The cable unjointed is likely to cost considerably more than £200. When it is considered that from 180 to 360 joints per mile have to be made, the total inadequacy of these figures is apparent. As regards the joint-boxes, these are not at present incorporated in the switch gear under the contacts, but may be in future. At any rate, the estimate includes nothing for this considerable item. The switch boxes themselves are put down at £5 each, and we see no reason why they should not be made for this, but judging from other electrical supplies

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there is little, if any, profit at this figure. As to how the development of the system is to be undertaken we know nothing, but it must be remembered that the inventors' royalties have to be capitalised and added to the corrected estimate. With this added, we think that the final price will not be appreciably cheaper than the conduit. As a system the line is interesting, and shows that the inventors know how to take advantage of the previous attempts in the same field, but we do not think that the conduit line has been improved upon, either from an electrical or mechanical point of view.

ELECTRIC TRACTION BY SURFACE CONTACTS.*

BY PROF. S. P. THOMPSON, F.R.S., AND MILES WALKER.

Surface contacts are of interest at the present time because local authorities object to trolley wires, tramway companies do not like the expense of conduits with open slots, and everyone is disgusted with the weight and rapid deterioration of accumulator cells. The only other approved method of supplying a tramcar with electric power is by means of surface contacts, and with regard to these people are asking for information.

One of the pioneers in surface contact electric traction was the late Dr. John Hopkinson. In a patent specification filed in 1882 he was the first to describe all the essential features of electromagnetic mechanism for successively connecting sections of conductor to a supply main. The object in view at that time was the prevention of the serious leakage which would occur from a long insulated rail. The device that he proposed is shown in Fig. 1.

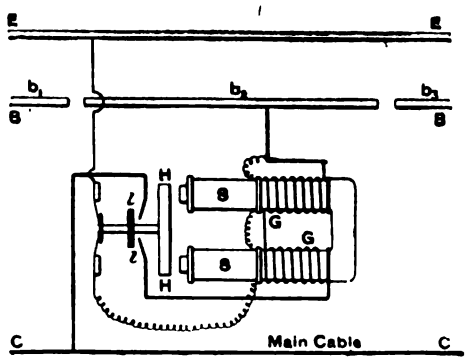

FIG. 1.—Dr. John Hopkinson's Method, 1882.

The insulated rail, B, is cut up into sections, b_1, b_2, b_3. Each of these can be connected with a supply cable, C, through the switch points, *l l*. The switch is operated in the following way: Suppose a car to be running on the rails picking up current from the section b_1, and putting it down to the return rail, E E. As soon as one of the collecting brushes comes in contact with the section b_2, current passes round the shunt coils, S S, of the electromagnet and to the return rail, E E. This raises the armature, H, and completes the circuit from the cable, C, through *l l* and through G G, the series coils of the electromagnet to the section b_2. At the same time the shunt circuit is broken, the electromagnet being now excited only by the main current passing through G G. Thus the car can pass over section b_2, and as soon as it leaves it the current no longer flows through G G, so that the armature drops and the section b_2 is cut out. It will be noted that the primary object of the invention was to enable B to be cut up into sections so as to diminish the leakage which would occur on a very long line. It was not intended to expose a high-voltage rail in a public thoroughfare, so no special precautions were necessary to ensure the absolute reliability of the switches. A year earlier Ayrton and Perry had suggested mechanical and electrical means for effecting the same object, and in 1883 they filed a second specification giving a most complete and lucid account of various ways of connecting up electromagnetic switches and various forms of magnet suitable for the same. It would take too long to give the substance of the 31 drawings of this specification, but it is of interest to notice one of them.

* Paper read before the British Association at Bristol.

In Fig. 2 the sections of the rail are: A B, J and C D, E F is the return rail, G H is the supply cable. The switch lever when not operated upon by the electromagnet rests in the position shown. The locomotive is intended to run in the direction indicated by the arrow. Assuming that the section A B is "alive" when the locomotive reaches J, the main current passes by the contact point, *t*, through the electromagnet by *p* and *q*, and the lever is rocked over, making contact between *u* and *v* and thus connecting C D to the main. It will be noticed that this method differs from Hopkinson's in so far that it is the main current on its way to the locomotive that first operates the switch.

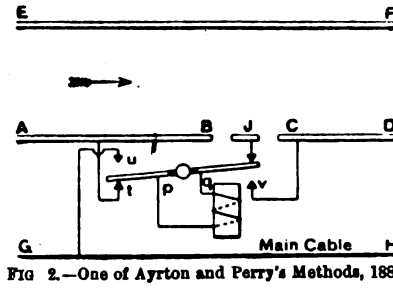

FIG 2.—One of Ayrton and Perry's Methods, 1883.

There are really two functions to be performed by the coils of the electromagnet: (1) the switch must be in the first place closed, and then (2) kept closed while the car is running over the section. In Hopkinson's switch the two functions are carried out by a shunt coil and a series coil respectively. Fig. 2 shows the first published method of both closing and holding on the switch by means of the main current. Ayrton and Perry also employed shunt coils as operating coils, and suggested the use of a magnet carried on the car to perform the same function. Indeed, so wide and varied are the descriptions in their specifications that they cover much of the ground of inventors who came after them.

So far, the main object in view had been the prevention of leakage from a long line, or the automatic blocking of trains by cutting off the supply of electricity from any second train that might run upon an occupied section. But the demand for some system of picking up current without employing a trolley wire or open slot in the road led inventors to try this method of surface contacts for ordinary streets. In 1886 Wynne devised a system in which the contacts were short pieces laid in the road, and connected successively to the main feeder by means of a little trolley that ran in a closed tunnel under the roadway. Then Pollak and Binswanger, developing a suggestion which had been thrown out by Ayrton and Perry, described a method of operating the switches by means of a magnet carried on the car. Fig. 3 shows their specification drawing, which certainly has the air of simplicity. In connection with this system, it may be well to mention

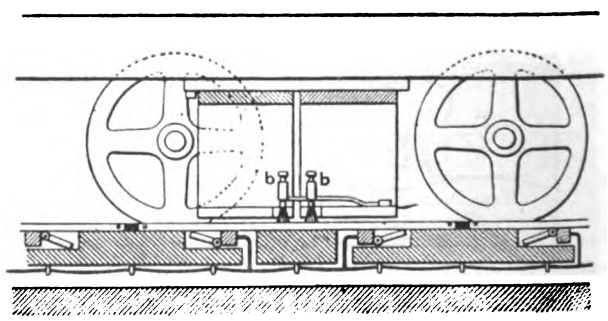

FIG. 3.—Pollak and Binswanger, 1886.

at once Diatto's more recent experiments. Diatto employs an electromagnet (Fig. 4), consisting of a number of cylindrical magnets, M M, with their similar poles riveted into a long strip of steel, P, thus making up a long polar face, which is suspended from the car and extends along its length. This pole comes in contact with an iron peg, F, fixed in each road contact, and magnetises it, so that it attracts a movable iron peg, G, floating in mercury, H, and connected to the main, C. Thus connection is made between road contact and the main. Diatto has worked out successfully the practical details of his system on a line in Italy.

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There is no doubt that systems based upon this principle have one great advantage over many other systems. The force tending to keep the switch closed can only operate when the car is over the switch. If the contact points of the switch can be made so that they will never stick together, then so far as the safety of the public is concerned there is no better system than this direct magnetic pick-up system. It is, however, to be doubted whether in the small space available under an ordinary

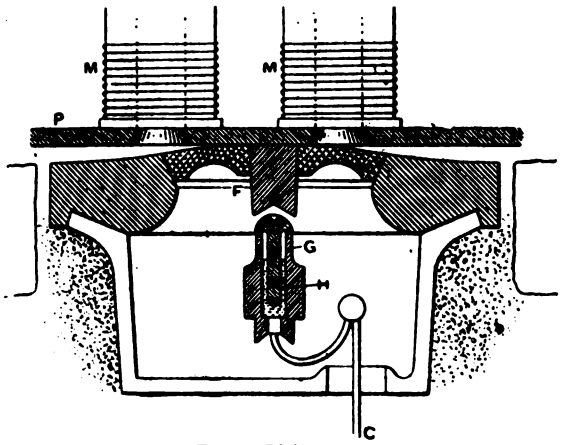

FIG. 4.—Diatto, 1894.

electric car there is sufficient room to place a long electro-magnet which will operate really reliable switches. The difficulty is increased when going at full speed or round sharp curves. Some methods which are allied to the above are those described in the specifications of Lineff. Fig. 5 illustrates an early type. An iron or steel strip lies in contact with the insulated main conductor; immediately over it are the surface studs. A magnet on the car attracts the strip upwards so that it comes in contact with the surface studs, thus connecting them with the main. As the car moves forward the wave in the strip moves forward like the sinus in the back of the mythical serpent. The method is as ingenious as it is simple, but there must always be a difficulty in making in this fashion a good contact with the surface studs.

The feebleness of the effect under the roadway of a magnet carried on the car has led many inventors to prefer an electric method of communicating with the switch, after the manner of Hopkinson and Ayrton and Perry. Very many different methods of operating the switches electrically have been devised. They fall into three classes: (1) those in which the operating coil is a shunt to the motor circuit; (2) those in which it is in series with the motor; and (3) those in which it is excited by a battery carried on the car. Each method has its advantages and disadvantages. The main objection to a shunt coil is its cost. It may further be open to the objection that a very small leak in

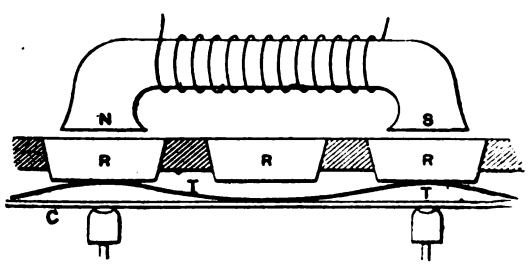

FIG. 5.—Lineff, 1888.

the insulation of the main may be sufficient to keep it in operation when it ought not to be. On the other hand, it has points of advantage over a series coil. As it always exercises the same pull, it can be designed to a nicety to do the work required of it, and, in general, can be put into a very small space; whereas a series coil is dependent in its action upon the current taken by the car, and while on the one hand its winding must be able to carry 100 amperes for a short time, it must have enough turns in it to operate the switch when only carrying two or three amperes. This necessitates a bulky winding, which increases the size of the switch and its box. Besides this, the force operating the switch is apt to be too violent with large currents or too feeble with small currents. The great advantage of the series coil has always been that by its use the operation of the switch could be made more dependent upon the presence of the car. If the car is not over the surface contact it cannot draw current from it, and it might be argued that the series coil would then of necessity have no current through it. This would afford abundant safety to street passengers if it were not for the fact that some current may be leaking from the road contact to mud in street, and this may be sufficient to keep the switch closed. To illustrate this let us take a very old design of Frank Wynne's. The view (Fig. 6) is, of course, diagrammatic. The car is intended to

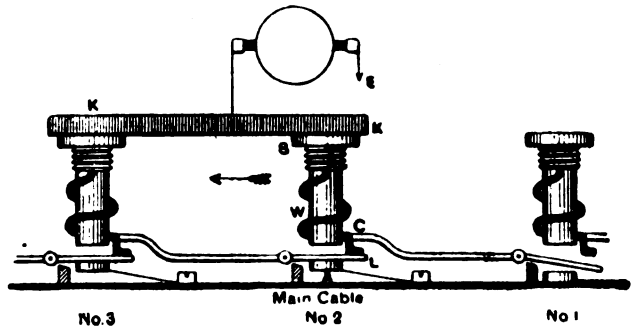

FIG. 6.—Wynne, 1887.

run in the direction indicated by the arrow. When switch No. 2 is closed current can flow from the main cable by means of the armature, A, through the lever, L, to the contact, C, from thence it passes round the winding of the magnet, W, to a stud, S, laid in the road. In contact with the stud, S, is a long metal skate, K K, carried on the car. The current passes to this and on through the motor to earth. As soon as K K comes in contact with stud No. 3 the current divides, part of it going through the winding of switch No. 3 and operating it. Stud No. 1 is shown disconnected, the switch having opened when the skate left its stud; but it is easy to see that if current could leak from stud No. 1 to earth there would be some current in the coil to keep the switch closed. Many devices have been suggested to remedy this defect. Mr. Wynne himself has proposed numerous methods. In a recent design carried out in conjunction with Mr. David Urquhart the current which operates the switch is an alternating current flowing into and out of the condenser. The continuous current which works the car cannot go through the magnet winding, because it cannot get through

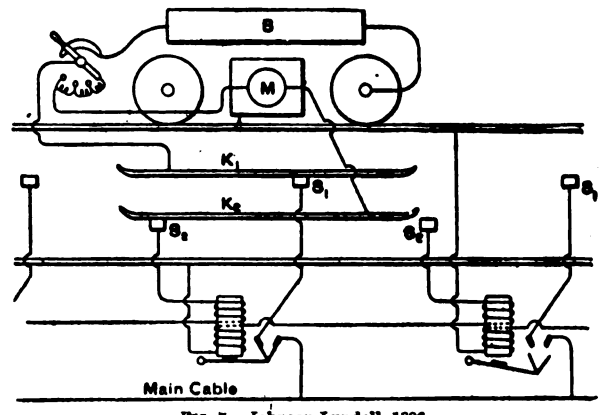

FIG 7.—Johnson-Lundell, 1896.

the condenser. The methods suggested by some inventors are exceedingly complex, their diagrams being perfect mazes of connections and interconnections; the number of studs and skates being increased to an alarming extent. One of the simplest arrangements is that of Johnson and Lundell. They adopted a method which originated on the Continent, and consisted in operating the switches by the current on its way from the car to earth, instead of on its way from the main to the car. Fig. 7 shows one of their diagrams. It will be seen that the current passes from the main cable through the switch direct to the stud marked S_1 without passing through any magnet winding, thence it passes to the motor by

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means of skate K_1. From the motor, instead of going direct to earth, it passes to skate K_2, thence to S_2, and so through the magnet windings to earth. Now, the stud S_2 is at very nearly the same potential as the earth return, so that the question of leakage from it does not trouble us. By placing S_2 outside the rails it can be effectually guarded against stray currents from S_1. One feature in this design is the interconnection of the switches whereby a switch is operated before it is required to supply current to the car. This gives greater time for the switch to close. A large number of methods for series working are due to Mr. F. C. Esmond, of New York. One of his simplest is shown in Fig. 8. Here no interconnection

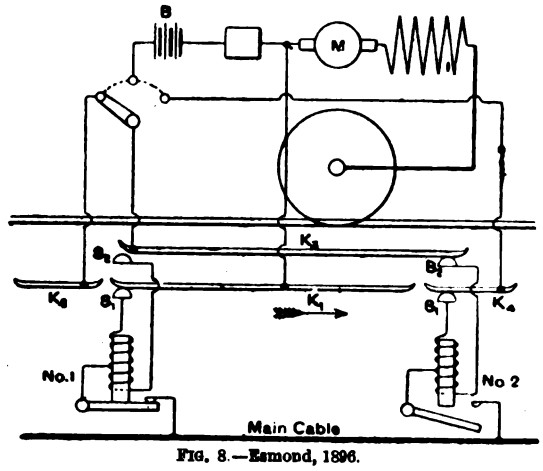

FIG. 8.—Esmond, 1896.

is required between the switch-boxes, the current being carried forward by means of several skates. In the diagram (Fig. 8) the current is flowing to the motor from the main by means of K_1 and S_1 of switch No. 1. A moment later K_2 will come in contact with S_1. The current will then pass to K_3 and thence by S_2 of switch No. 2, through the winding of that switch to S_1, and thence to the car. Thus switch No. 2 is closed, and the process made continuous. The method of closing the switches by means of an independent battery may be illustrated in Fig. 9. Two rows of studs, S_1 and S_2, are required, and two skates, K_1 and K_2. The diagram explains itself. The practical details of a system of this kind have been brought to great perfection by the Westinghouse Company of America. A branch line

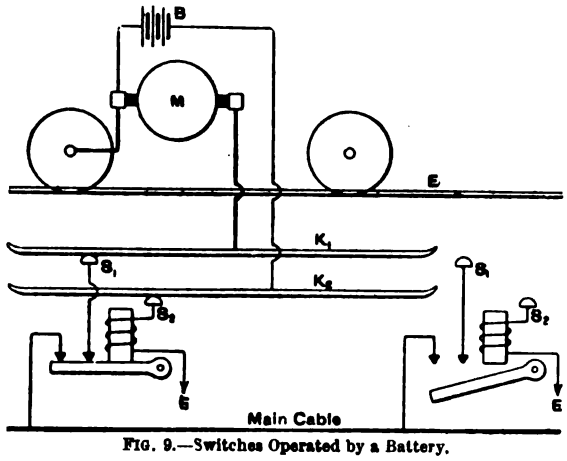

FIG. 9.—Switches Operated by a Battery.

of the Washington tramways has been operated by this company since 1894 on what has been called the Wheless system. Mr. Holroyd Smith has described several modifications of the method. There are two drawbacks apart from the necessity of two rows of studs. In the first place, the accumulator cells are continually in use, and the running of the car is entirely dependent upon them. In the next place, the low pressure of a few accumulator cells is not so satisfactory for overcoming the resistance of mud or ice upon the studs as the full 500 volts of the supply main. It would take too long to describe the commutator system of Claret-Vuilleumier as laid in Paris, and the line equipped at Monaco by the General Electric Company of America. It is sufficient to note that these systems have proved the practicability of picking up current from studs in the road.

When we review all these different methods, we see that the direct magnetic pick-up systems, with a magnet on the car, while operating with somewhat feeble forces, have a great element of safety, in the fact that the forces cannot operate when the car is not there. The system in which the electromagnet is in the switch itself, on the other hand, can be made to operate with very great forces, but there is a danger (only to be avoided by complicating the system) of those very forces keeping the switch closed when the car is absent.

Now, it is possible to combine the advantages of both methods, and to avoid their defects. All that is necessary is to make the magnet of the switch operate by attraction on a piece of iron on the car. When the car is absent the switch cannot be held closed, because the magnet has nothing

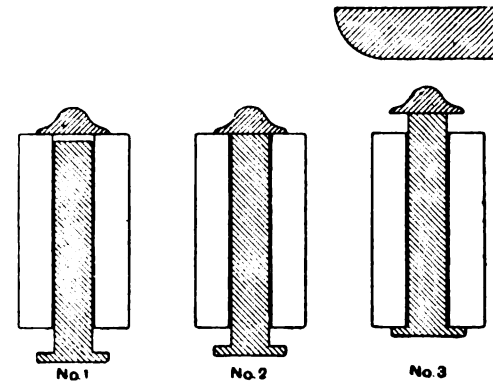

FIG. 10.—Experiments on Plungers.

to attract; at the same time it is found possible in practice to obtain very great working forces. Upon this principle the authors have constructed an experimental line near Willesden Junction, the main object being to try the practicability of the system upon curves, crossings, and sudden changes of slope. Out of various designs depending upon the closing of a magnetic circuit by the iron of the car, the arrangement which has so far proved most successful in experiment consists of an iron plunger sliding in a vertical tube. If we take an iron plunger with expanded ends, like that numbered 2 in Fig. 10, and surround it by a solenoid

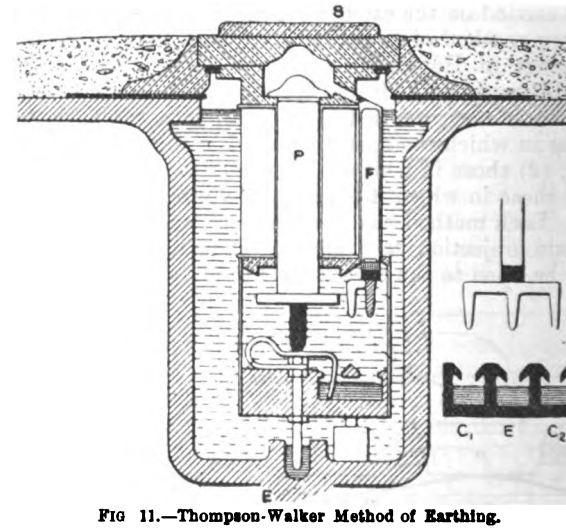

FIG 11.—Thompson-Walker Method of Earthing.

of wire, carrying a current, it is possible to choose the size of the heads so that the tendency of the plunger to assume a central position is balanced by the attraction of the solenoid on the iron heads. With probably chosen heads the solenoid exerts no force whatever on the plunger. Gravity being the only force upon it, it will, of course, take up the position shown. If, now, a piece of iron is placed over it (as shown in No. 3), the plunger may be raised by the attraction between the two. In case a very heavy plunger is used, it is possible to support part of its weight by merely increasing the size of the lower head by a small amount. Thus we have a simple piece of mechanism whose movement is entirely dependent upon the presence of a mass of iron in its neighbourhood, and which cannot be moved by the solenoid itself, even though the magnetising current

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carries the iron up to the saturation limit. This has been converted into the operating part of the switch. Now, though the force of attraction is sufficient to lift a fairly heavy plunger and operate a switch, it is desirable to have something more than this. We want a switch which will, notwithstanding its massive moving parts, close in an exceedingly short space of time. We want a very great acceleration upon the moving parts during the first part of their motion. This is easily obtained by merely separating the upper head from the plunger by a short air-gap, and arranging matters so that the mass of iron comes over the switch before current is put through the magnetising coil. As soon as current passes, the attraction upon the head is so great that the plunger gets up a high velocity before the two come together, with the result that the switch operates as though it had been hit with a hammer. A very simple device, a mere film of oil acting as a cushion, can be employed to prevent the switch from being injured by the concussion. The connection of this operating part to the contact points of the switch has been the subject of some very varied experiments. It would be a pity to hamper a part so simple in itself with any gear at all. If the safety of street passengers could be made dependent upon nothing else than the falling of the plunger when the mass of iron is removed, it was thought that as great perfection would be attained as we can hope for from any moving mechanism. The attachment of any gear at once introduces the risk of friction and the simplicity of

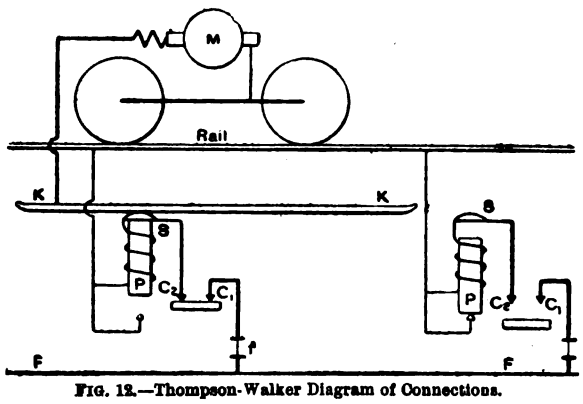

FIG. 12.—Thompson-Walker Diagram of Connections.

the issue is destroyed. For that reason, as well as for cheapness and convenience, the method shown in Fig. 11 was decided upon, though there are some simpler modifications of it still under experiment. The diagram, which is merely an incomplete sketch for a lantern slide, shows in the first place the cast-iron box which is laid in the street. This is surmounted by a gunmetal stud, S, faced with a phosphor-bronze wearing cap. The stud is insulated from the iron box by a sheet of micanite. A non-porous road material is placed around the stud to make up the level.

The box is filled with oil, which, besides performing the function presently to be considered, maintains very high insulation throughout. The switch is attached to the stud, and comes away with it in one piece. Being only about 4in. in diameter, no difficulty is found in making a perfectly watertight joint. The next point to consider is the method of making electrical contact. The requirements of switch points for disconnecting surface studs are the following: When closed, the contacts should be of low resistance, and capable of carrying 100 amperes easily. They should be incapable of fusing or sticking in any way, and should require only a small force to open them. They should retain their shape and efficiency unimpaired for a long time without requiring attention. It will be observed that the current through the stud ceases as soon as the skate parts company with the stud as the car moves forward. Hence in the operation of the car as the switch plunger falls it does not have to break the main current, that having already ceased. Yet although the switches are not required in the ordinary course to break a large current, it is desirable that they should be able in case of accident to do so without injury. After experimenting with different forms of contact it was found that nothing fulfils these requirements so completely as a properly designed mercury contact. Mercury contacts are, therefore, used throughout these switches. The yoke of copper which dips into the mercury is supported by a brass tube which floats in the oil and fits loosely into a fixed brass tube which acts as a guide. When the plunger rises it takes the oil from under the float, which accordingly falls and connection is made. When the plunger falls the float rises. As the plunger moves quickly the oil has not time to leak past the sides, notwithstanding the very loose fit of the parts, and the force upon the yoke piece is very great. At the same time a long movement is obtained.

Safety to the public being the prime consideration, we have kept back our invention until we could be absolutely certain that by no circumstance likely in human probability to arise could the switch be left alive. To operate the switch contacts requires a fraction of an ounce. The forces which operate on the moving plunger (which slides freely in a brass tube in oil) are over 80lb. at the commencement of the stroke, and are several pounds at the end. The sliding plunger itself weighs 5lb. We have, therefore, a margin of safety of many hundred per cent. As the car passes on there is a breaking of the magnetic and also of the electric circuit, making security doubly sure. And there is yet a third line of defence to the public in that our switch is actually earthed, if when the car passes on the switch fails to open: for then the plunger earths the switch. In that event the fuse would be blown, effectually protecting the public from the possibility of a stud being left alive in the roadway. It will be seen from the diagram that three cups are employed; the two outer being connected to the main and the stud respectively. The main cup is enclosed in a metal sheath (not shown) permanently connected to earth, so that it is impossible for current to reach the stud except when the yoke is down. Now, it will be seen from Fig. 11 that when the plunger is down it earths the centre cup, so that if from any accident whatever the yoke piece fails to open the switch after a car has gone past, the plunger puts the stud to earth and blows the fuse between it and the main. It is not necessary to have any special mode of connecting up the switch-boxes. Either shunt or series coils may be used. In practice we prefer a shunt coil because the slightly increased expense is more than compensated for by the smallness of the bulk. Our connections are shown diagrammatically in Fig. 12, which sufficiently explains itself. Only one skate is employed, and this is in the centre of the car. This gives much greater facility in going round curves than where two skates and two rows of studs are necessary. As there are no complications of interconnecting cross wires from stud to stud, and as the studs are in the centre of the roadway, the system is admirably adapted for cases where tramway lines cross one another, as in networks of lines in cities. In this respect it is superior to all the conduit systems hitherto proposed.

There are a number of practical details for which we have no room here, but which we hope shortly to bring before the Institution of Electrical Engineers. Throughout the work upon the experimental line we have been indebted to Mr. C. E. Holland for many valuable suggestions.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

MONDAY, OCT. 31.

Municipal Officers' Association.—At Sion College, Victoria-embankment, at 8 p.m., Conference on Superannuation.

TUESDAY, NOV. 1.

Institution of Civil Engineers.—At 8 p.m., Presidential Address, by Mr. W. H. Preece, C.B., F.R.S., and presentation of medals and prizes awarded by the council.

WEDNESDAY, NOV. 2.

Liverpool Engineering Society.—At the Royal Institution, Liverpool, at 8 p.m., Presidential Address, by Mr. John A. Brodie, Wh.Sch., M.I.C.E.

THURSDAY, NOV. 3.

Institution of Electrical Engineers.—Meeting of members only, at 4 p.m., to consider proposed alterations to articles of association.

Chemical Society.—At Burlington House, at 8 p.m., ordinary meeting.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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SHOREDITCH—AWAITING OFFICIAL FIGURES.

The letter of Mr. Baker inserted last week in various papers interested in the Shoreditch working, has called forth a rejoinder. We expected it would do so, and congratulate Mr. Baker in having obtained an authoritative promise that definite and official facts and figures will be forthcoming immediately. Mr. Kershaw is quite right in stating that many " are desirous of knowing the truth " about the Shoreditch scheme. Mr. Kershaw, in his official position, has no doubt had many enquiries. We, who occupy no such official position have been constantly asked for figures—authoritative figures as against rumours. Different parties will approach the consideration of the figures when obtained from different points of view, and Mr. Kershaw must expect an almost microscopical examination of the official figures when issued. One point the electrical profession would like to see treated exhaustively in an official report. Great things were expected of the Druitt-Halpin system of heat storage. Theoretically, we did not see why such a system should not be of considerable service. Is that system a success at Shoreditch, and what is the value of that success? Is that system a failure? If a failure, is the failure through inherent defects in principle, or has this installation been misdesigned? In other words, the combination at Shoreditch may be very successful as a whole, yet may be a complete failure in some of its details. It would be of the greatest advantage to professional men to know exactly how things stand. Then, again, it is more or less of an open secret that the destruction of refuse has to be supplemented by the burning of coal for the raising of the steam necessary for the electric light plant. What many people want to know is the official statement as to the heat from the destructors that may be depended upon to supplement the coal consumed, or it may be put the other way, and the coal be looked upon as the supplemental fuel. The question of cost of destruction of refuse will no doubt be sharply discussed, but we hold that it should be considered in a very broad light. In these days of huge populations upon restricted areas it is absolutely necessary to sanitarily destroy the refuse. The first question is sanitary destruction, the second question is cost. There may be two or more ways equally good of sanitary destruction; then, of course, in deciding for one or other of these ways the question of cost is paramount. Shoreditch introduced its installation with a glare of trumpets and a galaxy of promises, and the officials must not be surprised to find the actual results scrutinised more closely than would otherwise be the case. The official figures will, no doubt, be carefully and properly apportioned. It does not seem quite fair criticism to suggest that increased cost of collection, etc., is caused by the changing over to a new system. This increased cost may be caused in many ways, though, of course, Mr. Baker may be right. It will, however, be well to wait for official statements before coming to any conclusions on this point. Let electrical engineers have authentic information

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about heat storage, also the available heat to supplement the coal used, and they will be able to discount the question of cost of collection. They want facts, not generalisations, and will not be satisfied with anything less.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SHOREDITCH DUST DESTRUCTOR.

SIR,—I am at a loss to understand Mr. T. W. Baker's attack upon the above scheme, especially when viewed in the light of the fact that Mr. Baker submitted a scheme to our Vestry for dust destruction, in conjunction with the electric light, in 1893, but that scheme was so ridiculous in its proposals that the Vestry, with but few dissentients, refused to have anything to do with it.

Is it a bid for a cheap notoriety? Or is Mr. Baker's criticism the justification of his own scheme? for he states, "I do not infer or wish to be understood that all dust destructors are or will be financial failures." Or is it the outcome of his chagrin that a more successful engineer should be in the happy position of being the first to successfully instal an electric light and dust destruction combined scheme?

Your contemporary, *London*, having facts at its disposal, cleverly answers this attack in the last issue, for it must be known to you, Sir, that Mr. Baker's letter appears simultaneously in *London*, the *Contract Journal*, the *Electrical Engineer*, *Lightning*, the *Electrician*, and the *Hackney Express* of this week—and, no doubt, there are more to follow—and I am put to the trouble, for the benefit of the many who are desirous of knowing the truth of our scheme, to reply to this unwarrantable attack.

As *London* points out, the basis of Mr. Baker's calculations of financial results falls to the ground in the face of the fact that he has taken our Vestry's financial reports, which only give accounts up to March this year, and is based upon a 12 months' expenditure with a nine months' income, the first quarter of which is invariably a heavy loss to any undertaking. Mr. Baker very ably connects the two schemes—the sale of electricity and the destruction of dust—and asks which is correct: the vestry clerk's stated profit of £1,268. 17s. 9d., or Mr. Baker's supposed total loss of £1,522. 16s. 7d.? Well, I emphatically state, not Mr. Baker; and the vestry clerk is correct, so far as he goes, but from my point of view he does not go far enough. I will state here—and within the course of a few weeks justify my statement, as my committee's report on this matter will shortly be before the Vestry; and when it has passed that Board, it can be made public—on our combined scheme we made a profit in the first year's working, after making all allowances, of £2,000 net.

This is as emphatic as I can put it, although probably Mr. Baker will again say, "I note no amount for depreciation is allowed." I sincerely hope there never will be, because it must be remembered that we are paying back something like £5,000 per annum interest and capital on these undertakings, which means that in 30 years the dust destructor and electric lighting station will become a valuable freehold asset. That being so, where is the need of depreciation with the maintenance charges included in our estimates year by year? Further, I might add, as *London* reminds me, that the London County Council have practically verified the figures I have given you. Their valuer, in valuing us for assessment, went fully into these figures, and based our assessment upon a profit of £1,800.

I cannot, without violating my position as chairman of this committee, give you details of the Scavenging Committee's figures, but they will all be included in the report I have mentioned, which I know is being anxiously awaited throughout the whole country, and which, I venture again to say, will give the satisfaction that this phenomenal scheme deserves.—Yours, etc.,

H. E. KERSHAW,
Chairman of Electric Lighting Committee,
Oct. 24, 1898. Shoreditch Vestry.

SIR,—Mr. Baker, in his lengthy criticism of the above accounts in your last issue, makes such palpable blunders that whilst I have no intention of entering into a controversy as to the success or otherwise of this scheme, it is necessary that I should correct Mr. Baker's misreading of plain English, as it is to similar perversion of facts that some of the "conflicting statements" he refers to are due.

Mr. Baker's case consists of showing that the figures in my report, p. 2, do not harmonise with the surveyor's report and the electricity and destructor accounts. My statement, that the "destructor has also succeeded in destroying the whole of the dust in this parish and more besides up to a total of 18,842 tons in nine months" (p. 2), is not inconsistent, as Mr. Baker suggests, with the surveyor's statement at pp. 188, that "during the year" 18,378 tons were collected by the scavenging department, as the latter figures refer only to the refuse of Shoreditch, whereas my figures expressly include "more besides," such as parish refuse from St. Luke's and trade refuse from the City sent to the destructor, and not collected by the scavenging department at all.

Again, my figures as to coal burned were expressly stated to be for nine months, and were taken from the revenue account, p. 361, whereas the "conflicting" figures at pp. 350 and 323 of the accounts are headed in large type as accounts from March 25, 1897, to March 25, 1898; and Mr. Baker, as an engineer, ought to know that it takes many weeks' slow firing to prepare a destructor and make tests, etc., before steam-raising can be attempted.

He makes the same mistake in the dust destructor maintenance cost by comparing my figures for nine months with those for a year in the accounts, and when he asks dramatically "Which are correct?" the obvious answer is that both figures are correct, as they are for different periods, and are so expressly stated. On the one item of repayment of debt and interest one quarter's charge exceeds £288 alone.

Now, either Mr. Baker knew he was comparing figures for dissimilar periods, and so tried to wilfully mislead your readers, or he had not read the paragraphs or the figures which he criticises, and criticism displaying such gross carelessness is unworthy of a schoolboy. Moreover, if Mr. Baker were to follow up the methods of his critique by suggesting to a trading company that they must pay back a large proportion of their capital (including cost of freehold land) to their shareholders out of income before they could declare a "profit," they would, I think, invite Mr. Baker to communicate his opinion to the marines. It may interest him to know that the valuer of the London County Council from the nine months' figures, out of which Mr. Baker distorts a loss of £1,522, values the first year's profits of this joint undertaking at £1,800, after allowing £800 for depreciation and £500 for establishment charges.

As to the other "curious feature" Mr. Baker discovers in the increase of the Scavenging Committee's accounts, it hardly needs to be pointed out that the destructor undertaking has no more to do with the cost of collecting refuse and sweeping roads than it has to do with flushing gullies or mending the streets.

The increase in the stokers' wages over the contractor's estimate is due to the Vestry adopting three shifts of eight hours each in place of the two shifts of 12 hours each, which were reckoned by the contractors on the lines of those destructors where the cost is "sweated" down out of labour.

Possibly Mr. Baker has some cheaper and better scheme up his sleeve (as he darkly hints), but I would remind him that when he placed his scheme for this joint undertaking before the Shoreditch Vestry in 1893 (which found some curious support), he admitted he had not then built either an electricity station or dust destructor (his patent for the latter being then only on paper). Shoreditch has at least been wise enough not to trust the spending of what amounts to date to nearly £100,000 to amateur adventurers, and the results of the first full year's working (which should be published in about a fortnight) will, I think, bring quietness, if not conviction, to the most unreasoning opponents of this pioneer undertaking.—Yours, etc.,

H. MANSFIELD ROBINSON.
Town Hall, Old-street, E.C., Oct. 24, 1898.

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ELECTRIC MAINS.

SIR,—There seems to be an error ("printer's") on p. 533 of the *Electrical Engineer*, first column: "Or S = ·24 square inch section. Consulting wire tables, we find $^{7}/_{14}$ cable," etc.

Should it not be ·024 square inch section? This is nearly equivalent to a $^{7}/_{14}$ cable, but I respectfully suggest that a $^{7}/_{\cdot066}$ strand would be more accurate; ·24 square inch section would be a $^{37}/_{\cdot091}$ cable.—Yours, etc.,

H. B. PADDOCK.

REVIEWS.

Law and Practice Relating to Letters Patent for Inventions. By ROBERT FROST, B.Sc. (Lond.), F.C.S., etc. Second edition. London, 1898. Stevens and Haynes.

This second edition of what the author modestly calls a treatise has been largely re-written. By printing the text slightly closer, and the employment of a somewhat smaller type for extracts from the judgments of the courts and epitomes of cases given by way of principles of law involved, a very considerable quantity of new matter has been added to the body of the work, whilst its bulk, over 900 pages, has not been seriously increased. The value of the work as a book of reference has been increased by the introduction of heavy shoulder notes, together with side notes. Furthermore, the various chapters have been freely divided and sub-divided into distinct sections, and the index has been increased by more than half its original size. The book is well up to date, as the decided cases, including some reported during September, have been referred to, and in most instances the dates are given.

ELECTRIC INSTALLATIONS FOR LIGHTING AND POWER ON THE MIDLAND RAILWAY, WITH NOTES ON POWER ABSORBED BY SHAFTING AND BELTING.*

BY W. E. LANGDON, SUPERINTENDENT OF THE ELECTRICAL DEPARTMENT.

The several installations which have been established on the Midland Railway are enumerated in Table I. The approximate brake horse-power amounts in the aggregate to some 3,500.

Engines.—The form of engine employed in the several stations varies. With the earlier apparatus a simple horizontal engine has been employed, driving by belting either direct or by countershafting. In the later installations the dynamo shaft has been coupled direct to that of the engine, or both dynamo and engine have been mounted upon the same shaft. The steam-engines are in all cases compound, and run at 350 to 460 revolutions per minute, according to their power capacity, which ranges from 75 b.h.p. to 300 b.h.p. In some instances gas-motors have been provided. At Leicester the prime movers are all worked by gas, which is generated by a Dowson apparatus on the premises; and the intake valves of the engines are arranged so that either Dowson gas or the town (coal) gas may be used. The steam power at the Midland central goods depôt, Birmingham, has been supplemented by one gas-engine, and that at Bradford by three gas-engines. These have been introduced for economical reasons, either to save the cost of extending the steam plant or to meet occasional demands. At Wellingborough the laying down of a gas-engine for the small power required—namely, a few arc lights—is more economical than the establishment of steam plant, including engines, boilers, chimney shaft, etc.

Electrical Apparatus.—The electrical plant varies. In all instances where the arc lights are run in series, dynamos are employed capable of affording a variable pressure of from 50 to 2,750 volts according to the demand. In other cases—especially where the lamps are situated in near proximity to the generating plant—low-tension machines are used, and the lamps are then run in parallel or series parallel. The high-tension machines employed are the Thomson-Houston, the Parker, and the Brush, while the low-tension machines include the Siemens, Parker, Brush, Edison-Hopkinson, Crompton, and others. Table I. shows that nearly all installations provide for incandescent as well as arc lighting. This tabulated statement also shows the cost of working for the half-year ending Dec. 31, 1897. These results are exclusive of interest on primary outlay and taxes, and make no provision for what is termed depreciation. The entire plant is maintained in the most perfect condition possible. Each half-year carries the cost of such renewals or improvements as are found necessary; so that depreciation, in its ordinary sense, arises only from the replacement of obsolete machinery, and improvements due to these new parts should, in order to warrant the change, secure more economical results, and thus pay for their introduction. The charges are tabulated per unit, and the statement furnishes approximately the number of arc lamps and the number of incandescent lights embraced within each installation. These charges vary to some extent with the load generated and with the number of hours the light is in operation. The cost indicated covers all charges incurred, inclusive of repairs and renewals, carbons for lamps, replacement of lamps, and the labour attending the same, together with the cost of supervision from headquarters.

Although high-potential generators have been used for series arc lighting for some time, it is only recently that high-tension direct-current machines have been laid down with a view to transforming to a lower potential at points somewhat distant from the initial generating stations. At the Hunslet goods depôt, Leeds, a pair of 65 kw. generators have been recently brought into use for the purpose of providing current for lighting and power at the Wellington-street passenger station, a distance of about two miles by the railway. These generators work at 2,200 volts, and the mains are designed to involve a loss of only 5 per cent. when worked at their full normal capacity; the current is transformed down to 210 volts. At Kentish Town a central generating station of similar description is now approaching completion. This station is to supersede three local independent generating stations; and the concentration thus to be effected should result in a tangible saving in staff expenses. The stoking and engine driving, as well as the dynamo work, will be concentrated and reduced to a minimum. Here 300-b.h.p. units of the Willans type, giving at each dynamo an output of 200 kw., will form a nucleus which may be doubled in a few years, and perhaps be still further extended. Transforming centres are at present established at the St. Pancras goods and passenger stations, where the current will be distributed at a pressure of 210 volts. This plant has been designed to deal with both lighting and power. It is to work pumps now being erecting by the president of this institution, Mr. S. W. Johnson, which are intended to lift and distribute some 45,000 gallons of water per hour to a height of 350ft. It will work coal-wagon traversers, and a powerful fan erected by Mr. J. A. McDonald for improving the ventilation of the Midland portion of the Metropolitan tunnel; and it will probably meet other demands for traversers for locomotive engines and for driving tools in workshops, while the requirements for lighting will call for some 400 h.p. This generating station will thus have a fair day load as well as a night load, and is expected to effect its purpose in an economical manner. The Midland Railway hotels at St. Pancras, Bradford, Leeds, and Liverpool are also electrically lighted; but as the accounts are dealt with by the hotel department, they are not included in the statement in Table I.

Derby Installation.—It is perhaps unnecessary to enter into further details of each of the installations referred to in Table I.; but as Derby has been selected for this year's summer meeting of the institution, a more complete description is given of the installation established here. The offices of the Midland Railway lighted from this installation consist of several independent blocks extending over an area approximately 520 yards long and 340 yards broad. The blocks of buildings served are the mineral offices, goods offices, accountant's offices, the station proper,

* Paper read before the Institution of Mechanical Engineers.

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TABLE I.—Cost of Working Electric Light Stations on the Midland Railway.—Half-year ending Dec. 31, 1897, and Corresponding Period of 1896.

Station.	Half-year ending Dec. 31.	Number of arc lamps.	Approximate number of incandescent lamps.	Total units.	Total cost.	Total cost per unit.	Cost per unit for labour.	Cost per unit for material.	Cost per unit for repairs.	Cost per unit for coal.	Cost per unit for gas.	Total cost per unit for fuel.
		No.		Units.	£	d.	d.	d.	d.	d.	d.	d.
Somers Town	1897	246	—	213,358	2,560	2·88	1 23	0·69	0·27	0·69	—	0·69
	1896	246	—	208,767	2,391	2·71	1·14	0·67	0·22	0·68	—	0·68
Wellingborough*	1897	24	63	24,200	412	4·08	1·80	0·63	0·25	—	1·40	1·40
	1896	24	63	24,350	656	6 25	2·17	2 81	0·07	—	1·20	1·20
Leicester	1897	141	320	154,711	1,493	2·31	1·30	0·52	0·10	0·14	1·36	0·39
	1896	137	288	147,302	1.945	3·17	1·50	0·97	0·25	0·13	1·34	—
Derby	1897	8	2,550	110,037	1,137	2·47	1·12	0·83	0·11	0·41	—	0·41
	1896	8	2,480	95,187	891	2·24	1·15	0·56	0 06	0·47	—	—
Birmingham.....	1897	139	52	136,430	1,363	2·39	1·18	0·48	0·38	0 35	—	0·35
(Lawley-street)	1896	137	52	132,536	1,290	2·34	1·11	0·54	0·35	0·34	—	—
Birmingham.....	1897	72	297	90,669	1,060	2·80	1·35	0·52	0·46	0·36	1·07	0·47
(Central)	1896	70	283	95,833	859	2·21	1·13	0·41	0·20	0·32	—	—
Nottingham.....	1897	131	266	126,014	1,273	2·42	0·95	0·63	0·46	0·38	—	0·38
	1896	95	202	92,115	949	2·46	1·20	0·87	0·02	0·37	—	—
Sheffield...	1897	115	350	123,226	1,280	2·49	1·15	0·68	0·28	0·38	—	0·38
	1896	115	345	128,260	1,275	2·39	1·12	0·74	0·20	0·33	—	—
Leeds (Hunslet) ...	1897	150	280	169,176	1,726	2·44	1·22	0·64	0·22	0·36	—	0·36
	1896	150	278	102,486	1,251	2·90	1·48	0·56	0·48	0·38	—	—
Bradford	1897	194	784	163,508	1,573	2·31	1·03	0·43	0·27	0·32	1·88	0·58
	1896	194	784	155,002	1,827	2·82	1·11	0·90	0·18	0·33	0·30	—
Liverpool*	1897	115	111	36,161	759	5·03	2·53	1·45	0 53	0·52	—	0·53
(Sandon Dock)	1896	115	110	39,290	729	4·45	2·26	1·08	0·71	0·40	—	—
Total for 1897		1,335	5,073	1,347,490	14,636	Average cost in 1897 = 2·511d. per unit.						
,, ,, 1896		1,291	4,885	1,221,128	14,063	Average cost in 1896 = 2·629d. per unit.						

* These stations are in operation but a few hours daily, and are excluded from the average cost.

including parcels and booking offices and halls, the traffic department, waiting-rooms, and the secretary's and general manager's offices. At the extreme north end of the station are two blocks of buildings devoted to the staff of the engineer of the line; and on the opposite side of the station are the general storekeeper's offices. These, with the Midland Railway Institute, complete the list of buildings which have to be thus provided for.

Number of Lamps.—The total number of lamps in operation consists of 2,175 of 16 c.p., and 348 of 8 c.p. A few arc lights are employed for special purposes, but the railway station platforms are not electrically lighted.

Generating Station.—The generating station is situated in Calvert-street, a point on the north-west border of the area served. This building was erected and the machinery installed during the latter portion of 1892. The system employed is the continuous-current three-wire system. The current is delivered to the lamps at a potential of 110 volts. It was brought into operation in March, 1893, and has now been running night and day for over five years without a single failure. The only stoppages during that time have been on three occasions when some alteration has had to be made to the steam-piping, necessitating a shut-down for a few hours on a Sunday.

Boilers.—There are three locomotive-type tubular boilers, together having 2,808 square feet of heating surface, of which 265 square feet are in the fire-boxes, working at 140lb. pressure, and each evaporating about 2,500lb. of water per hour. They are fed during times of moderate and heavy loads by means of an exhaust injector, and at other times by a donkey pump.

Engines and Dynamos.—In the engine-room are four steam dynamos; two give 500 amperes each at a maximum pressure of 125 volts, and two give 275 amperes each at the same maximum pressure. The engines are Willans central valve, and the dynamos are by Messrs. Siemens Bros. There are also two sets of compensators or regulators, each set controlling automatically the potential difference on one of the two distinct groups of lighting. These compensators each consist of two series dynamos, coupled together and driven by a shunt motor, the current from the outside mains being sent through them in the usual way. They are wound in addition with a coil, which is connected in series with the middle wire of the three-wire system; but this coil is wound in opposite directions upon each series machine. By this means any drop in the third wire, due to current in it, is compensated automatically by the volts being raised on one compensator, and dropped an equal amount on the other. There are three sets of feeders to each of the two groups of lighting, each group consisting, roughly, of about 1,200 lamps of 16 c.p. These feeders are connected to the ring mains at different points. On the switchboard arrangements are made for working on the two-wire system at light loads, thus saving one engine from running, and this is managed without stopping the lighting anywhere.

Output and Cost.—The following figures indicate the amount of electricity supplied:

Year	1893	1894	1895	1896	1897
Annual output of units..	93,268	137,348	151,867	175,054	203,519
Increase per cent	—	—	10	15	16
Cost per unit, in pence..	3·63	3·37	2·67	2·29	2·58

The maximum possible output for 24 hours is 4,080 units; the maximum current observed in ordinary work, 1,430 amperes; the maximum load of any complete day, 1,695 units; and the minimum load for any one day, 146 units.

In comparing the costs of working this station with those of other electric generating stations it is necessary to bear in mind that the demands for the lighting required are exceptional, as compared with the usual demand on an electric generating station. By far the greater portion of the current is required for the service of offices in which the duties cease about 5.30 p.m. Consequently, in the summer there is ordinarily no lighting required; and yet should a fog or thunder cloud pass over, the whole of the lighting would be called for, perhaps merely for half an hour; hence the boilers have to be kept constantly under steam. Even in winter the demand, although heavy for a time, covers but a short period. In the depth of winter the light is required for cleaning offices, and for a short time perhaps for the early duties, and again in the afternoon from about 4 to 5.30 p.m. All this tends to make the stand-by losses much higher than those of a generating station established purely for commercial purposes where the demand for current would be not only much heavier, but also more continuous both morning and evening.

Application to Power.—So far, the application of electricity in large quantities has been mainly devoted to lighting. Its value as an agent for transmission of power—for traction, haulage, pumping, and for working all kinds of machinery—is becoming daily more recognised; and in erecting electric generating stations, especially on railways and in factories where both lighting and power are needed, it is desirable this should be borne in mind. The advantage to be derived from the employment of electricity over

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other methods of transmitting power lies in the fact that it can be applied just at the time, and for the time only, during which it is required, and at the speed needed. It can be conveyed to points distant from its source of origin with at least equal economy, and with greater convenience than other agencies of power; and it is practically unaffected by climatic changes. Where the demands are diverse, one source of power common to the whole may be applied with greater economy than is possible with two or more sources.

An instance of the advantage to be derived from the general use of electricity presents itself in recent applications to lighting and power at the Wellington-street

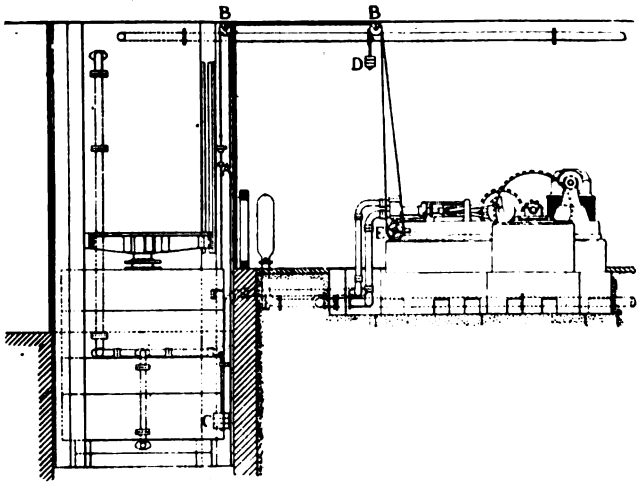

FIG. 1.

Station, Leeds. Power was required to operate certain lifts in the hotel. To have laid down a steam plant or even gas-engines for the purpose would have entailed a considerable outlay and occupied much valuable space. The company possessed an electric lighting installation at their Hunslet goods depôt. By supplementing the machinery there by high-tension generators, and transforming this high-tension current down to a lower potential at Wellington-street, the work required to be done, as well as the establishment of the electric light throughout the station and the hotel, was effected at much less cost than would otherwise have been the case. As previously mentioned, current is generated at 2,200 volts and conveyed by concentric cables along the line of railway from Hunslet to Wellington-street, a distance of some 2¼ miles. At Wellington-street it is transformed down to a pressure of 210 volts, and employed for both arc and incandescent lighting, and for operating pumps for the service of the lifts. These lifts, when completed, will embrace one Ellington hydraulic balance passenger lift, one hydraulic suspended luggage lift, and five small hydraulic suspended service lifts. The passenger lift is capable of carrying six persons, and has a stroke of 46ft., and the luggage lift can raise loads of 10cwt. through 54ft. 6in. The pumping plant (Figs. 1 and 2) has been laid down by the Hydraulic Engineering Company, Chester, and includes some novel features. It consists of two sets of horizontal three-throw single-acting hydraulic pumps, each with a capacity of 23 gallons when running at 46 revolutions per minute, and forcing water into an accumulator with a ram of 10in. diameter and 8ft. stroke, loaded to a pressure of 700lb. per square inch. One set of pumps meets the requirements of the service; the other is held in reserve. Each set of pumps is driven by a Parker motor, capable of giving an output of 23 b.h.p. at 650 revolutions per minute. This speed is brought down to about 46 revolutions at the pump crankshaft by the interposition of double helical steel spur gearing. It has been customary when the demand for pressure water temporarily ceases to allow the motor to run continuously, and, by means of a diverting valve operated by the accumulator, to return the water from the pumps to the suction tank, thus relieving the pumps of the load, or to stop and start the motor as required. In this installation the Hydraulic Engineering Company has employed a device which enables the motor to run continuously while the load on the pumps is varied according to the position of the accumulator. The arrangement will perhaps be understood by reference to the accompanying drawings. Figs. 1 and 2 show the general arrangement of the pumping plant, and Figs. 3

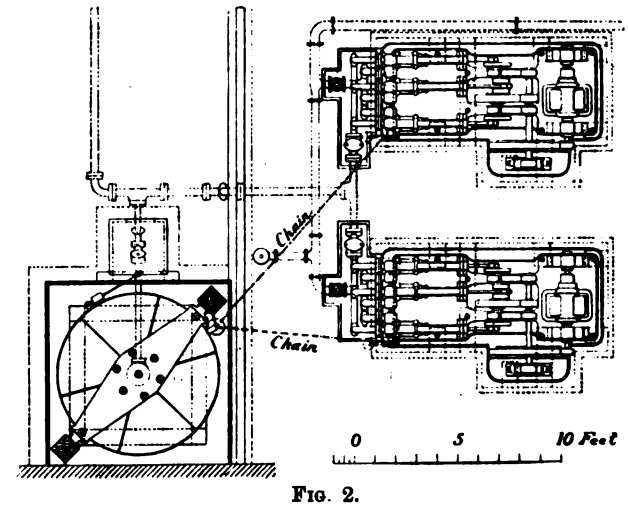

FIG. 2.

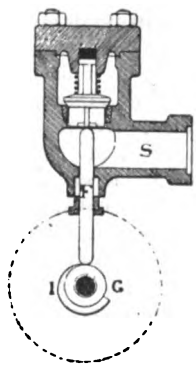

FIG. 3.

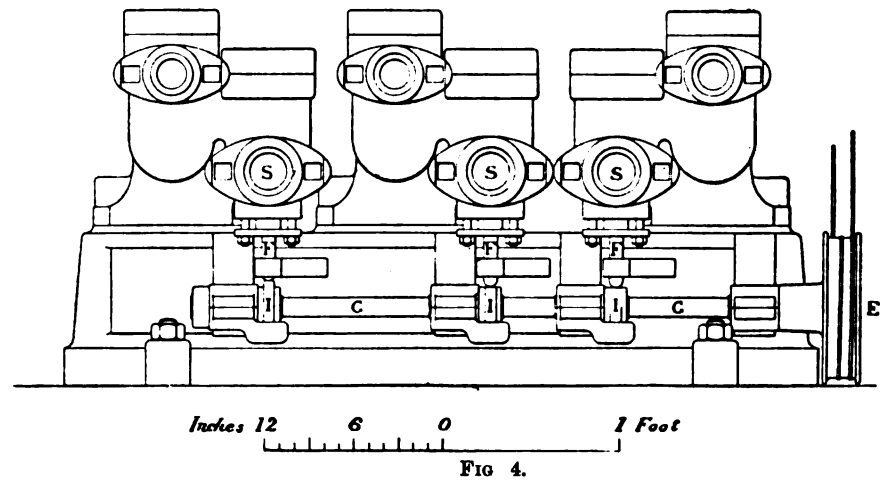

FIG 4.

and 4 the detail of the load-relieving gear attached to the pumps. The chambers, S S S (Fig. 4), beneath the valve are provided with stuffing boxes and glands, through which gunmetal spindles, F F F, capable of raising the suction valves from their seats are intended to work. Supported in bearings underneath these spindles is a shaft, G, having a drum, E, and three cams, I I I, keyed upon it vertically beneath the spindles. The cams are so arranged by setting the protuberance of each at a different angle to the horizontal plane through the shaft, that, as the drum is

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rotated by the pull of a cord attached to the accumulator, the three suction valves are raised successively from their seats. The mode of action is as follows: When the accumulator approaches the top of the stroke it strikes a tappet, A (Fig. 1), fixed on a chain, which passes over pulleys, B B, to the drum, E, and relieves the chain of the pull due to the weight, C. The weight, D, suspended from another chain, also secured to the drum, E, is now able to rotate the shaft, and in so doing to raise each suction valve in succession from its seat, thus allowing the water drawn into the pumps by the suction stroke to be returned to the suction tank. When the accumulator falls again C is able to reassert its influence, and, being heavier than D, to turn the shaft, G (Figs. 3 and 4), back again to its original position, and to allow the suction valves to fall one after another on to their seats again, permitting the pumps to gradually recommence their action.

(To be continued.)

COMBINED ELECTRIC LIGHTING AND POWER PLANT FOR DOCKS AND HARBOURS.*

BY J. G. W. ALDRIDGE.

The introduction of hydraulic machinery by Lord Armstrong and its subsequent development have resulted in the application of the hydraulic system to machinery of the most varied type, and more particularly to the equipment of almost every important dock and harbour in the world with hydraulic plant.

Whilst the hydraulic appliances in docks and harbours have become more efficient, the lighting of such places by gas has improved very little, and until recently was quite inadequate to the requirements of the present day. The introduction of electric lighting has, however, overcome this difficulty, it has largely been adopted as a means of illuminating these busy places, and is now superseding gas altogether. This, however, necessitates two separate sets of machinery, one for hydraulic power and the other for electric lighting. Necessarily a certain amount of spare power must be provided, and for about one-third of the 24 hours each set of machinery will be at a standstill.

In order to work the system economically there should be one generating station for both lighting and power, and it is obvious that it is easier to use electric plant for lighting and utilise this for motive power than to use hydraulic machinery, and to endeavour to transform that power into electricity for lighting only. At the present moment electric machinery is being largely used, supplied from the same source as the lighting, and it would have been more extensively adopted but for reasons which the author will give hereafter. It is not the purpose of this paper to give details of the various electrical appliances, but to consider this question mainly from the dock owner's point of view.

Copenhagen.—The most notable instance is that of Copenhagen Harbour, where the whole of the machinery for handling goods from and to the ships, all the motors in the warehouses, turntables and capstans on the quays, and the whole of the lighting is supplied from one generating station, and with marked economy. I have attached diagrams showing the variation of the lighting and the motive power respectively during the 24 hours, and the running of the plant at the time when for one or the other it would be comparatively idle, which enables the plant to be kept running at approximately full load, and, therefore, at its highest efficiency.

On reference to Diagram No. 1, it will be noticed that from about one o'clock in the morning until six there is very little doing; then the work of the dock begins, and both light and power are in demand, as shown. The lighting by nine o'clock has dropped down to its normal day load, but the machinery is employed in supplying current for power during the whole day, with the exception of a short interval between one and two. Again, just after three the demand for lighting increases, and rises up to its maximum, and when the light is falling off the cranes and other machinery are still at work. This diagram, from an actual day's work, was taken on Dec. 6, 1897, clearly showing how the combination of the lighting and power enables one set of machinery to supply the necessary power for both, because to a large extent the demand for one does not overlap the other. The diagram would, of course, vary slightly from day to day, according to the season of the year, and the amount of dock business in hand at the time; but such variation is not great, as the proportion for light and power remains approximately the same throughout the year.

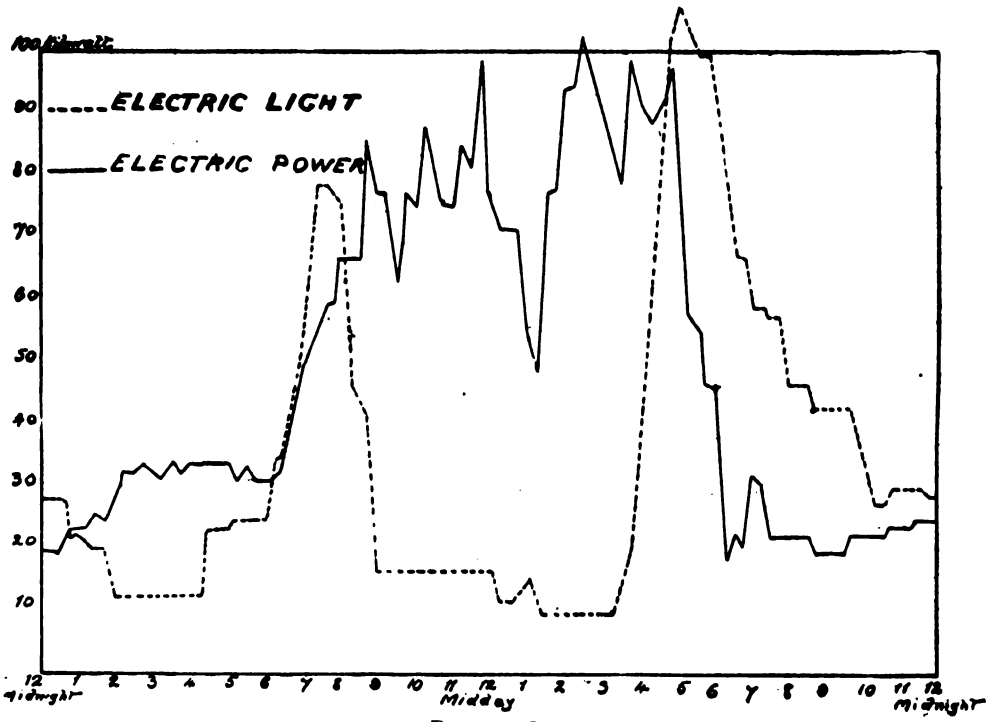

DIAGRAM 1.

With the employment of electricity it is necessary to have a reserve to correspond with the ordinary hydraulic accumulator, so that excessive demands for short periods may be met without the necessity of increasing the fixed running machinery. The ordinary battery supplies this want in exactly the same way as the accumulator does for the hydraulic system, with the additional advantage for the electric accumulator that power may be stored for a considerable period, whereas the reserve power of the hydraulic accumulator is of comparatively short duration, and acts more as a regulator than a reserve.

* Paper read before the British Association at Bristol.

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Copenhagen Harbour is equipped with about 2,000 incandescent lamps, 260 arc lamps (5 to 15 amperes), and 100 large and small motors of an aggregate of 900 h.p., making a total capacity of about 1,250 h.p., and the whole of this is supplied from one generating station, in which are placed five engines of 720 i.h.p. total, with the necessary steam-boilers, etc., also two batteries, one of 150 ampere-hours capacity for the lighting, and the other 300-ampere capacity for general dock appliances. This station also provides the necessary charging current for six sets of accumulators of 60 amperes each.

It will be seen that if this plant were divided, and the whole of the power worked upon the hydraulic system, it would even then be necessary to have at least two-thirds of the steam plant for the lighting only. Moreover, this lighting plant would be idle for at least two-thirds of the 24 hours, whereas the diagram shows the machinery is employed for about 16 hours out of the 24, and this in itself is an absolute proof of the economy of utilising the same machinery for both light and power in such an installation as would be required by the ordinary dock or harbour board.

Rotterdam.—Among the appliances with which this port is equipped, there are 18 electric cranes, nine each of 4 tons and 2½ tons capacity, and four electric capstans. The generating station is under the control of the municipal gasworks, who charge the port 3d. per unit for current. Mr. Van Ysselsteyn, the harbour engineer, kindly prepared the table for the author, giving details of the working costs of these cranes for 1896, also a summary of the costs for 1897, which is as follows:

Total number of working hours	32,066
Total consumption of current	72,245 units
Wages of crane drivers	£421 14 8
Oil, waste, etc.	31 17 3
Small repairs and sundry expenses	132 8 1
Supervision (part salary)	30 11 2
	£616 11 2

This is equivalent to 6·75d. per hour; cost of electric supply at 3·27 units per hour 9·75d.—16·50d. Separate meters are not provided for ascertaining the consumption of current for the capstans. The table referred to shows that only a small number of cranes were used at one time, and the expenses of working are consequently proportionately higher, but the results are very satisfactory, as shown by the receipts. In addition to the above-mentioned electric appliances, both hydraulic and steam cranes are also used, but all new plant is to be electric. The total cost of this installation was £18,750, excluding 1897 additions.

Southampton.—The Southampton Docks were completely equipped with electric lighting plant when this property was taken over by the South-Western Railway Company in 1893. The generating station adjoins the hydraulic engine-house, which thus forms the power station, and whilst the machinery for each is quite distinct, the same boilers supply steam to both, thereby economising boiler power. The generating plant consists of four 80-h.p. Crompton-Willans sets, with a battery supplying about 100 arc lamps, with few exceptions of 15 amperes each, and incandescent lamps equivalent to 3,434 16-c.p. Twenty-five candle-power lamps are used chiefly in the sheds, but one shed is lighted by inverted arc lamps with satisfactory results. The new corn warehouses are supplied with the most modern corn-conveying machinery, and a portion of this is driven electrically. Since 1893 the demand for light and power has altogether outgrown the generating plant, and, acting upon the author's advice, the company are extending the plant by two additional steam sets of one of 120 h.p. and one of 80 h.p. The pressure, which is now 208 volts across the outer mains of a three-wire system, will be increased to 480 volts, and the existing plant altered accordingly at a comparatively small cost. The company supply current to a number of consumers upon the dock premises, and this revenue equals about half the total working expenses, thus considerably reducing the cost of the company's own light and power.

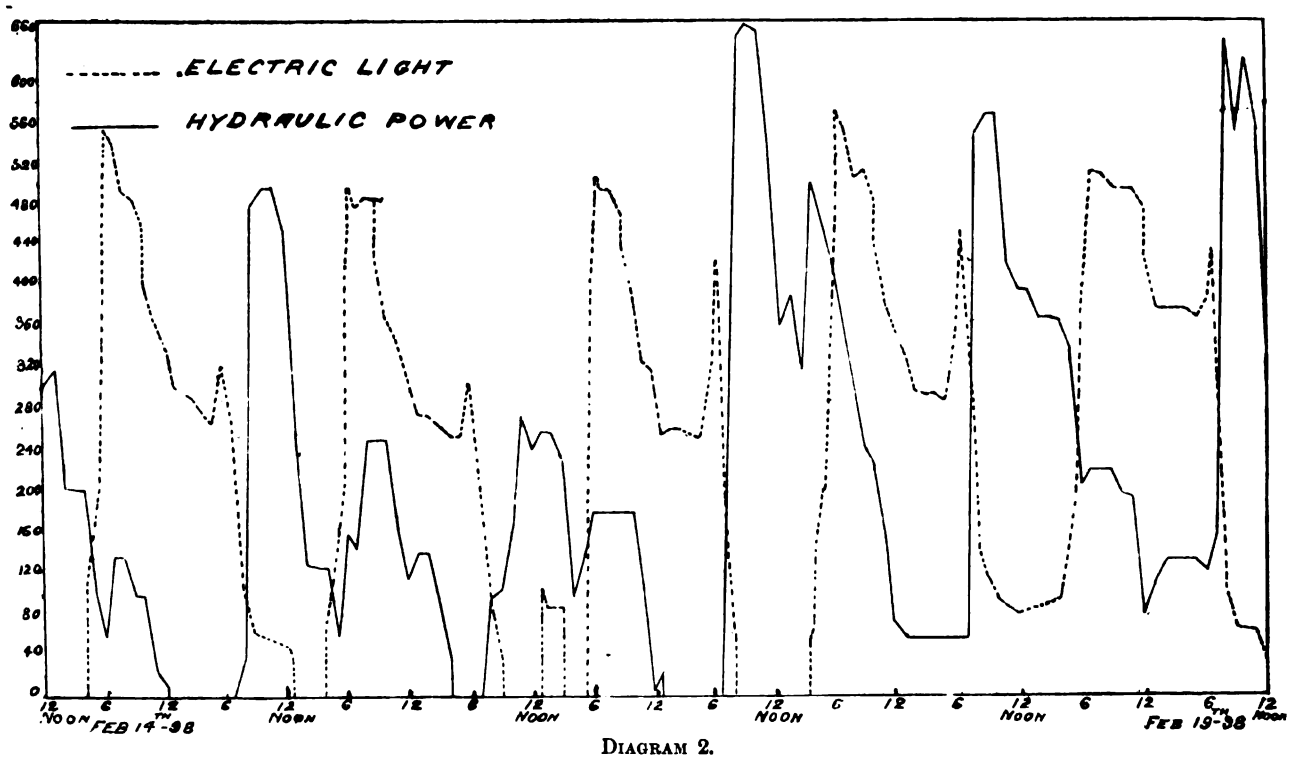

DIAGRAM 2.

Upon Diagram No. 2 are plotted the load curves for one continuous week of both the electric and the hydraulic power supplied simultaneously from the two distinct generating stations. It clearly shows the comparative periods during which the electric and hydraulic plant are at work, and that approximately the same power is required for each. Mr. John Dixon, the dock superintendent, is employing electric motors wherever possible. This has the effect of improving the lighting diagram by filling up the valleys occupied by the hydraulic curves. The result, as shown by the diagram, is increased efficiency of the lighting machinery. It is obvious that where the power and light curves overlap each other the electric current used is equal to double the area covered by the two curves, but this additional call upon the generating station could, where necessary, be met by the spare plant, which should, of course, be available for such overloads and other emergencies. The foregoing clearly shows the economy of a combined plant, and the superiority of electrical machinery for dock and harbour appliances.

The members of Section G who had the opportunity of attending the meeting at Toronto last year probably saw,

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WORKING RESULTS OF SIXTEEN ELECTRIC CRANES AT ROTTERDAM HARBOUR.

COMPILED BY H. A. VAN YSSELSTEYN, ESQ., ENGINEER.

1896. 16 cranes. 2 capstans.	Number of — Working hours.	Number of — Hours necessary for repairs.	Number of — Working cranes on one day.	Cost or expense for — Electricity. £ s. d.	Cost or expense for — Oil and sundry materials. £ s. d.	Cost or expense for — Working and repairs. £ s. d.	Cost or expense for — General inspection. £ s. d.	Cost or expense for — Small repairs. £ s. d.	Total cost of working. £ s. d.	Cost of one hour's working. £ s. d.	Receipts from customers for use of working — Cranes. £ s. d.	Receipts from customers for use of working — Bridges. £ s. d.	Receipts from customers for use of working — Capstans. £ s. d.	Total receipts. £ s. d.
January	1,026	135	3 1/6	28 16 1	0 19 10½	19 1 11	2 10 11	—	51 8 9½	5 0 2	60 15 0	—	—	60 15 0
February	831	35	3	18 14 8	0 19 2	14 12 2½	2 10 11	0 14 10	37 11 9½	4 10 5	104 16 8	—	—	104 16 8
March	1,057	59	3 0/6	39 13 8	1 8 3	18 9 2½	2 10 11	2 5 1	64 7 1½	6 1 9	86 12 6	—	—	86 12 6
April	1,420	120	3 1/6	49 17 3	1 6 2½	24 14 7	2 10 11	1 10 10	79 19 9½	5 12 8	142 0 0	26 2 4	1 0 0	169 2 10
May	928	144	2 1/6	24 4 7	0 18 10½	16 11 11	2 10 11	1 7 9	45 14 0½	4 18 5	99 16 4	1 3 5	1 6 8	103 6 5
June	1,097	167	3 1/6	35 8 11	1 3 4½	19 8 4	2 10 11	—	58 11 6¼	5 6 10	76 15 10	1 3 9	—	77 19 7
July	1,466	125	4	51 19 10	1 16 1	25 3 4	2 10 11	6 13 4	88 3 6	5 19 1	132 18 7	11 9 2	4 15 5	149 3 2
August	881	160	2 2/6	21 9 7	1 2 8	15 11 3	2 10 11	—	40 14 5	4 12 5	89 8 4	—	0 10 10	89 19 2
September	1,043	90	3 1/6	32 8 5	0 17 6	16 19 7	2 10 11	0 9 2	53 5 7	5 2 2	67 16 8	—	0 2 1	67 18 9
October	1,398	250	4 1/6	42 17 7	2 3 9	21 15 0	2 10 11	2 10 10	71 18 1	5 10 0	122 0 1	—	1 2 11	123 3 0
November	1,435	50	5	44 10 3	2 4 7	26 17 2½	2 10 11	1 10 11	77 13 10½	5 7 11	126 14 5	—	1 5 0	127 19 5
December	1,654	139	4 1/6	50 11 1	2 7 3	33 9 2	2 10 11	2 8 8	91 7 1	5 16 6	212 3 7	5 13 2	5 0 5	222 17 2
Totals	14,236	1,474	—	440 11 11	17 7 7	252 13 8¼	30 11 0	19 11 5	760 15 7½	—	1,321 18 6	45 11 10	16 3 4	1,383 13 8

as the author did at Cleveland and elsewhere, electrical machinery for handling goods on the quayside much more developed than in England. The appliances erected by the Brown Hoisting Company, of Ohio, especially for loading coal and iron ore, are placed on rails along the quayside on overhead gantries of sufficient width to allow two or more tracks to run under them. The material to be transhipped is placed in buckets or tubs, raised to a sufficient height to traverse a longitudinal girder, and the tubs are then lowered and automatically tipped either into ship or wagon. These appliances can be operated by one man, and will load as much as 120 tons of coal in an hour. The whole of the operations are exceedingly simple, and are all, including the travelling along the quayside, controlled electrically. One reason of the progress of electrical machinery in America lies in the fact, that the climatic conditions render any hydraulic system useless during a considerable portion of the year.

In 1892 the Southampton Harbour Board instructed the author to design two electric three-ton overhead jib cranes. These cranes have been working most successfully. At first there was a prejudice against their use by the men who formerly operated the steam cranes, and all sorts of pranks were played upon the cranes; for example, by fastening the hook under the coamings of the hatchway, so that instead of lifting the goods the crane was attempting to lift the ship. It was, however, found that the use of the cranes did not diminish the number of hands employed, as trade increased and the men soon became reconciled to the new appliances; experience has since shown that the element of success (given that the crane is properly designed and constructed) is an experienced driver. As an example, the crane which cost practically nothing for repairs, was driven by a driver who had no knowledge of electricity, but had been employed all his life in crane driving, whilst, strange to say, the crane which gave the most trouble was driven by an electrical fitter. The Board are now erecting on the same quay four cranes, making six altogether. The cranes lift two tons at 200ft. per minute and slew simultaneously. These cranes are fitted with two motors, one each of 50 h.p. for lifting and 10 h.p. for slewing, the motion being transmitted to the barrel shaft through worm gearing. Connections to the supply mains are made through waterproof connecting boxes spaced about 40ft. apart upon the quay. The current is supplied by the Corporation at 200 volts.

In an electric system required for docks and other similar places, any extensions can be made with much less expenditure of time and money than would be necessary in a hydraulic system, for which the mains and connections are larger, heavier, and more costly. If a dock were entirely equipped with appliances for coal or other similar work, in which the load is fairly constant and no lighting were required, the cost for power and the efficiency of the hydraulic system would be quite as favourable as for an electric installation, but the disadvantages of the hydraulic system are that its appliances are so varied, and that, more particularly with cranes, the loads are continually changing, the ordinary 30cwt. crane being generally employed in taking lifts averaging one ton and less, which is a constant loss in the hydraulic system; and it is here that the electric system is so elastic. The power absorbed by electric cranes varies according to the class of cargo, and may be generally estimated from 3½ to 5 units per hour.

The author stated in the beginning of this paper that there were reasons why electric machinery, more particularly the type here described, had not made more progress. In this connection it must be remembered that most of the docks and harbours in this country are already equipped with the hydraulic system, and as this system has proved efficient, it cannot be expected that it will be replaced by another, though more economical, unless extensive renewals or alterations are necessary. There would, of course, be an exception to this in countries having a colder climate. At Copenhagen, for instance, the severe winter weather would seriously affect a hydraulic system, and even in England the exceptionally cold winter of two years ago stopped most of the hydraulic machinery round the coast. At Southampton Harbour, however, the electric cranes were in no way affected, and continued their work as usual.

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In 1894 the Clyde Navigation Trust invited tenders for hydraulic cranes, but gave the contractors the option to substitute the hydraulic system by electricity. The result, as far as the author is aware, was that no electric tender could compete with the hydraulic system. Had electric contractors at this period been in a position to avail themselves of this opportunity, we should have seen a greater development in electrical appliances in our docks and harbours. The author hopes, however, that the day has arrived when electric cranes will compete with hydraulic in every way. He has designed some electric cranes to be erected shortly on the River Tees, and bearing in mind the necessity for keeping down the cost of construction, every detail has been studied to this end. The makers of the lifting and slewing motors are only supplying the armature, commutators, fields, and connections, without bed-plate or bearings, as this will be supplied by the crane framing itself, thus reducing the amount of material and weight to a minimum. These motors are to be series-wound, with liquid resistances, and there will be no switchboard or instruments beyond one wattmeter, and even this is not a necessity. It is believed that such cranes as these can be erected complete, including generating plant, at a price that will compare favourably with any hydraulic system. These cranes are being constructed by Messrs. Stothert and Pitt, who have ably seconded all the intentions of the author in this direction to bring about the desired result.

The author is indebted to Mr. John Dixon, dock and marine superintendent, Southampton; Mr. Agerskov, Copenhagen Free Harbour; and Mr. H. A. Van Ysselsteyn, of Rotterdam, for much of the information he has had the opportunity to lay before Section G.

P. R. JACKSON AND CO.'S NEW DYNAMOS.

During the past two years Messrs. P. R. Jackson and Co., Limited, of the Salford Rolling Mills, Manchester, have been carrying out an important series of experiments with dynamos having slot-wound armatures and copper brushes. The object of these experiments was to secure sparkless commutation, with an absolutely fixed brush position for all loads, and even when the dynamos were considerably overloaded. The result has amply justified the heavy cost of the undertaking, inasmuch as a large number of dynamos embodying the foregoing features and ranging in size from 40 h.p. to 400 h.p. have been constructed. The machines are built on the Sayers system of winding, but with the special improvements of Messrs. Jackson, which have been patented in this country and abroad, including Germany and America.

Fig. 1 is an illustration of a 150-kw. Jackson-Bellis steam set. The dynamo is a four-pole. The outer ring or yoke of the magnets is of Messrs. Jackson's own special steel, as are also the magnets and pole-pieces. The ring is partially enclosed at the sides with gunmetal gratings, which

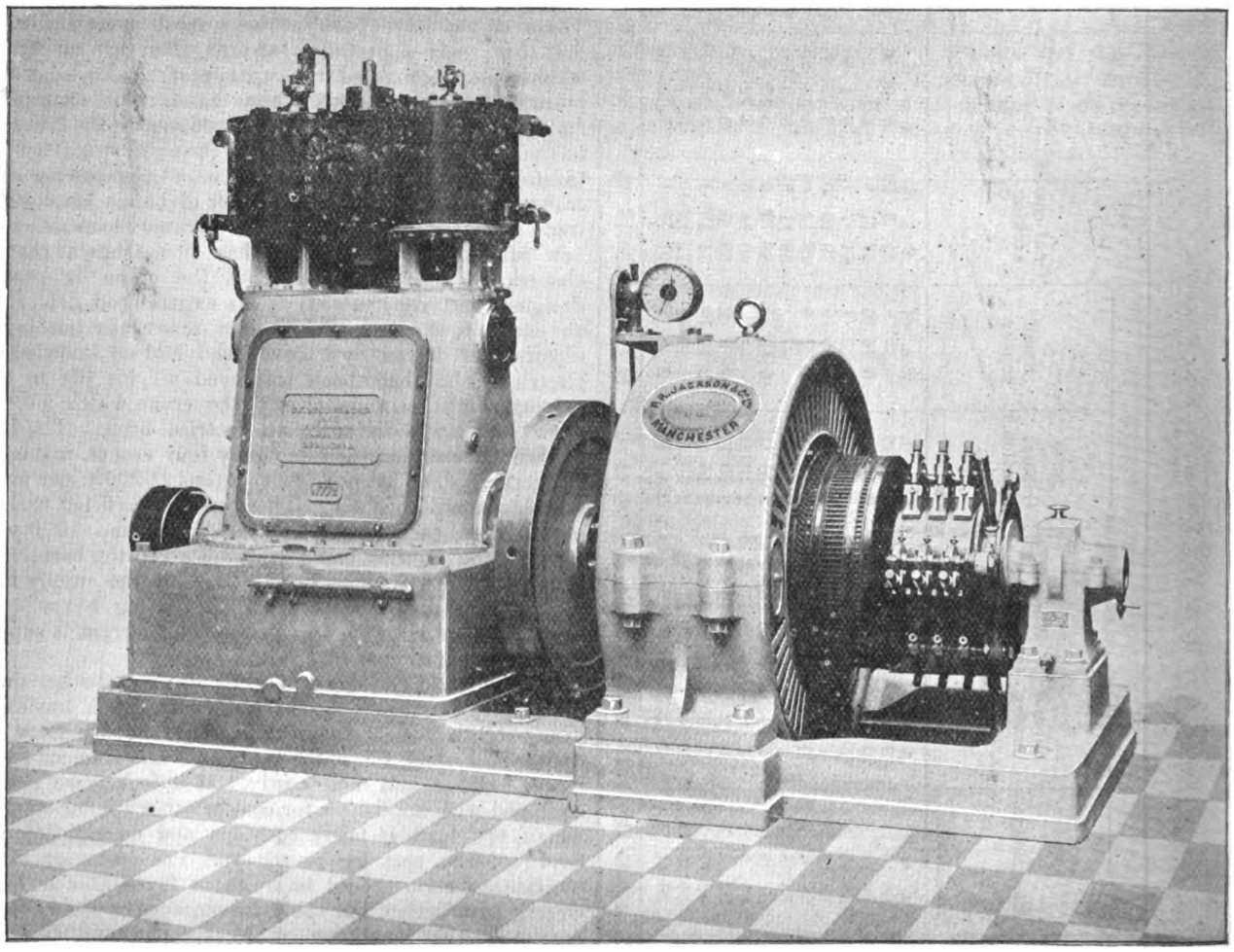

FIG. 1.—Jackson-Bellis Steam Dynamo.

not only afford protection to the field-magnet coils and the armature, but facilitate the work of connecting the magnet coils, and afford considerable support to the pole-pieces. The whole of the pole-pieces are cast and machined together in a special patented method of Messrs. Jackson's. This method secures solid metal at the pole-tips, and obviates the necessity of annealing the steel. The shunt winding is quite separate from the series winding, and all joints are made with thimbles and bolts. The core is built on a spider, and the shafts are removable. The bearings are of the split type, and are self-oiling, without loose rings or other such devices. The brush gear is also of patented form, the holders being designed to give a light elastic tread to the brushes. The brush-holders are adjustable lengthways on the brush spindle, and there is also screw feed and hold-off adjustment. The springs, which are all of stout flat steel, are enclosed in the body of the holder, and can be adjusted to give any desired brush pressure. The brush leads are attached underneath the commutator to two circular collectors. These enable the leads to swing clear of everything to two terminals on the bottom side of the gunmetal

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gratings. The two main terminals are on the opposite grating, from which point they may be very conveniently connected to the underground or overhead cables.

Fig. 2 is a two-pole machine, with a capacity of 200 kw. at 450 revolutions per minute. Three of these dynamos are now at work in a large works in Lancashire, where the current frequently varies throughout the full range of the machines. The brushes (copper) are not only absolutely fixed in one position throughout the full variation of the load, but even when it is exceeded by 20 or 30 per cent. Notwithstanding this overload, the dynamos run absolutely sparklessly, and without trouble of any kind whatever.

Mr. Slater Lewis is largely responsible for the design of these dynamos, while Mr. F. J. Howitt, the electrical engineer to the company, has had full charge of the experiments by which the requirements for constant lead were ascertained.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

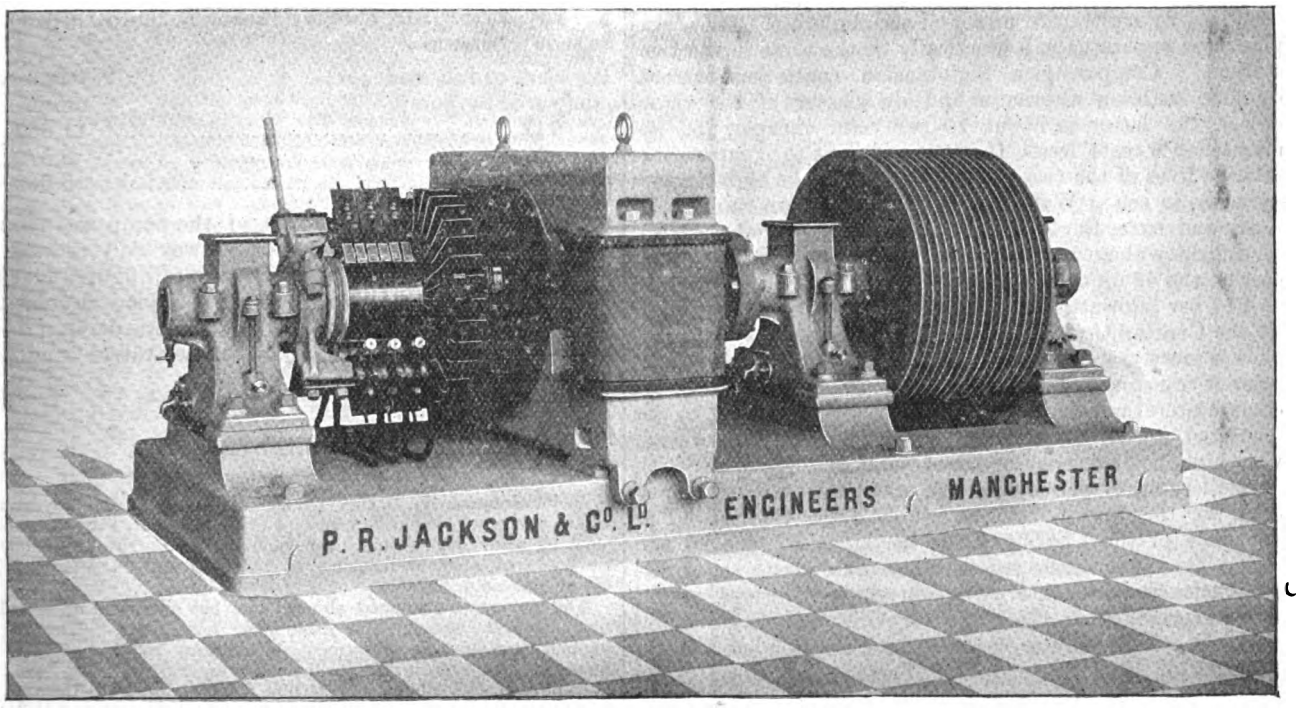

FIG 2.—A Rope-Driven 200-kw. Dynamo, 450 Revolutions.

QUESTIONS.

110. Is it better to use motor-generators or accumulators as "boosters" at the end of feeders in electric traction work?—J. C. R.

111. It is sometimes desirable to reduce the pressure of steam in order that an engine requiring low-pressure steam may be worked with high-pressure steam. How is this best done?—C. S.

ANSWERS.

Question No. 104.—How does a high-tension continuous plant compare with a high-tension alternating one in capital cost, and in repairs and maintenance?

Best Answer to No. 104 (*awarded* 10*s.*).—In view of the comparatively small number of high-tension continuous-current stations in existence, and the wide divergence in capital outlay per kilowatt, also, of some alternate-current stations, it is somewhat difficult to lay down a hard-and-fast line as to the relative cost of the two systems. Looking at the individual items in each case, we find that a high-tension direct-current dynamo from 200 kw. to 300 kw. would cost about £4. 6s. per kilowatt, while an alternating machine of about the same size would probably cost about £5. 10s. per kilowatt, leaving a margin in favour of the continuous-current machine of £1. 4s., or, say, on a 300-kw. machine about £360. The exciter is included in the latter case as being indispensable, but not in the former, as there are such a variety of methods of exciting the generator without the aid of special plant.

Coming to one of the principal features of each system—namely, the transformers—we find that the alternate-current plant is a long way in advance. For instance, a direct-current rotary transformer of about 100 kw. capacity costs about £8. 8s. per kilowatt, whereas in an alternating-current transformer of similar size the cost is about £2. 4s. per kilowatt, thus showing a very big divergence of £6. 4s. per kilowatt, or £620 on the machine. Presuming the capacity of the transformer is made equal to that of the generator—viz, 300 kw.—then the total difference between the two is £1,860, thus much more than counterbalancing the difference in cost of the generators. This difference is still more marked in the smaller sizes of machine: 10-kw. continuous-current transformers, £17. 10s. per kilowatt; 10-kw. alternate-current transformers, £3. 6s. per kilowatt; or somewhat over five times as much. In sub-stations, it may as a rule be taken that the alternating system has the advantage, since they can often be placed in situations (thus utilising any available ground) which would be well-nigh impossible with rotary machines. The capital outlay on mains, provided practically the same system is adopted in each case, will probably be similar, or, if anything, slightly bigger in an alternate-current installation, owing to the necessity for superior insulation which it entails. And finally, in switch-gear there is no great difference between the two.

From this it will be seen that the total capital outlay will be somewhat in favour of alternating-current plant, which seems to be the experience in actual practice. Thus, taking the capital outlay of the three best instances of continuous-current work, we find that their average is £93 per kilowatt, while the average of three alternating-current stations of similar size is £73 per kilowatt, or, roughly, a difference of about £20 per kilowatt.

Now, as far as repairs and maintenance are concerned, an alternating-current station as a rule has the advantage, owing to the lesser attention required for the transformers

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and the absence of commutators, etc., this latter becoming rather a serious item either with abnormally big rotary transformers or with a large number of comparatively small ones. This, again, is borne out by figures in actual practice. Taking again these same three high-tension continuous stations, we find that their average repairs and maintenance bill amounts to ·46d. per unit generated; while in three alternating stations, generating a similar number of units, and of about the same age, the average is only ·14d. per unit, or more than three times as little.

Reviewing the above, it will be seen that the alternating-current station has both a smaller capital outlay and lesser repairs and maintenance bill for the same output than a high-tension continuous plant, but it must not be forgotten that while one has been brought to a comparatively high state of perfection owing to years of experience, the other is, as it were, only in an incipient stage; and generally in each successive station laid down there are improvements effected both in capital outlay and in repairs and maintenance costs, so that in a year or two we can expect they will be much more alike than at present.—H. B.

Answer to No. 104 *(awarded* 5*s.*).—In order to make a just comparison we need to compare the cost of a high-tension continuous-current station and sub-stations containing high-tension dynamos, motor-generators, booster, and accumulators, with a high-tension alternating-current station containing alternators and exciters, transformers, rectifiers, rotary transformer, and accumulators. The other plant and apparatus will practically be the same in the two stations. Comparing a high-tension continuous-current dynamo with an alternator and its exciter of the same power, the latter is about 10 per cent. cheaper, and its maintenance costs less. It is too early yet to compare the relative lives of the two, but we know that the high-tension dynamos in use at Walsall and Wolverhampton run sparklessly and exceedingly well at 2,000 volts. There is also no difficulty about getting them to run in parallel. The cost of the 40-unit motor-generators at Walsall works out to £14 per kilowatt, and that of the much larger ones used by the Charing Cross Company to about £11 per kilowatt. This is more than twice as much as the cost of alternating-current transformers. Each motor-generator has also two commutators and four brushes, and so they need to be inspected at least twice a day. Their efficiency is, however, very high, the efficiency of the 40-unit motor-generators at Walsall being 87 per cent. at the maximum load and 78 per cent. at the lowest load at which they are run. The efficiency of the Charing Cross machines is over 90 per cent. These efficiencies compare favourably with the working efficiencies of the alternating current transformer, which, however excellent in theory, is very disappointing in practice. We have only to consider how the London Electric Corporation have changed their Ferranti transformers for Westinghouse apparatus and then to E.C.C. and Mordey transformers and then to Berry's transformers. This wholesale changing is no doubt partly due to the low efficiency and frequent breakdown of transformers after being several months *in situ*.

The rectifiers have nothing corresponding to them in the continuous-current system. According to the discussions at the meeting of the municipal engineers, they have a low efficiency, are difficult to start, and upset the station voltage at the start. They are also, as at present, made a great source of danger to the employés.

Larger accumulators have to be used with the continuous-current system, and the item for their maintenance is consequently much higher. The efficiency of the low-tension booster employed is, however, much higher than that of the rotary converter, as the ratio of the conversion is so much less. The effective voltage being the same in the two systems of distribution, the cost of mains, etc., will be practically the same.

From the actual figures given by Mr. Wyllie at Walsall, we find that his station (240 kw., pressure 2,000 volts) cost £80 per kilowatt installed, and employs six men, including jointers and trimmers for arcs. If the station had been designed for alternating current, the cost would probably have come out about £70 per kilowatt installed, and the number of men employed would have been the same. The cost of maintenance and repairs owing to the fewer accumulators mainly would also be slightly less. These economical considerations are out-balanced by others in the opinion of many engineers—*e.g.*, possible tramway system, etc.—which, however, are not asked for by the question.—J. C. R.

Question No. 105.—With reference to Question No. 97, is the by-pass method of regulating feed pumps economical?

[No answer has been received dealing correctly with this question, and there seems to be some doubt as to what is meant by the "by-pass." We cannot give a better instance of this most uneconomical method than the electrical feed pump at the Bristol electric lighting station. This was described by Mr. Faraday Proctor in his recent paper before the British Association. The pump in question was a three-throw one, driven by a 600-volt continuous-current motor with double-reduction gear. The pump has by-pass cocks connecting the deliveries with the common suction, by which the amount of water pumped can be regulated while the pump speed is constant. This is practically equivalent to providing a pump cylinder with a leak in it, and the pump does not then deliver water into the boiler until nearly the end of the stroke. Then the resistance to the water rushing out of the by-pass is so great that the pressure rises to a point at which the boiler check valves opens. This arrangement is, therefore, wasteful, as all the water forced under pressure through the by-pass represents wasted power. Mr. Faraday Proctor's figures prove this, as shown below:

Per cent. of full load delivered by pump.	Watts used in motor.
111	11,860
19	8,372
9	8,052

Thus, while the useful output of the pump was reduced by 930 per cent., the power taken was only reduced by 32 per cent. A further perusal of the full figures given on p. 371 of our present volume will convince anyone that there is little, if any, advantage from electric driving if this wasteful method of regulating by by-pass valves is adopted. Ed. *E. E.*]

MANCHESTER.

Major-General H. Darley Crozier, R.E., a Local Government Board inspector, held an enquiry on the 24th inst. into an application by the City Council for sanction to borrow £200,000 for purposes of electric lighting in the city and outside districts. There was no opposition.

The evidence produced showed that the electrical undertaking had been in existence a little over five years. The capital expenditure of the electricity department to the end of the financial year, ending March 31 last, was £357,617. In 1893 the capacity of the plant was 40,000 8-c.p. lamps, in 1894 it was increased by another 16,000, and in 1895-6 it was increased by a further 72,000; but in 1897-8, owing to the labour dispute, no further plant was put down, although it had been ordered. At the present time there were 214,946 8-c.p. lamps connected, and 130 consumers with 31,760 lamps were waiting to be connected. New applicants for current averaged 12 per week applying for 1,550 8-c.p. lamps. The Corporation would not be able to connect those lamps until the plant referred to, which was now being constructed, had come into operation. The charges for electrical current were 5d. per unit fixed charge, and for long hours' consumers 1½d. per unit, and £7 per annum per kilowatt. During the four years and eight months that had elapsed from the initiation of the undertaking until March last, the Corporation Electricity Committee placed to reserve and renewal funds £34,245, and handed over to the city fund £26,694, making a total of £60,939, which, for the period over which it extended, was equal to a rate of rather more than a penny in the pound. By the Manchester Corporation Act of 1897 the Council had obtained powers to enable them to supply electrical energy. In the same session several of the surrounding districts applied for and obtained provisional orders from the Board of Trade, which were confirmed by Act of Parliament, for the supply of electric light. They were Denton, Droylesden, Levenshulme, Moss Side, Stretford, and Withington. Four other districts—viz., Failsworth, Heaton Norris, Gorton, and Openshaw—were also seeking powers. The Corporation had made definite arrangements for supplying current to four districts—viz., Levenshulme, Moss Side, Withington, and Heaton Norris—but inasmuch as Heaton Norris had not yet obtained its order it was not possible to take any immediate action in that township. They had given notice for an order in the coming session, and the matter would be dealt with on a future occasion. The main purpose of the Corporation in that application was therefore in order to make provision for Levens-

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hulme, Moss Side, and Withington. Negotiations were pending with many other districts, and there was a probability that other districts would seek to obtain from Manchester a portion of that supply which was to be afforded to the districts mentioned. The present charge for current would be maintained, and no difference would be made between the charge in Manchester and the outlying districts. The proposed works were designed to meet the present demand, as well as to provide for prospective requirements.

LEGAL INTELLIGENCE.

CHARGES AGAINST AN ELECTRICAL ENGINEER.

Alleged Wholesale Frauds.

At Exmouth, on Saturday, Ward Thomas, 40, described as an electrical engineer, of Plymouth, late of Exeter, was charged before the Devonshire magistrates with obtaining by fraud a quantity of electrical plant, belting, etc., from different firms all over the country.

Mr. J. Beal, in opening, said the prisoner passed under the name of Ward Thomas, but he (Mr. Beal) believed that his correct name was Ernest James Thomas. Some little time ago he was residing at Laira, Plymouth. The charge against him was that he had obtained from various merchants all over the kingdom belting and other leather goods by false pretences, and thereby secured credit for the amount of these goods by fraud. The facts of the various cases were brought to the notice of the Public Prosecutor, and he had considered that the cases were of sufficient importance to take up a public prosecution. Mr. Beal read a note-head which had been received by one of the firms, and which ran: "Waterside entrance, Commercial Wharf; Stores, Commercial-road. From the Western Counties Electrical Company, Barbican, Plymouth, electrical and general engineers, telephone, telegraph, and electric light contractors, marine engineers, sundrymen, general agents." Another note-head ran: "St. Jude's, Plymouth. At home two to four p.m." And another: "Drayton House, Laira, Plymouth." From that, Mr. Beal contended, the various firms were given to understand that they were dealing with a *bonâ fide* firm, and that was the reason they allowed credit. There was no such firm as the Western Counties Electrical Company, and the other addresses, which conveyed the idea of houses of great magnitude, were poverty-stricken places barely furnished.

The accused was remanded till Wednesday, when **Mr. Beal**, appearing on behalf of the Public Prosecutor, said that the prisoner had carried on a most extensive fraud. He had made it a practice to send out headed note-paper to various firms, representing himself to be carrying on a genuine business, whereas he was carrying on no business at all. At the head of some of the letters he described the firm as the Western Counties Electrical Company, Barbican, Plymouth, and goods were forwarded as asked for. No sooner did the prisoner receive them than they were disposed of for considerably less sums than were charged to him. Among the firms which had been so victimised were the Gandy Belt Manufactory, Seacombe, Cheshire, and Messrs. G. Craddock and Co., of Wakefield, wire-rope manufacturers. When arrested, the accused said, in answer to the charge, "I can stand that like a man. I can plead under the Debtors' Act." On the charges of fraud against the two firms named the prisoner was committed for trial.

The case was further adjourned to enable other matters to be gone into.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of the Brazilian Submarine Telegraph Company, Limited, was held at Winchester House on the 26th inst., Mr. J. Denison Pender presiding.

The **Chairman**, in moving the adoption of the report, said that the decrease in the total expenditure for the half-year of £4,690 was entirely a question of repairs or no repairs of cables. In the previous half-year there was a sum of £5,725 standing to repairs of cables, and in the half-year ending with June last the Company were fortunate in having no such expense. After providing £3,200 for debenture interest and sinking fund, and £1,713 for income tax, there remained a balance on the half-year's business of £77,300 odd. The repair of one of the cables would be rather an expensive matter, considering it was lying at a depth of over 2,000 fathoms. The present statement dealt with the Brazilian accounts, but next half-year there would be taken into consideration also the receipts of the Western Brazilian, in conformity with the arrangements that had been carried out.

The report was adopted.

EASTERN EXTENSION TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting of the Eastern Extension, Australasia, and China Telegraph Company, Limited, was held at Winchester House on the 26th inst., the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, said the gross revenue showed a decrease of over £13,000, mainly due to the reduction of rates to China and Japan and the cutting of the cables in consequence of the war between the United States and Spain. Some parts of the line had been completely renewed, and in some cases extended, at a cost of over £40,000. The Chairman expressed great admiration of the conduct of Mr. Herbert Jones and his subordinates in the Philippines. The claim of the company against the United States for cutting the cable had not yet been admitted.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Middlesbrough.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Nov. 29.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Dec. 1.

Leatherhead.—The Urban District Council intend to sell the lease of their electric lighting order for a number of years. Details may be obtained at the office of the Clerk to the Council. The offer is open until Nov. 21.

Hornsey.—The Urban District Council are prepared to receive tenders for the supply of electric lighting plant and its erection at the Council's central public library. For particulars see our advertisement columns. Tenders by Nov. 7.

Barrow-in-Furness.—The Corporation invite tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches, and fittings. For particulars see our advertisement columns. Tenders by Nov. 14.

Knowle.—Tenders are invited for the supply and fixing of two engines and dynamos, equal to an output of 24,000 watts each, etc., for the County Lunatic Asylum, Knowle, near Fareham. Tenders by Nov. 10. Further particulars appear in our advertising columns.

Cork.—Tenders are invited by the Cork Electric Tramway and Lighting Company for proposed offices adjoining the power house, Albert-street, Cork. Specification, etc., may be inspected at the offices of Mr. Robert Walker, P.P.S.A., architect and C.E., 17, South-mall, Cork, with whom sealed tenders are to be lodged by Nov. 14.

Hanley (Staffs).—Tenders are invited for the erection of a refuse destructor. The building in which the destructor is to be placed, or the brick chimney shaft, is not included in the contract. Further particulars, together with copies of the plan of two suggested sites, may be obtained on application to Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley, by Nov. 15

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of transformers and accessories. Specification, form of tender, and general conditions can be obtained at the offices of Mr. A. H. Preece, A.M.I.C.E., 29, Victoria-street, S.W. Tenders, sealed and endorsed "Tender for Transformers," must be delivered at the office of Mr. W. H. Whitfield, clerk, Council Offices, Wimbledon, by 5 p.m. on Nov. 7.

London, E.C.—The East Indian Railway Company being desirous of introducing electrically-controlled block instruments on their system, invite proposals from makers only for the supply of (for single line) 18 instruments for nine blocks; (for double line) 80 instruments for 41 stations and six spare instruments. Tenders will be received up to 1 p.m. on Nov. 23, and particulars can be obtained on reference to Mr. A. P. Dunstan, secretary, Nicholas-lane, London, E.C.

Nottingham.—Tenders are invited by the Electricity Committee for the erection of a new electricity station in Talbot-street, Hanley-street, and Wollaton-street. The works will consist of an engine-room 148ft. long and 38ft. 6in. wide, a boiler-house 185ft. 6in. long and 31ft. 6in. wide, chimney 180ft. high, stores, boundary walls, etc., and the whole of the works are to be completed by July 9, 1899. Specification, etc., may be obtained at the office of Mr. Arthur Brown, M.I.C.E., city engineer, Guildhall, Nottingham, on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by Nov. 4.

Edinburgh.—Tenders are invited by the Magistrates and Council for the following works in connection with their electric light station in McDonald-road: (Contract No. 1) boilers (marine type) and mechanical stokers; (2) engines and dynamos. In contract No. 2 it is a condition that the firms tendering must have constructed machines of the very largest size for use in this country, and that the engines are made either by Messrs. Willans and Robinson, Rugby, or by Messrs. Belliss, Birmingham. Specifications, etc., can be obtained from the Resident Engineer, Dewar-place, Edinburgh, upon payment of £2. 2s. for each specification, to be returned on receipt by the Council of a bona fide tender. Specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by Nov. 14.

Bilston.—Tenders are invited by the Bilston Urban District Council for the construction of a line of telephonic communication between the Bilston waterworks pumping station at the Bratch and the town hall at Bilston, with the necessary receiving and

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transmitting instruments, and also the setting up of electric recording apparatus in the reservoir at Goldthorn Hill, with communication wires from the recording apparatus to the pumping station at the Bratch, and also to the town hall, Bilston. Plans may be seen at the office of Mr. Baldwin Latham, M.I.C.E., engineer for the works, 13, Victoria-street, Westminster, S.W., and also at the office of Mr. John D. Wassell, clerk, Town Hall, Bilston, and the form of tender may be obtained on application to the Engineer or to the Clerk on deposit of £5, which will be returned to all persons making a bona fide tender. Tender by 29th inst.

RESULTS OF TENDERS.

Dewsbury.—The Town Council have accepted the tender of the Callender Cable Construction Company for a new electrical cable for the sum of £1,396.

Dundee.—The Gas Commissioners have accepted the following tenders: Doulton and Co., underground conduits, £692. 3s. 4d.; Callender Cable Construction Company, lead-covered cables, £1,373. 17s. 8d.

Bolton.—The Town Council have accepted the following tenders: Mather and Platt for supply and erection of two continuous-current generators with Musgrave's engines and boosters; the Thomson-Houston Company for switchboards; and the British Insulated Wire Company for cables.

Bexhill.—The Urban District Council have accepted the following tenders for works connected with their proposed electric lighting station:—Section A, boilers (12 tenders): R. Hornsby and Sons, 75A, Queen Victoria-street, London, E.C., £1,748. 10s. Section B, engines, dynamos, etc. (16 tenders): W. H. Allen and Co., Queen's Engineering Works, Bedford, £2,570. Section C, switchboards (eight tenders): None accepted yet. Section D, storage battery (13 tenders): Chloride Electrical Storage Syndicate, Limited, Clifton Junction, near Manchester, £1,020. Section E, cables (seven tenders): British Insulated Wire Company, Limited, Prescot, Lancs., £5 958. Section F, arc lamps, etc. (eight tenders): British Insulated Wire Company, Limited, £665. 15s. 6d.

Gloucester.—The Electricity Supply Committee of the City Council have received the following tenders for the buildings required for the proposed electricity works:

Name.	Time required for completion.	Amount.
Freeman and Jones, Gloucester ...	12 months ...	7,300 0 0
J. Gurney and Sons, Gloucester ...	9 months ...	*7,676 0 0
W. Jones, Gloucester	15 months ...	7,711 0 0
P. Ford, Stroud...	No time given ...	8,026 1 1
Collins and Godfrey, Tewkesbury	9 months ...	8,146 0 0
A. King, jun., and A. E. King, Gloucester	No time given ...	8,378 0 0
W. Bowers and Co., Hereford ...	No time given ...	8,691 17 0
H. A. Forse, Bristol	12 months ...	9,278 0 0
Stephens, Bastow, and Co., Limited, Bristol	9 months ...	10,774 0 0

* Recommended for acceptance.

BUSINESS NOTES.

Eccles.—It is expected that the electric light for the borough will be ready within a few days.

Brislington.—The Parish Council is making enquiries as to the cost of electric lighting at Keynsham.

Halifax.—Mr. H. F. Street, assistant electrical engineer, has been appointed borough electrical engineer.

Portsmouth.—The Town Council have decided to insure the whole of their electrical staff against accidents.

Wycombe.—The electric lamps are being gradually extended in all the streets, the old gas lamp-posts being used for the purpose.

Littleborough.—The Council have resolved to leave in abeyance until early next year the application for an electric lighting order.

Bexley.—The Urban District Council have now definitely decided to oppose the company, and are applying for a provisional order.

Chiswick.—The Urban District Council are making provision for bracket lanterns to be attached to the posts to be used for electric traction.

Newton Abbot.—The Council will not take in hand the matter of electric lighting at present, preferring to leave it in the hands of a private company.

Wrexham.—The application of the Town Council to the Local Government Board for a loan of £8,200 includes £1,180 for an electric lighting station.

Rawmarsh.—It is proposed to appoint a committee to consider the best means of lighting the area covered by the order recently obtained by the Council.

Removal.—Mr. Henry Edmunds, M.I.E.E., electrical engineer, has removed his offices from 39, Victoria-street to 2, Queen Anne's-gate, Westminster, S.W.

Scarborough.—The Corporation are considering the various modes of electric traction, and the policy of introducing them into the borough or otherwise.

Farnham.—Mr. F. J. Warden-Stevens, A.M.I.E.E., has been instructed by the District Council to prepare a report on the electric lighting of the town.

Lye.—The District Council has retained Mr. F. J. Warden-Stevens, A.M.I.E.E., to advise them respecting the introduction of an electricity supply scheme.

Warrington.—Mr. A. H. Preece has been requested by the Town Council to prepare a scheme for the lighting of the borough by electric light as soon as possible.

East Barnet.—The Urban District Council have formally resolved that the necessary steps be taken for the purpose of obtaining an electric lighting provisional order.

Grays.—The Urban District Council have decided that steps are to be taken at once to obtain in the next session of Parliament a provisional order for electric light for the district.

Walker.—The Urban District Council have published the statutory notices of intention to apply to the Board of Trade for a provisional order under the Electric Lighting Acts.

Kensington.—The Vestry are preparing a memorial to the Board of Trade for a provisional order authorising the supply of electricity by the Vestry within the district over which they exercise jurisdiction.

Personal.—The United Asbestos Company, Limited, has appointed Mr. S. H. H. Barratt, A.M.I.C.E., A.I.E.E., late of 19, Old Queen-street, Westminster, to be manager of their lubricant department.

St. Annes.—The Council have resolved that it was not desirable to transfer the powers of the provisional order to any other persons, and have empowered a committee to call in an electrical engineer to advise them.

Personal.—Mr. T. H. Harvey has been appointed London traveller for Johnson and Phillips's electric cable works in the place of Mr. McKrell, whose connection with this firm ceased as from the 31st ult.

Barnet.—The draft agreement of the Electrical Power Distributing Company, Limited, for lighting the Council's district with electricity will come before the Urban District Council for consideration next week.

Tangier.—An engineer, various officials, and artisans of all trades are proceeding to the Sus coast to open a new port and customs house at Arksis, not far from the point where the crew of the "Tourmaline" landed.

Acton.—The Metropolitan Electric Supply Company have decided to apply to Parliament next session for powers to supply electrical energy in the district of Acton. The Urban District Council have already an order.

Maidstone.—A report by the Electric Lighting and Drainage Committee on the site for the proposed electric lighting station and refuse destructor, and recommending as such a portion of the Fair Meadow, has been referred back.

Hornsey.—The Urban Council have decided not to discuss the question of combined areas for the supply of electricity as suggested by the Finchley Council, and not to entertain proposals from the Electric Power Distribution Company.

Tobermory.—The Burgh Commissioners are consulting Mr. Yorke, electrical engineer, as to the advantages of the electric light. Mr. Yorke is engaged on two private electric lighting contracts in the district, involving a cost of £700.

Southampton.—The Tramways Committee have recommended the Corporation to use electricity as the motive power on their tramways. The probable cost will be between £60,000 and £70,000, not counting the extra cost of a generating station.

Hendon.—It is stated that other proposals have been made to the Council for the supply of electric light at Hendon, exclusive of the scheme of the North London Electricity Company. A public meeting to discuss the whole matter will be held next Monday.

Oriental Telephone and Electric Company, Limited.—The directors have declared an interim dividend of 4d. per share, free of income tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted on 31st inst.

Eston.—The Urban District Council have had a conference with a representative of the Imperial Tramways Company, who are desirous of extending their system of tramways into the district, and the Council will give every facility to the carrying out of this object.

Monte Video Telephone Company.—According to the report for the year ended July 31, the net profit was £6,826 exclusive of £976 brought forward. The dividend on the preference shares is to be paid in full £1,000 placed to reserve, and £2,602 carried forward.

Eastbourne.—The Telephone Sub-Committee's recommendation, that the Council apply to the Postmaster-General for a license to establish a municipal telephone exchange with a private wire in connection with the Post Office, has been adopted by the Town Council.

St. Marylebone.—At a meeting of the Vestry of this parish, held yesterday, the Electric Lighting Committee asked for authority to enter into preliminary negotiations with the Metropolitan Electric Supply Company for the purchase of their undertaking in the parish.

Aylesbury.—Edmundson's Electric Lighting Company have given notice that they intend to apply to the Board of Trade for a provisional order to light Aylesbury by electricity. The Urban Council, however, have considered the matter, and will shortly decide about undertaking a public scheme.

Wallasey.—Although the District Council have carried by a vote of 14 to 6 their proposed parliamentary Bills, seeking to

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borrow £284,000 on promenade extensions, electric tramways, and road improvements, at a subsequent public meeting of ratepayers the voting was unsatisfactory, and a poll will have to be taken.

Sheffield.—The Tramways Committee of the Corporation recommend that no advertisements whatever be placed on or in the new electric tramcars. They propose to issue a £5 book of tramcar tickets as a donation to the Blind Institution, for the use of their lady visitor while on duty visiting the poor blind in various parts of the city.

Glasgow.—At the next meeting of the Corporation the following motion will be considered: "As the consensus of public opinion, as manifested at the various ward meetings of electors and also in the public Press, is opposed to the scheme for supplying Paisley with tramways, that no further action be taken by the Corporation in the matter."

Wolverhampton.—On Saturday night, about half-past seven, the whole of the street and private lamps went out, and although just before eight o'clock the current was rectified for a few minutes, darkness again set in and the light did not reappear until ten minutes past nine o'clock, while it took another hour before the arc lamps were in working order.

Dewsbury.—Application is to be made for sanction to borrow £9,060 for the work necessitated by the increase of the voltage of supply, for extending the mains into a residential part of the borough, and for installing an additional steam dynamo, etc. Mr. C. H. Robinson, of Oldham, has been appointed an assistant at the central electric lighting station.

Birkenhead.—The Town Council will promote a Bill for the purpose of constructing electric tramways in the borough; also acquiring compulsorily or by agreement certain property, and for acquiring by agreement the interests of the Birkenhead United Tramways, Omnibus, and Carriage Company, Limited, and the Wirral Tramways Company, Limited.

Wellingborough.—In consequence of the Wellingborough Gas Company's application for powers to raise additional capital, the Urban District Council have asked the Lighting Committee to consider whether the Council should take over the gas supply, and eventually to get a clause inserted in the new Bill giving them power to take the works over within a certain period.

Northallerton.—A letter from Mr. J. Ernest Hutton, stating that a company had been formed for the purpose of supplying electric light in the district of the Rural District Council, and that he begged to apply to them for their permission to make an application to the Board of Trade for the requisite license, will be discussed at the next meeting of the Urban District Council.

Northfleet.—The Electric Trams Joint Committee appear to be favourably impressed with the proposal of the Drake-Gorham Company to substitute electric traction upon the tramways connecting Gravesend and Northfleet. A western extension is also proposed. The committee are continuing their work, but the matter will have to be decided by the two councils interested.

Paddington.—The Vestry will oppose the application of the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order for supplying Paddington with electricity. The question of lighting Sutherland-avenue by electricity has been deferred until such time as the result of the arc installation in Westbourne-terrace shall have been ascertained.

Motherwell.—The Town Council have adopted a report by Prof. A. B. W. Kennedy on the installation of electric light within the burgh. The total capital expenditure is calculated to be over £23,000, the scheme providing for private lighting, 30 arc lamps and 400 32-c.p incandescent lamps for street purposes, and for power for mechanical purposes. The works will be proceeded with at once.

Coatbridge.—It is stated that the convener of the Lighting Committee is about to propose to the Town Council the advisability of purchasing the works of the Scottish House-to-House Electricity Company, Limited, in the burgh, as he believes that the works, which have hitherto proved unsuccessful in the hands of the company, would become successful in the hands of the Corporation.

West India and Panama Telegraph Company.—The directors notify that, owing to the recent war in Cuba and Porto Rico, some delay has occurred in settling for traffic with other telegraph companies, and consequently the accounts for the half-year ended June 30 cannot be submitted to the shareholders, nor the general meeting held, until later in the year than usual, due notice of which will be given.

Stock Exchange.—The market in electric shares is improving, according to the *Financial News*, which reports that electric shares are all a shade better. Very few shares have changed hands during the recent slump. Citys improved £2 to 23½-24, in consequence of the last quarterly statement. House-to-House, London Preference, St. James's, Westminster, and others were in demand at improved quotations.

Bowness-on-Windermere.—The Urban District Council have agreed to an application by Mr. Fowkes, manager of the Windermere Electrical Supply Company, to lay cables under the footpaths, and also to build a transformer chamber in a position between the two banks in St. Martin's-square, Bowness, subject to the approval of the Postmaster General. Part of the flagging is to be made good by Mr. Fowkes.

Oldham.—At a special meeting of the Town Council on the 26th inst. it was decided to apply for powers from Parliament to take over the local tramway system, and extend it to Royton, Crompton, and Lees by electrical or other mechanical power. It was stated that the Corporation scheme would cost £5,000 per mile, or £60,000 altogether, and the hope was expressed that the conduit system would be adopted in preference to overhead wires.

Telegraph Construction and Maintenance Company, Limited. This Company have decided to renew the £150,000 5 per cent. debentures, which mature on Jan. 1, 1899, for a further period of 10 years, at the rate of 4 per cent. per annum. Arrangements have been made with Messrs. Barclay and Co., Limited, to take up at par all debentures which the holders do not wish to renew.

Stourbridge.—A committee, to be called the Electric Powers Committee, consisting of the members of the Gas Committee and Consulting Committees of the Council, has been appointed with plenary powers to promote the Urban District Council's application for a provisional order under the Electric Lighting Acts, 1882 and 1888, in the ensuing session of Parliament, and to employ and consult an electrical engineer for the purposes of the application.

Whitehaven.—Electric lighting business is extending very rapidly at Whitehaven. With the applications now received for current, the plant at the lighting station will be fully occupied during the winter. Five dynamos are already required, with a sixth as a stand-by. In the spring the recent purchase of adjoining property will be utilised for the purpose of extension. Two new boilers and a very considerable addition to the generating plant will be required.

Pembroke.—The Commissioners have arranged the following scale of charges for electricity: for private lighting, 6d. per unit; for power and heat, 3d. per unit. For the hire of meters the rates are: five lights, 1s. per quarter; 10 lights, 1s. 6d. per quarter; 20 lights, 2s. per quarter; 30 lights, 2s. 6d. per quarter; 50 lights, 3s. per quarter; 60 lights, 4s. per quarter; 80 lights, 4s. 6d. per quarter; 100 lights, 5s. per quarter; 150 lights, 7s. 6d. per quarter; 200 lights, 10s. per quarter.

Brighton.—In answer to the application of the British Electric Traction Company for a Board of Trade order to supply electric tramways in Brighton, the Town Council have resolved to undertake the construction and working of tramways in the borough themselves, and have informed Mr. Reason that they do not deem it advisable to entertain the scheme of the British Electric Traction Company. All other companies and persons having submitted proposals for constructing tramways and railways in Brighton will receive a similar reply.

Bermondsey.—The Vestry recently passed a resolution disapproving of certain works proposed to be executed in Bermondsey by the London Electric Supply Corporation. A letter has now been received from the Board of Trade stating that the corporation had appealed against the decision, and that Major Cardew, R.E., had been appointed by the Board of Trade to enquire into the matter. Mr. Cox (chairman of the Electric Lighting Committee), the vestry clerk (Mr. F. Ryall), and the surveyor (Mr. Sumner) have been appointed to represent the Vestry at the enquiry.

Croydon.—The Guardians have adopted a report of the special committee appointed to consider the subject of the advisability of adopting electric lighting for the union establishments from which it appears that while the committee are of opinion that it will be an advantage to adopt electric lighting for the union establishments, yet having regard to the somewhat heavy initial expenditure necessary, they would be glad to have the advantage of the opinion of an independent expert on the whole subject before bringing up to the Board any definite recommendation thereon.

Liverpool.—The Tramway Committee of the City Council have decided to recommend a further outlay of £143,000 during 1899 in the reconstruction of existing tramlines for the extension of the electric trolley system. The estimated cost of the street works, exclusive of overhead or underground electrical equipment, will be: new lines—Aigburth-road extension, £15,660; Croxteth-road, £5,220; Smithdown-road (including Parliament-street), £30,930—total, £51,810; reconstruction—West Derby route, £25,000; Stanley-road route, £22,500; Kensington route, £22,500; Walton route, £21,250—total, £91,250.

Bradford.—A special meeting of the City Council will be held to-day, at which the Gas and Electricity Committee will ask the Corporation to seek power to borrow money for the purchase of motors and electrical fittings, and to enable them to be let on hire; also that two new 300-h.p engine and dynamo combined sets be ordered at an estimated cost of £4,000. The Tramways Committee will propose acceptance of the tender of the Westinghouse Electric Company, Limited, for the supply of eight new motorcars, and of the Brush Electrical Engineering Company, Limited, for the supply of four trailer cars at the price of £238 each.

Huddersfield.—The number of consumers have increased from 720 in September to 727 in October, whilst the lamps connected show an increase of from 48 045 to 49,114. The units supplied in September were 43 046 as compared with 35,931 in the corresponding month of last year. This increase of 7,115 is equal to 20 per cent. The name of the committee is to be changed to the Electricity Committee. An extension of the mains from Westgate corner to St. George's-street is to be made, and the town clerk has been instructed to take steps to enforce the carrying out of the contract by the contractors for the generating plant.

Blackpool.—The Blackpool and Fleetwood Tramway Company have secured a portion of land on the Euston Estate, and directly opposite the terminus, for the erection of a large tram-shed and commodious waiting-rooms with the necessary sanitary conveniences. The company intend to have these buildings ready before the spring traffic commences. The Council intend having the electric lamps for the town as ornamental and neat as possible. The present pillars are to be used, but the top portion will probably

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be entirely new. Arc lamps will be erected on the promenade, and at various points in the town where the traffic is greatest.

Bury St. Edmunds.—The *East Anglian Daily Times* reports that the Local Government Board have declined to receive a deputation from Bury St. Edmunds as to the reopening of the question of electric lighting. It may be remembered that after holding a public enquiry the Local Government Board decided not to sanction the borrowing of a loan of £20,000 for electric lighting purposes. A modified scheme was suggested, but it did not find favour with the Town Council, who reverted to the original scheme. In the hope of urging its advantages, the deputation had been appointed with a view of obtaining an interview with the Local Government Board.

Hammersmith.—The special committee of the whole Vestry *re* the application of the London United Tramways, Limited, for consent to use a system of electric traction, reported to the meeting on Wednesday last that, before the Vestry was prepared to consider the application of the London United Tramways, Limited, for consent to the use by the company of a system of electric traction upon their tramways in the parish, the company should, without prejudicing any future action of the Vestry, undertake to pay to the Vestry the amount of the expenses incurred in opposing their Bill in the last session of Parliament, and that the company deposit plans with the Vestry showing the system proposed to be adopted.

Warwick.—The *Warwick Advertiser* says the British Electric Traction Company has taken over the Southport and Birkdale tramway lines with a view of introducing electric traction, and the Southport newspapers are very enthusiastic about the change. They speak as to improved means of communication being of vital importance to the continued prosperity of the town. The Southport Corporation has reported in favour of the trolley system, and it is anticipated that the traffic will be quadrupled by the reduction of fares and the rapid service. The fact is of local interest because the same company has offered to purchase the Warwick and Leamington tramway, and the matter is still under the consideration of the local authorities.

City of London Electric Lighting Company, Limited.—The return of gross revenue from supply of electricity only during quarter ended Sept. 30, 1898, just issued, states the gross revenue from public lighting as £3,196 under the new scale, compared with £3,146 in the corresponding quarter last year under the old scale. The gross revenue from private lighting, etc. (less allowances to customers), was £23,705, against £21,978; giving a total of £26,901, against £25,124; and showing an increase of £1,777. The equivalent of 8-c.p. lamps connected on Sept. 28, 1898, was 334,573, or an increase during quarter of 12 873; the equivalent on Sept. 29, 1897, was 278,162, giving an increase during corresponding quarter last year of 7,264.

Llandudno.—Mr. A. Dickenson, engineer to the light railway company, has written to the Urban District Council for a definite and early reply as to whether the Council intended to supply electrical energy to the light railway. He said it was impossible to proceed with the work of the company until the Council had decided this matter, and the company were anxious to do the road-work as early as possible. It is stated that if the Council supply the electrical energy it will necessitate the erection of new buildings at an outlay of £10,000, while under the agreement with the company if the Council do not supply the electricity they are entitled to £500 a year wayleave from the company. A final reply is to be decided upon at the special meeting this week.

Barrow.—A special meeting of the County Council is announced for Nov. 18 to take into consideration an intimation from the liquidator (Mr. H. B Francis) to sell the undertaking of the tramways company to the British Electric Traction Company, Limited, for £22,750, and also to consider and determine whether they will require the Barrow Tramways Company, Limited, to sell the tramways to the Corporation. The following resolution of the General Purposes Committee will also be considered: "That in view of the uncertainty whether tramways 17 and 18 are comprised in the offer under consideration, and the inability of the Corporation to obtain definite information from the vendors on this head, this committee cannot recommend the Council to make an offer of £22,750 for the purchase of the tramways undertaking."

Glasgow.—Ten new double-deck cars are to be built; they are licensed to carry 55 passengers each. A somewhat serious mishap occurred to one of the single-deck electric cars on the recently-opened Glasgow electric car route. The car was proceeding up the steep incline when, it is supposed owing to the slippery nature of the streets, the wheels failed to grip the rails. The result was that the car backed down the hill for some 20 yards, almost running into an ordinary traction tram which was following, before the brake action could bring it to a standstill. Another accident was caused by the breaking of a trolley arm, which fell down on the street. As the connection broke there was a vivid flash. There were about 20 passengers, all men, on the top of the car, and several, including women and girls, inside, but nobody was hurt.

Tottenham.—At the last meeting of the Urban District Council the clerk reported that by Section 3 of the Electric Lighting Act no application of a local authority for a provisional order could be made except in pursuance of a resolution passed at a special meeting of the Council after a month's notice. This course, therefore, would need to be adopted, but he had in the meantime given notice to the Board of Trade that the Council intended applying, and to the companies who had given the Council notice of application that the Council were going to oppose them. In reply to Mr. Ward, he said the Board of Trade could grant an order to anyone applying without the consent of the local authority, but in such case they had to report to Parliament on the subject, and he had never known it to be done. Mr. Ward said it had been done in the case of Guildford.

Extension of Premises.—In consequence of the increasing demand for telephones of their manufacture, the General Electric Company, Limited, have found it necessary to extend their premises very considerably. They have therefore taken over the premises at 92, Queen Victoria-street, and have opened them as a telephone department, where they will stock a large number of those instruments and their accessories, so as to enable them to supply from stock any orders they may receive. In this they will be backed up by their works at Manchester, where another wing has recently been added, and more room will be available for manufacturing telephones. The company inform us that though they do not undertake the installation of telephones, they will always be ready to favour their clients with any advice or give them any assistance they can to enable them to tender.

Drumcondra.—A difficulty has arisen with regard to the laying of electric tramlines through the village of Glasnevin. It appears from the plans that the space left for the purposes of traffic between the faces of the tramcars and the kerbstone fronting his premises would be only 11ft., and a resident wrote to the Commissioners that this would interfere with the accommodation for carts to and from the markets. As these carts usually stopped at his premises, as a resting place, the new arrangement would interfere with his business, and, in his opinion, the larger space of 13ft. would be necessary for the traffic at this point. The Board most considerately gave directions for a letter to be addressed to Mr. Wm. Anderson, secretary of the tramway company, with the view of ascertaining whether these wishes could be met with, otherwise the tramway will have to be given up, or the market carts will have to find another resting place.

Middleton.—The Middleton light railway scheme came before Sir Courtenay Boyle and Sir Thomas Blomfield, of the Board of Trade, on Thursday last week for confirmation. The scheme, which is promoted by a London syndicate, with Sir Charles Rivers Wilson at its head—viz., the British Electric Traction Company—is to construct an electrical tramway or light railway, with Middleton as centre. The tramway will commence at the Three Arrows public-house, on the Middleton-road, and at Middleton branch off to Castleton on one fork, and to Chadderton and Oldham on the other. With regard to the Oldham part of the proposals, it was agreed that the company should have power to construct the line, but should not exercise it for a period of two years. In the meantime the Corporation of Oldham intend to bring in a measure for power to construct a line of its own. On the points concerning the other districts the decision of the Board of Trade was reserved.

Gateshead.—The County Borough Council have consented to the grant by the Board of Trade to the Electrical Power Distribution Company, Limited, of a provisional order subject to the company carrying out the proposal made by them, and to the insertion in the provisional order of certain clauses safeguarding the interests of the Corporation. The company undertake to pay all expenses of the Corporation in connection with the promotion of the provisional order, and agree to supply current at the rate of 2d. per unit for public and 2½d. for private lighting after the first hour, for which 7d. will be charged. This covers free wiring, fittings, and first cost of lamps. In flats and artisans' dwellings the charge is to be a uniform one of 6½d. per unit, or by coin-fed meter. This also includes free wiring and meter rent. For power purposes 2d. per hour after the first hour at 7d. would be charged; this includes motors and wiring. The Corporation is to have the right of purchase after 13 years at two years' notice at a valuation made by independent valuers.

London County Council.—At the meeting of the Council held on Tuesday last, it was decided to appoint a head of their new tramway department under the style of chief officer of tramways at a salary of £1,500 per annum. A recommendation to make more stringent regulations with regard to cinematograph performances was referred back to committee. A notice from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth order, 1892, of intention to lay mains in the parish of Streatham was disapproved of. Notices from the same company of intention to lay low-tension and power mains along Chadwell-street and along and across Arlington-street, and notices from the Notting Hill Electric Lighting Company, the Metropolitan Electric Supply Company, the St. James's and Pall Mall Electric Light Company, the House-to-House Electric Light Supply Company, and the London Electric Supply Corporation of intention to lay mains in various streets were agreed subject to the usual conditions.

Dudley.—Agreements have been exchanged between the Town Council and the British Electric Traction Company, Limited, allowing the latter to enter into the borough for the purpose of reconstructing the tramway from the depôt in the Birmingham-road to the borough boundary at Hartshill for electric traction. The company have nearly completed the reconstruction of the tramline from Brierley Hill to Stourbridge. It appears that the tramway has been sold to the company for something like £45,000. At a special meeting on Monday the Mayor said the Corporation might work the electric lighting order themselves or adopt the alternative policy of leasing the order for 10 years, which was a course many corporations had adopted, and had its advantages and disadvantages. He suggested that they should advertise for offers to take over the order for 10 years, and that if they found the terms offered were not sufficiently remunerative the Corporation carry out an electric lighting scheme of their own, which, he was convinced, would ultimately be a great financial success.

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Ealing.—At the last meeting of the Council, the Electric Lighting Committee recommended the appointment of a sub-committee to visit various new electric lighting stations within the London area with a view of obtaining information on the best and most up-to-date plant in order to cope with the probable extra business in the future. Also, that monkey-climbing apparatus be fitted to all new arc lamp-posts erected. Since the last meeting applications have been received for 449 8 c.p. lamps to be connected, making a total number of 19,022 8-c.p. lamps; of this number, 18,276 are connected to the mains. In reference to the accounts, the Chairman said he considered them exceedingly satisfactory, for they showed that the net loss for the last year was under £500, and if the Council had this time—as in the past—included in the accounts the saving on the gas bill, a clear profit would have been shown. The accounts fully bore out his original expectation that there would be a loss for the first three years, and that the business would then prove remunerative. The Surveyor said that since the Electric Lighting Committee's report had been prepared, they had had applications for 400 more lights.

Gourock.—At the annual meeting of ratepayers, Provost Steel made a statement relating to electric power in connection with the tramway system between Port Glasgow, Greenock, and Gourock. He said that there must be some decided change in connection with the whole system. There was a proposal, likely to be carried into effect, for a Bill to be lodged before the next session of Parliament for the purpose of enabling a company to lay an electric tramway from Port Glasgow to Ashton. The sum calculated to be expended on it was something like £200,000. Now, he believed that no one would expend a large sum of money on the Greenock and Port Glasgow sections without also getting a connection with Gourock. The Greenock authorities had in a sort of indefinite way put it that they might be prepared to go on with an electric tramways within their own boundaries, and they had asked the Commissioners if the Gourock people would be prepared to go on with the tramway within their bounds, the lease of which would expire in two years. His impression was that it would be foolish to risk expending, say, £20,000 in Gourock on electric tramways, and it was very problematical if it could be got to pay; but it might pay in connection with, and as a feeder to, a larger scheme, and help to raise the returns of the company of Greenock and Port Glasgow systems.

Hull.—The following interesting report on tenders for rolling-stock has been adopted by the Corporation: "Motorcars for 51 passengers (45 cars required): The Westinghouse Company's tender appears to be satisfactory. They offer the choice of Brill or Peckham trucks, and are willing to supply cars with bodies partly of one make and partly of another, and are further willing to adopt any improved design of trolleys which may be placed upon the market before a time to be agreed upon. They will also supply chilled-iron wheels in place of the steel wheels specified at a reduction of £10. The specifications for the car bodies do not indicate any difference in value between the several makes, but the reputation of the Brill and Milnes cars is somewhat better than that of Brush cars. The tender of Messrs. Warburg, Dymond, and Co. is somewhat lower than the Westinghouse Company's tenders for Milnes and Brill cars, but they submit no specification, and neither the motors nor the cars offered are in use in this country, and we have not been able to obtain any definite information with regard to them. We therefore beg to recommend the acceptance of the Westinghouse Company's tender, subject to the suggested conditions with regard to the trolleys. We further recommend the selection of the Brill truck, and that 30 of the cars be fitted with chilled-iron wheels, and we suggest that the car bodies be divided amongst the different makes offered, in the proportion of Brush 30, Milnes 10, and Brill 5. The accepted tender is at £522. 10s. for Brush bodies, £536 for Milnes bodies, £586 for Brill bodies, the motors in all cases being made by the Westinghouse Company. Double-deck trail cars for 52 passengers (20 cars required): There appears to be nothing to choose between the designs of the lower-priced cars offered. If Messrs. Siemens Bros. do not object to supply trail cars without motorcars, we beg to recommend that their tender be accepted for 10 by the Electric Railway Carriage Company, and 10 by Messrs. Milnes and Co. Failing this arrangement, we recommend that the Westinghouse Company's tender be accepted for 20 Milnes cars. Siemens Bros.' tender was at £155 for cars built by the Electric Railway Company, and £210 for Milnes cars. The Westinghouse Company's tender was at £215. Open trail cars (five required): None of the designs offered seem to meet the requirements very well, and we recommend that the consideration of these tenders be deferred. Sprinkling cars (two required): The Westinghouse Company's tender (£336 per car) is the lowest, and we recommend its acceptance, subject to such alterations as we may require being made in the details. Traversing platforms: It is uncertain whether these will actually be required, and we, therefore, recommend that the consideration of these tenders be deferred. Overhead travelling crane: Messrs. Parsons and Sons provide girders of insufficient strength, and Messrs. Carrick's lower tender provides for rolled girders which are not suitable for the work. Messrs. Carrick's higher tender (£228) provides for a crane superior to that offered by Mr. J. Hitchen, and we beg to recommend the acceptance of their tender." On the same minutes was a recommendation from the engineers for the provision of three spare ways for underground cables on the Anlaby-road, the cost for the power station being about £400. The minutes of the Tramways (Deputation) Sub-Committee refusing to assent to the proposed tramway from Hull to Hessle, which a London firm had proposed to construct, have been confirmed.

PROVISIONAL PATENTS, 1898.

October 17.

21785. A mercury contact for automatic switches or for "knock-over" switches. Edward Price, 18, High-street, Portsmouth.

21829. Improvements in incandescent electric lamps. Jules Edgard de Marcay, 45, Southampton-buildings, Chancery-lane, London.

21835. Improvements in storage batteries. William Joseph Still, 4, South-street, Finsbury, London.

21841. Improvements in the armatures of multipolar dynamo-electric machines. Siemens Bros. and Co., Limited, Robert Dumas, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21843. Improvements in electrical safety fuses. Herbert Cecil Hodges, 18, Southampton-buildings, Chancery-lane, London.

October 18.

21865. Improvements in the manufacture of zinc oxide. Sherard Osborn Cowper-Coles, Grosvenor Mansions, Victoria-street, Westminster, London.

21866. Mechanical music instrument with tune combs and interchangeable discs provided with electric-carbonic acid or other motive power. Ludwig Hupfeld, 45A, Market-street, Manchester.

21906. A new or improved switchboard or frame for electro-physical experiments. Anton Skrobanek, 102, Burdett-road, London. (Complete specification.)

21941. An improved electricity meter for registering the amount of current consumed on direct or on alternating current circuits. Frederick John Beaumont, 166, Fleet-street, London.

21943. Improvements in electrical contact breakers. Reginald Haddan, 18, Buckingham-street, Strand, London. (The Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

21944. Improvements in multiple electric switches. Owen David Lucas, 37, Essex-street, Strand, London.

21947. An electric winch suitable for ash hoists and such like appliances. Siemens Bros. and Co., Limited, and Ernest Holmes, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21961. Improvements in electric arc lamps specially suitable for projectors. William Morris Mordey, 46, Lincoln's-inn-fields, London.

October 19.

21974. Improvements in the electro-deposition of metals. Sherard Osborn Cowper-Coles, 39, Victoria-street, Westminster, London.

21985. A new and improved screwless casing for electrical wires. Jerome Henry Kraus, 13, Lord-street, Middlesbrough-on-Tees.

21997. Improvements in or relating to the reflector fittings of incandescent electric lamps. Walter Simpson, 55, Market-street, Manchester.

22027. Improvements in and relating to electricity meters. Percy Wilbraham Northey and the Electric Motive Power Company, Limited, 74 Caistor-road, Balham, London.

22036. Improvements in electric arc lamps. Hubert Hallam Bigland, 6, Bank-street, Manchester.

22037. An improved machine for wrapping thread, silk, and other workable materials around wire rod or cord lengths; especially applicable for wrapping electrical conducting wire. William Phillips Thompson, 11, Burlington-chambers, New-street, Birmingham. (Joh Schmidt, Germany.)

October 20.

22046. Improvements in electrical regulating resistances. Frederick Hagger Headley, Elm Cottage, St. Austell, Cornwall.

22070. Improvements in and relating to galvanic and other batteries. Charles Levetus, 50, Wellington-street, Leeds.

22071. Improvements in safety devices for use with electric cables. John Ambrose Fleming, The Electrical Laboratory, University College, Gower-street, London.

22079. Improvements in carbon-holders for dynamo-electric machines or motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert L. Rohrer, United States.) (Complete specification.)

22080. Improvements in protecting static voltmeters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

22081. Improvements in means for adjusting the reluctance of magnetic circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

22085. Improvements relating to electric railways. Charles Henry Myers, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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22082. Improvements in trolley cars for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoener, United States.) (Complete specification.)

22096. Improvements relating to electric storage batteries. Henry Clay Bull, Frederick George Bate, and Barnard Alfred Spaull, 6, Bream's-buildings, Chancery-lane, London.

22115. Improvements in galvanic batteries. Elenore Baresch, Rosa Maria Anna Baresch, Elenore Maria Tosler, and Wilhelm von Zabern, 46, Lincoln's-inn-fields, London.

OCTOBER 21.

22130. Improvements in electric railways and tramways. William George Heys, 70, Market-street, Manchester. (Jean Jacques Heilmann, France.) (Complete specification.)

22165. Improvements in electric light message or advertisement indicators. Benjamin Samuel Weston, 5, Parkholme-road, Dalston, London.

22171. Improvements in insulating devices for the electrodes of accumulators. Jacob Heinrich Graeber and Henri Tobler, 70, Chancery-lane, London. (Complete specification.)

22181. Improvements in electrical conducting mains. John Somerville Highfield and John McIlvaine Cater, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22183. Improvements in electric arc lamps. Walter Claude Johnson and Adolph Wunderlich, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22190. Improvements in joint-boxes and switches therefor in connection with concentric systems of electrical conductors. George Wilkinson, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

OCTOBER 24.

22223. A phosphorescent button or indicator for use in connection with electric light switches. Walter Bowness Benns, 115, St. Vincent-street, Glasgow.

22238. New or improved means for preventing the breaking of the cords of electric incandescent lamp holders and lamps. Thomas Smith Shevling, 104, Colmore-row, Birmingham.

22240. Improvements in automatic electrical cut-outs. August Eckstein and Edward Stanley Shoults, Peel Works, Silk-street, Salford, Manchester.

22252. A telephonic apparatus for use on vessels for determining the position of bodies moving outside of same. Mario Russo D'Asar, 55, Chancery-lane, London. (Complete specification.)

22259. Improvements in or connected with electric arc lamps. Frederick John Borland, 40, Chancery-lane, London.

22261. Improvements in methods of and means for manufacturing metal tubing, and in utilising the heating effect of electrical energy in connection therewith. Elias Elkan Ries, 4, West 115th-street, New York, U.S.A.

22282. Improvements in electric traction, especially applicable to tramcars. William Aubert, jun., 22, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

22978. Fusible cut-out for electric lighting and the like. Peschek.

24651. Electrodes for primary and secondary batteries in chemical cells. Fabian.

25061. Switches for electric motors. Turner, Turner, Turner, and Aveyard.

25183. Brackets, chandeliers, electroliers, and the like. Darrah and Gibson.

25434. Trolley-wire hangers for use in overhead lines of electrical railways or tramways. Dawson.

25546. Topophones or other sound-receiving instruments. Thorne.

26057. Porous cells or receptacles for galvanic batteries. Bair.

27970. Dynamos and motors. Smith. (Date applied for under International Convention, May 3, 1897.)

28242. Negative plates for secondary batteries. Dujardin.

1898.

13273 Systems of electrical distribution. The British Thomson Houston Company, Limited. (Steinmetz.)

15360. Electrically-heated rolls for drying paper or fabric, and for similar purposes. Snow.

15430. Diaphragm for electrolytic apparatus. Thompson. (Langguth.)

16834. Means for the automatically regulated charging of electrical accumulators. Petersen.

17163. Sound transmitting, recording, and reproducing apparatus, applicable to telephones, gramophones, and the like. Thompson. (Berliner and Sanders.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Oct. 22	3 978	3,678	+ 300	—	—
Blackpool and Fleetwood Tramroad	,, 22	242	—	—	12,681	—
Bristol Tramways and Carriage Co.	,, 21	2,566	2,613	- 47	—	—
City and South London Railway	,, 23	1 024	970	+ 54	16,277	15,521
Dover Tramways	,, 22	184	122	+ 62	6,984	—
Dublin U.T., elec. cars	,, 21	319	†293	+ 26	8,677	6,174†
Dublin S.D. Electric Tramways	,, 21	647	493	+ 154	16,907	11,735
Halifax Corporation Tramways	,, 19	222	—	—	4,445	—
Liverpool Overhead Railway	,, 23	1,376	1.335	+ 41	—	—.
South Staffordshire Tramways	,, 21	638	664	- 26	26,559*	26,848*

* Receipts since Jan. 1. † Horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	15½-16½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10-10½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	16-17
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	2-2½
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9½-10½
——	6	5½ 6½
—— Pref. Half-Shares	1	1½-1½
—— " "	5	4½-5
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23-24
—— 90,001-100,000	10	22½-23½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	50	70-72
—— Ordinary	3	2½-2½
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co. Ltd.	10	12½-13½
—— " " No. 80,000 40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1½ 2
—— 5 per cent. Debentures	-	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	126-130
—— Preference 5 per cent. Stock	100	140-146
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-103
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	5	2½ 2¾
—— 7 per cent. Cumulative Pref.	9	2¾-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	⅜ ½
Elmore's Wire Company	1	1½
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	8½ 9½
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7½-8½
London Electric Supply, Ordinary	5	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-6½
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Electric Lighting Company, Limited	10	15-16
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7½-7¾
—— £4½ Shares, New	4½	6½-7
Oriental Telephone and Electric Company	1	⅛-¼
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2½-2¾
St. James's and Pall Mall, Limited, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	104-107
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	110-111
Westminster Electric Supply, Ordinary	5	14½-15½

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NOTES.

Royal Institution of Great Britain.—The general monthly meeting of the members of the Royal Institution will be held on Monday, Nov. 7, at 5 p m.

Royal Engineers (Electrical Engineers) Volunteers.—Enrolment of men into this corps recommences this month. The headquarters are open between 7 and 8 p.m. on Mondays and Thursdays.

Institution of Junior Engineers.—The members of this institution will, on Saturday, Nov. 12, at 3 p.m., pay a visit to the King William street station of the City and South London Railway extension works.

The Institution Dinner.—The annual dinner of the Institution of Electrical Engineers is announced for Wednesday, Dec. 7. It will this year be held in the Grand Hall of the Hotel Cecil. An early application for tickets is asked for.

Electric Mining Plant.—Mr. L. W. de Grave, of Derby, delivered a lecture last week at Ashby-de-la-Zouch on "Recent Practice in the Design and Construction of Electric Mining Plant." There was a fairly large gathering of colliery officials and miners present at the lecture, and they manifested great interest in the subject.

Physical Society of London.—At the next meeting of this society the following business will be transacted: (1) Discussion of Mr. A. Campbell's paper on "The Magnetic Fluxes in Meters and other Electrical Instruments," to be opened by Prof. W. E. Ayrton, F.R.S.; (2) a paper will be read by Prof. W. B. Morton, M.A., "On the Propagation of Damped Electrical Oscillations along Parallel Wires"; (3) Dr. R. A. Lehfeldt will read a communication on the "Properties of Liquid Mixtures."

The Franklin Institute of America.—We notice from a circular which has reached us that the Franklin Institute of America is asking its members to form an endowment fund. The circular says that it is of the utmost importance for the future prosperity and progress of the institute that a substantial addition to its annual revenues be acquired, not only to provide income sufficient to carry on the present work, but to enable it to extend this in other directions. The Board hope that the members will respond generously to this appeal.

Electric Light at Hamburg.—The central station at Hamburg shows a remarkable growth since its establishment five years ago. In April, 1894, the lamps and motors connected to the mains were equivalent to 27,000 lamps of 16 c.p. At the end of June, 1898, the connections had increased to the equivalent of 163,277 lamps, made up as follows: 107,324 incandescent lamps and 2,636 arc lamps, taking 904,250 watts; 759 motors of 2,313 h.p. If all motors and lamps were on at the same time, the load would be about 8,160 kw. The network of mains comprise some 560 miles of lighting and 75 miles of traction cable.

New Book.—We understand that Messrs. Archibald Constable and Co. will publish in November "The Life of the Late Sir Charles Tilston Bright, C.E, M.P.," wherein is included the story of the first Atlantic cable, the first telegraph to India and the Colonies, and the early land telegraphs of the United Kingdom. This work is written by Mr. E. B. Bright and Mr. Charles Bright, F.R.S.E., brother and son respectively of the subject of the memoir. The price, which before publication will be two guineas net, will be raised after the date of publication to three guineas.

Books Received.—We have received the following books: "Gas and Petroleum Engines," by A. G. Elliot, from Messrs. Whittaker and Co.; "Electricity Made Easy," by E. J. Houston, Ph.D., and A. Kennelly, Sc.D.; "Algebra Made Easy," by the same authors; "A Pocket Electrical Directory," by E. J. Houston, Ph.D.; and "The Interpretation of Mathematical Formulæ," by E. J. Houston and A. Kennelly, from Messrs. Swan Sonnenschein and Co.; "Railway Block Signalling," by James Pigg, A.I.E.E., from Messrs. Biggs and Co.; and "The Telephone System of the British Post Office," by T. E. Herbert, from Messrs. Page and Pratt.

Aid to Technological Classes.—The Technical Education Board of the London County Council signifies that it is prepared to receive applications from the committees conducting technological classes (not including either polytechnics or evening schools connected with the Education Department) within the administrative county of London for aid toward making the instruction imparted under their direction more practical and efficient. The aid, if granted, is to be for one session only, and shall imply no responsibility (moral or other) on the part of the Board with reference to future sessions. Full particulars of the conditions under which such aid will be granted may be found in the *London Technical Education Gazette* for October, 1898.

Transmission of Letters by Electricity.—The advantages which would accrue to a system by which packets of letters could be transmitted through tubes somewhat after the manner already adopted, in certain instances, but using electrical instead of pneumatic power, are obvious enough. Mr. MacGurty has constructed a small tramline, about two miles in length, along which he can easily run an electric car at the rate of 240 miles an hour, or four miles a minute. Such railroads, it is suggested, should be built preferably above ground, with stations at frequent intervals, each station being in charge of an electrician, who would receive the whole or part of the contents of the car, and also be in communication with neighbouring stationmasters.

Incandescent Lamps and Coal Mine Explosions. In the *Revue Industrielle* of Oct. 29, 1898, Messrs. H. Couriot and J. Meunier describe some interesting experiments in which known mixtures of air and methane, similar to the well-known "firedamp," are introduced into electric incandescent lamps. In the case of 10-c.p. lamps, the current being equal to 0·8 ampere, and the pressure to 45 volts, the filament almost instantaneously ceased to be luminous, except at a certain point where a rupture occurred soon afterwards, accompanied by a minute spark. No explosion was produced. Similar results were obtained with lamps carrying greater currents. The authors explain these results in consonance with a former communication, wherein it was shown that incandescent metallic filaments are powerless to produce explosions even in the most explosive mixtures.

Tramway Traction.—Now that electric tramways seem to have a fair chance of being generally employed in this country, great importance attaches to the selection of the best method of working. Overhead wires possess manifest inconveniences, but underground systems are also not without difficulties, and further possess the disadvantage of not having been so often tried as the overhead system. Mr. Pearson, of New York, in his report to the Liverpool Corporation, states, from personal knowledge, that the cost of construction, employing the overhead system, is £3,426 per single mile, and the total cost of working per car mile, including interest, etc., would be by overhead 4·77d., conduit 5·54d. Special work maintenance per car mile he reported as ·11d. for overhead and ·33d. for conduit. These excesses would make all the difference between loss and profit in working a line in a local town.

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The Self-Propelled Traffic Association.—The opening meeting of the Liverpool and district centre of this association will be held on Nov. 23 at 8 p.m. in the Arts Theatre, University College, Liverpool, when the report on the recent trials of motor vehicles for heavy traffic will be formally presented. The chair will be occupied on this occasion by the Earl of Derby, K.G., president of the centre. We are informed that the report will be published for sale, but that subscribers to the trials' fund and officers of the competition will receive complimentary copies. In regard to the proposed working arrangement between themselves and the Automobile Club of Great Britain and Ireland, the suggested bases of agreement are under consideration by the council of the association.

Electrical Plant, Indo-European Telegraphs, Karachi.—*Indian Engineering* gives an account of the electric lighting plant recently introduced at the above telegraph installation. It appears that for some considerable time past the operators have suffered extremely from the additional heat produced by the kerosine lamps, heretofore used exclusively for lighting the instrument rooms. The cost of the plant laid down was £345. The engine is an 8-h.p. "patent safety oil," made by Hornsby-Akroyd, Grantham, of 210 revolutions per minute. This is coupled to a compound-wound Castle dynamo, made by Holmes and Co., Newcastle-on-Tyne, and generates 50 amperes at a pressure of 100 volts, its speed being 800. It is calculated that the cost of lighting by electricity will be about double that by the kerosine oil. Great advantages are, however, anticipated by the operatives.

United States Patent Office Improvements.—We learn from the New York *Electrical Review* that the United States Patent Office has made a notable improvement in examinations under Commissioner Duell. During the last session of Congress he introduced a Bill to provide for increasing the staff of the office, and since its adoption the work of the office has been brought to an advanced stage. This improvement will considerably shorten the time necessary for applications to be dealt with. It is now proposed to revise the patent laws, and the President has appointed a commission, consisting of Assistant Commissioner Greeley, Mr. Francis Forbes (a patent attorney of New York), and Judge Grosscup (of Chicago), who will report on the matter to the next session of Congress. The proper management of the Patent Office is of so much importance to electrical companies that any change in the laws directly concerns them, and the action of the committee and of Congress will, no doubt, be followed with great interest.

Annual Special Issue of "Electricity."—This forms the annual number of the well-known technical journal. It is, perhaps, unnecessary to say that much useful information is contained, and that the illustrations leave nothing to be desired. Accounts are given of the work of Mr. Robt. Hammond, M.I.E.E., and Prof. A. B. W. Kennedy. The article on the Tees-Side electric tramway will also be read with interest. But what will strike many is a serious review of a book by Mr. Henry Campion, who sets forth the astounding doctrine that the earth has immense openings at the North and South Poles, and that these are connected by a hollow axis. Through this axis, and entering at the South Pole, passes a continuous stream of meteoric matter, emerging or discharging at the North Pole in a state of high incandescence. This incandescence forms the familiar aurora borealis, and hence we are confronted with the novel suggestion that intense heat instead of intense cold exists at the poles. Good for a tale in a Christmas annual, one would say, but that it should be heartily recommended for perusal by a technical journal seems somewhat strange.

Madrid Lighting.—The Spanish papers waste no words whenever they have a chance to attack the stranger within or, for the matter of that, without their gates. It appears that recently the rain flooded the boxes on the mains of the electric lighting company, and the light went out in the theatres. That was bad enough, but it also caused Egyptian darkness in the printing offices of the *Heraldo de Madrid*. Considering how badly Spanish papers are usually printed, we should say that they want all the light they could get to do it in. However, next morning a leader appeared, in which it was said: "Every time four drops of rain fall in Madrid the *magnificent* (the italics are the *Heraldo's*) installation of the English company shines out (?) conspicuously." After describing the damage done and bewailing the frequency of the occurrence, the Government is asked to look into the matter and to compel the company to lay its cables in a more efficient manner, especially as it had managed to formulate its contracts in such a way that no one could claim compensation for any damage caused by these frequent mistakes.

Mr. Preece on Electrical Progress.—Mr. W. H. Preece, C.B., F.R.S., in his inaugural address as president of the Institution of Electrical Engineers, printed elsewhere in the present issue, has given some account of the progress made during his time in various branches of applied electricity. Though much well-deserved praise was given to practical men, it is somewhat to be regretted that no credit was awarded to the mathematicians—Maxwell, Heaviside, Rayleigh, etc.—whose theories, once scouted as ridiculous academic diversions, can to-day be seen to underlie many of the most important and interesting modern electrical developments. As might be expected, Mr. Preece made some references to wireless telegraphy, though the nature of his remark, that wireless telegraphy is as old as telegraphy itself, must have come somewhat as a surprise to those who some time ago heard that wireless telegraphy was coeval with Marconi. Though by no means admitting Marconi to be the originator of wireless telegraphy, we should hardly carry its origin as far back as that of ordinary telegraphy. Perhaps Dr. Lodge might have been consulted with advantage on this point.

Recording Instruments.—Messrs. Elliott Bros. have issued a well got-up catalogue of the recording apparatus which they supply, including some useful information as to the method of using the same. Instruments are made of two patterns—the station pattern, in which the whole apparatus is enclosed in a cast-iron case, suitable for fixing against a wall; and a portable pattern, enclosed in a polished oak case. The instruments are constructed to record on long bands of paper, which are unwound off a spool by the clock and paid into a space in the lower part of the case. The paper is specially prepared in lengths of 65ft., and holes are punched down one edge at a uniform distance of ½in. apart; these engage on pins in a wheel driven by the clock, so that the movement of the paper is very definite and accurate. Unless specially required, the rate at which the paper travels is 1in. per hour. Recording voltmeters, ammeters, and wattmeters for both continuous and alternating currents are quoted, as well as recorders for steam and water pressure. A special recording set is also quoted for electrical tramway work. In this the electrical pressure and current, together with the speed of the car, are automatically registered.

Electrical Ventilation.—Mr. J. W. Hughes, of Montreal, the chairman of the committee on sanitation of the American Health Association, presented a report at the meeting of that organisation held

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at Ottawa last month, in which he remarked that the ventilation of the public buildings is now receiving the attention that its importance merits. The introduction of the power fan, combined with the developments of cheap electrical energy, has opened up a large field of possibilities. Whether the effectual ventilation of private buildings and dwellings will receive its solution from this source is a question. The greatest objection to the introduction of a system of ventilation into a private building that will at all approach the necessities of the case, especially in northern climates, is the greatly increased cost of fuel. Fresh air cannot be introduced, warmed, and expelled at the rate required for an apparatus that will be even approximately effective without a largely increased fuel bill. The question of effective and economical ventilation of dwellings is one presenting many difficulties and large profits to the inventor who can solve it. We are indebted to the *Canadian Architect* for the above abstract of the report.

Portable Testing Battery.—Messrs. Niblett and Sutherland announce a portable battery which should prove very useful to those engaged in testing. The battery consists of 50 special storage cells made up into two sections of 25 cells each. This arrangement is very convenient for recharging purposes. The two sections of the battery may be joined either in series or in parallel by means of a special commutating switch. When connected in parallel the cells may be conveniently charged from a 100-volt circuit. The switchboard is carefully insulated from the cells. The capacity of the complete battery is approximately half ampere-hour. The plates are separated by rigid but porous diaphragms, thus avoiding the possibility of internal short-circuits. Escape vents are provided for any gas evolved. No soldering or lead burning is employed, so that the formation of a bad connection is almost impossible. It is claimed that the total weight of the testing battery is only about a quarter that of the dry cell type commonly in use, amounting only to 14lb. Heavy currents may also be taken from it without fear of damage. Thus an 8-c.p. or 16-c.p. 100-volt lamp can be fully incandesced by it for a considerable time, thereby rendering the battery serviceable for making continuity tests of lighting circuits before the main current is connected. A complete recharge can be effected in from 20 to 30 minutes.

Institution of Civil Engineers' Association of Birmingham Students.—The opening meeting of the session was held on the 27th ult., when the members paid a visit in the afternoon to the engine works of Messrs. G. E. Belliss and Co., then dined together at the Grand Hotel, and assembled again at the Midland Institute at 7.30 to hear the inaugural address of the president, Mr. J. C. Vaudrey, M.I.C.E. After transacting the usual formal business, the President announced that the council of the Institution of Civil Engineers had awarded four Miller prizes to members of the association—viz., Messrs. A. B. E. Blackburn and D. E. Lloyd Davies for papers read before the local association, and C. E. Wolff and Henry C. Adams (the hon. secretary of the association) for papers read before the students in London. The president's address brought forward some of the more prominent features that have marked the history and progress of electrical engineering. Various systems of underground distribution were touched on, the surrounding of the mains with pure bitumen being advocated. The advances made possible by the introduction of the Willans and the Belliss high-speed engines was adverted to. Finally, the students were earnestly advised to gain a general knowledge of engineering, and not to remain satisfied only with the acquisition of knowledge in a special branch of the subject.

A Submarine Arc Lamp.—An airtight arc lamp for submarine work has been invented by Messrs. J. E. Burdick and F. G. Hall, jun., two students of electrical engineering in Yale University. The lamp has been successfully used in the Brooklyn naval yard. The inventors were employed by the United States Government last spring to conduct the work of laying electrical mines in certain harbours on the Maine coast. At that time the young men began to consider the feasibility of using the arc light under water, but owing to the war nothing was then done. Messrs. Burdick and Hall were finally instructed to make experiments for the Government, which they did with great success. An enclosed arc lamp is used, and the outer globe is fitted to the casing above it with an air and water-tight joint. Guard rods protect the outer globe, and the lamp is made strong and compact. Most of the tests made at the Brooklyn yard were at a depth of 25ft., but the lamp can be made to stand the pressure at any depth at which divers ever go. The mechanism of the lamp is similar to that of any other 2,000-c.p. lamp. This lamp will be found of great use in submarine photography. Hitherto, the only electric light used under water for photography has been of the incandescent kind. Much greater depths, especially in muddy water, can be penetrated with the arc than with the incandescent light, so that valuable results in this direction are anticipated.

Wolverhampton Electrical Undertaking.—Four years ago it was stated that the installation in Commercial-road was equipped with plant of the most modern character, which could not be excelled in the kingdom; now we are frankly informed by Alderman Charles Mander that one cause of the breakdown was that they did not possess a single battery worth 2d. "They had a battery that was part of their original plant, and had never been efficient, and 25 per cent. of which would probably never be paid for." Again, it was not very long ago that we were told that the new transmitting station at the Art Gallery would be of considerable service in lighting the town; whilst we now find that "one of the probable causes of this and a previous breakdown was the fact that the Art Gallery station was more or less unsuitable to its purpose, owing to its dampness, so much so that they had to be constantly pumping water from beneath the transformer." How to reconcile these conflicting statements? Perhaps a more pressing question is, how to obtain the £8,000 or £10,000 which is now required to put the installation on its legs again. The further fact of which Alderman Mander informed the Council, that "Wolverhampton is a town which has a peculiar lighting station, of which there are only two other examples in the country—viz., Oxford and Walsall"—where no such effect as that of Saturday night had ever happened, leads one to enquire whether these successive breakdowns are due to the faulty character of the system the Council were led to adopt in the first instance, or to the working of it.

The Post Office and the Telephone.—A unanimous resolution has been passed by the Manchester City Council recording its opinion that it is not desirable to continue the present monopoly of telephone service in the hands of the National Telephone Company. The Corporation does not mind whether the competition, which is regarded as essential to a cheap and efficient service, proceeds from another private company or from the Post Office, or, in the last instance, from the Corporation itself in the form of a municipal exchange. But it is anxious that there should be competition. Under these circumstances a deputation from the Manchester Corporation, headed by Mr. Southern, waited on the Postmaster-General (the Duke of Norfolk) asking his Grace to grant a license to the New Mutual

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Telephone Company. The Duke of Norfolk gave a very emphatic reply to the first point. Under no circumstanees whatever, he said, would the Department grant a license to the New Mutual Company, or to any other new company. That might be taken as final. In reply to a question, the Duke of Norfolk replied that he could give no information as to whether the Post Office itself would erect an efficient exchange to provide the competition required. Further, an emphatic negative was given to the question whether, in the event of the Corporation themselves erecting an exchange, the Post Office would give an extension of the license beyond 1911—the time fixed in the Treasury minute for the termination of the license of the National Telephone Company. No promise could be given as to whether the Post Office would purchase such an exchange at a fair valuation in 1911; the consideration of such a point must be left to Parliament.

Electrical Engineering at the London Polytechnics.—The continually increasing demand for artisans in the various branches connected with the electrical industries creates a growing demand for instruction in electrical technology. Teachers in the subjects comprised under this head can hardly fail to rejoice in the acquisition of students who really have a living interest in what they are being taught, and are not merely "cramming" for some more or less inconsistent system of examination. Only the students to whom we refer need to feel that their instructors are practical men, knowing their wants, and ready to assist them in the acquisition of knowledge which they may afterwards use in their daily avocations. With such students degrees and academic distinction generally count for little; they are in a position to determine from experiment whether the instruction they receive is of the sort needed. Our London polytechnics are largely taught by practical men, and as a natural consequence their successes become more and more striking year by year. For instance, Mr. Schwartz's classes in electrical engineering at the South-West London Polytechnic this year comprise 264 evening students entered in the first three weeks of the session, as against 192 students entered in the first four weeks of last session. It is with satisfaction that we learn that this institution is likely to increase its accommodation during the beginning of next year. The remaining London polytechnics also show a marked increase in the entries in technical classes. If these institutions continually endeavour to keep in touch with the artisan classes, and refrain from imparting only that showy appearance of knowledge which is so temptingly easy to communicate, not only London, but the whole country, will be their debtor.

University College, Liverpool.—In a long letter to a local contemporary, Prof. Oliver Lodge shows how urgently a new physical laboratory is needed at the above college. He details the history of the physical department of the college since he assumed control 18 years ago. It seems that the first practical class (one of five students only) which Prof. Lodge had was conducted in an upper room of a building formerly used as a lunatic asylum, with the apparatus mostly on the floor. Gradually, as the professors expanded into new buildings for their respective departments, the professor says he also expanded by occupying their discarded rooms. He would be loth to leave them now, having in a manner grown into the place, but for two serious drawbacks—viz., want of cleanliness and unhealthiness. He cannot recommend advanced students or graduates of other universities to come and do research work at University College—there is literally no room. He dilates on the material scientific advantages to be met with at Berlin, Strasburg, Zürich, Harvard, and Baltimore and at other places far poorer and smaller than Liverpool. He goes so far as to say that really advanced students, even his own, must migrate elsewhere. The pinch is felt most by the more advanced students. With an average attendance of 26 or 27 students at the present time, and these likely to increase as the session goes on, and in addition a few teachers only able to come on a Saturday, and a large number of evening students on Thursdays, he wonders how they all get fitted in; and then, over and above this number, there are 77 first-year students to be put through a beginner's course of laboratory instruction. These have to be taken in batches. They cannot be taught, nor can they be examined all at once, or in two sets, as in Manchester. At the electro-technical department the pressure is not so severe, but it, too, has to be carefully organised. Altogether Prof. Lodge makes out a good case for new laboratories, but he omits the strongest argument of all—that is, the fact that he and his students have done such good work in spite of the cramped space.

The Police and the Telephones.—It will surprise many to learn that the City police have no sort of telephonic communication. Further, it appears that it is not the fault of the Telephone Company that the numerous police stations in the City and throughout the metropolitan area are without the telephone. The company has done its best to induce the authorities to have the service, but for reasons best known to themselves the said authorities have declined to utilise the privilege. In this particular respect the Metropolis seems to be behind many provincial towns. In some provincial towns it is considered necessary for each constable to have a list of the local telephone subscribers, so that he can, if occasion demands, know where to go to in order to get on to the police office. Strangely enough, a comparable deficiency in the organisation of the London Fire Brigade exists. According to a representative of the *Daily Mail*, who had an interview with an official of the National Telephone Company, although the telephone is to be found in all fire stations, yet every call to a fire sent over the telephone has, under existing arrangements, to go first to headquarters, and then to be retransmitted to the station in the particular district in which the fire has broken out. "There must be a certain amount of delay under such circumstances," he observed, "which might be avoided at a comparatively small cost. For instance, say a fire broke out in the neighbourhood of Fleet-street. The alarm is given on the telephone. The line is cleared at once, but the call has first to go to the Holborn exchange, then to what we call the Hop Exchange, and from thence to headquarters. Then the message to the nearest fire station has to come back *vid* the Hop Exchange, and so it is with other cases when the fire is some distance away. What was suggested to the Fire Brigade Committee was that each of the principal fire stations should be so connected that the one nearest the fire would first receive the alarm. Then there could be no delay whatever. But at the time the plan was not adopted—the cost, about £10 a year for each station, being the factor that stood in the way."

In Darkest London.—We have received a marked copy of the issue of the *St. James's Gazette* for Oct. 15, which contains an article headed "The Lighting of London, the Darkest Capital in Europe." This article reminds us strongly of one which appeared in *London* at the end of July, and which we criticised at the time of issue. The wording of the two articles are so alike that we cannot refrain from giving a few extracts. First, in *London* we read with respect to the way some of the streets are lighted, "We frequently see attempts being made to fix up new incandescent burners in old-fashioned lanterns, tacked on to standards which have lost the perpendicular." On the

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same subject the *St. James's Gazette* says, "In London, however, the condition of the lanterns and columns is truly unsightly. It is not unusual to see a column out of the vertical and the lantern lopsided, and in such a condition as to make it quite useless. Consequently it can only be used with the miserable flickering flame of the neglected gas burner." Both the articles contain similar reflection on the neglect of the London local authorities in the matter of street-lighting, and both commend the suburban authorities as being more go-ahead. When however we get to comparisons between gas and arc lamps for lighting the streets, we find that the facts are, to put it mildly, somewhat misrepresented. When we come to the Welsbach incandescent gas burners, extreme figures as to candle-power per cubic foot of gas consumed are given. As a good example of this is given at the end of the article, the author supposes that 1,000 c.p. is to be used for 4,000 hours per annum. To provide this, using electricity at 3d. per unit, he works out the cost at £55 per annum, which in the face of the prices actually charged for arc lighting is at least 50 per cent. too high. With the new Welsbach burner he considers that the same light could be supplied for £25 per annum, and he assumes, to obtain this figure, that the burner always gives 25 candles per cubic foot of gas. In reading such articles, one is reminded of a popular method of advertising practised by vendors of pills and drugs; but it is only fair to say that the articles in question do not end with the magic word "Advt."

Hargreaves-Bird Process.—The students of alkali manufacture at the Widnes Technical Schools recently visited the works of the General Electrolytic Parent Company at Farnworth, and were received by Mr. James Hargreaves, F.I.C., and Mr. Luke Hargreaves. The general method used in the Hargreaves-Bird process, which was demonstrated on this occasion, is well known, though the theory underlying it is little understood. An anode chamber containing strong salt solution and carbon electrodes is separated by partitions, made from a substance somewhat resembling asbestos cloth, from the so-called cathode chambers. A sheet of copper wire gauze is pressed into the outside of the partitions just mentioned. The novel point about the method is that though the partitions are quite impervious to salt solution under ordinary circumstances, yet when an electric current passes from the carbon anode to the wire gauze, metallic sodium passes through the partition, and is converted into caustic soda by blowing steam into the cathode chambers. This passage of sodium through an apparently impervious partition, though curious, is by no means without a parallel; thus, if a thin iron vessel be made the cathode when a dilute acid solution is being electrolysed, hydrogen will be forced through the iron, and will generate a pressure of several hundred atmospheres in the interior of the vessel. The action in the case of the Hargreaves-Bird process also somewhat resembles the curious phenomenon to which the name "stenolysis" has been given. If a piece of glass tubing, after being sealed at the bottom, is plunged, while still hot, into water, the glass will be filled with innumerable cracks. If this tube be now partially filled with a dilute solution of silver nitrate, and be immersed in a vessel containing a similar solution, then if a silver anode is placed within the tube and a cathode in the outer vessel, on passing an electric current through the cell thus formed, silver will be deposited on the outside of the tube, and will flake off and fall to the bottom of the cathode vessel. Concerning the efficiency of the Hargreaves-Bird process, it was stated that 14 e.h.p. would decompose 15cwt. of salt per week. A simple calculation shows that, assuming the process to continue in action day and night for six days per week, the expenditure of energy will amount roughly to 117 watt-minutes per gramme of salt decomposed. The E.M.F. necessary to decompose a salt solution is about 2·2 volts. Hence it follows that theoretically the expenditure of energy necessary to decompose 1 grm. of sodium chloride is equal to 61 watt-minutes. Consequently, there would appear to be room for improvement in this respect. Considering, however, that the electric current has to pass through a diaphragm which is quite impervious to water, the only surprising thing is that the efficiency of the method is so high.

The Lucigraph. — There are at present several methods of night signalling on the warships of different nations. These systems are all more or less similar in general detail, being usually lights hung in the rigging or on the mast, which are lit and extinguished according to a given code. Merchant ships, however, have not this means of signalling, and even if provided with the apparatus used in the navy a universal code would have to be adopted for all nations. In order to overcome this deficiency, *Electricity*, of New York, informs us Mr. J. W. Haywood, of St. John's, Newfoundland, has invented an apparatus known as the lucigraph, whereby the letters of the international code are to be thrown on a suitable background, and thus made visible at night. The principle on which the lucigraph works is much the same as that of the magic lantern, except that a far more powerful light is used. The apparatus is fitted with a 4in. condenser and a 2in. lens. Between the two, on the side, are a number of movable stencil plates cut to represent the letters of the alphabet and numerals from 1 to 9. Along the top of the apparatus is a keyboard fitted with a double row of keys resembling those on a typewriter. When one of these keys is pressed down the stencil plate corresponding to that key springs up between the condenser and the light, its outline being projected upon any object lying in the path of the light-rays. A sheet of canvas tightly stretched has so far been made use of to throw the letters upon, but this background has not proved satisfactory for several reasons. On shipboard, for instance, it has been found impossible to stretch the sheet sufficiently tight to prevent its being shaken by the wind, resulting in indistinct letters. Another objection, which would undoubtedly prevent the adoption of the lucigraph by the navy, is that the showing of a white canvas on a man-of-war in time of hostilities would draw the fire of the enemy, resulting in the destruction of the background and the interruption of further communication. To overcome these defects the inventor proposes to make use of two canvas-covered arms, resembling those of a windmill, which on being revolved at a high speed would show an apparently unbroken surface on which the letters could be thrown. The distance at which the letters can be read depends, of course, upon the intensity of the light used. It is estimated that a 1,000-c.p. light will throw a 10ft. letter which can be made out without difficulty at sea a distance of two miles. We ourselves feel some doubt whether much improvement would be gained by the adoption of this arrangement. In the first place, we doubt very much whether the letters thrown would be very distinct even at a distance of two miles. Also, in the case of something coming between the lens and the background, only part of a letter might be seen. The system of the revolving arm does not seem much of an improvement on the ordinary stretched canvas, as if they revolved fast enough to take the letter properly they would show a white surface to the enemy, and thus draw their fire, and shots would most likely break the arms. Also it would be difficult to make these arms revolve at the required rate on such a place as the deck or rigging of a ship.

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ANDERSON'S TRAMWAY.

Last week we witnessed a trial of an experimental length, half-a-mile, of tramway line built upon Anderson's system at Leeds. The experimental line is situated in the Harehills-road, is partly on a gradient and partly flat, and

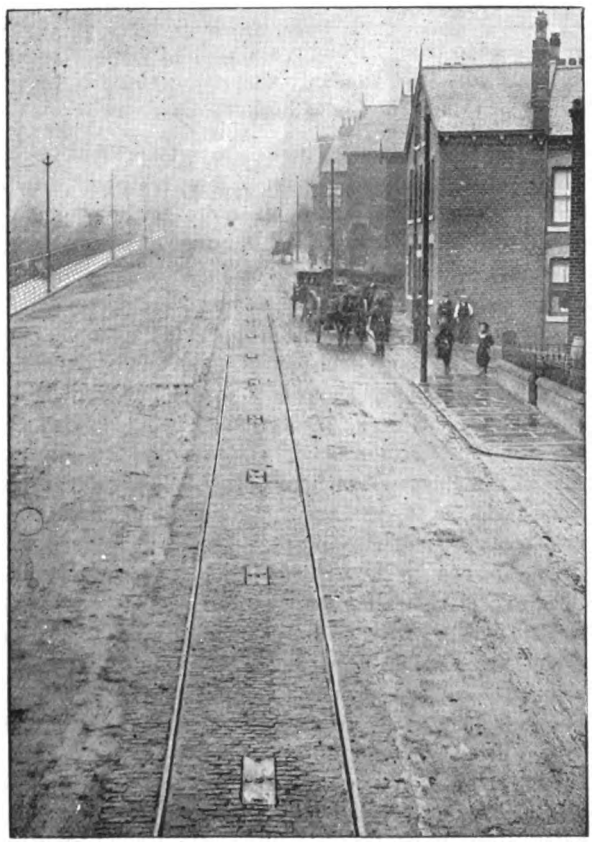

FIG. 1.—View of Track—Anderson's System.

of sufficient length to test any system. The system is an electric-mechanical one, and Mr. Anderson admits his weakness as regards personal knowledge of the electrical parts, and that at the moment these parts are not perfected. It is easy to see, however, that the electrical part presents fewer difficulties than the mechanical. The fundamental ideas in this system are two-fold—first, to get rid of the paraphernalia of overhead systems or of open conduits, and secondly, to cut the supply cable into segments so as to prevent leakage as far as is possible. The attempts that have been made in these directions have been from time described in our pages, and are fairly summarised in Prof. S. P. Thompson's paper to the British Association, given in our issue of last week. We restrict our description for the present principally to the mechanical part of the system only. The line itself presents no very striking feature. The rails used as a return are laid in the usual way, and between them, in the centre of the track, and at intervals of about 17ft., one sees a series of iron plates, with a hole in which appears a peg with its top flush with he plate (Fig. 1). The car carries a conducting shoe, which is suitably fashioned in the first place to come into

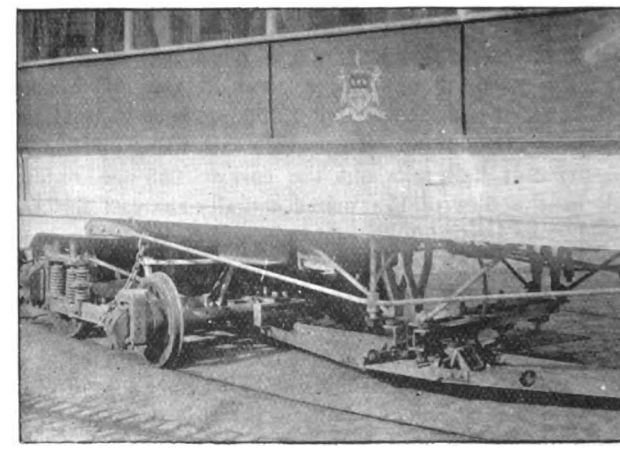

FIG. 2.—Car on Middle of Curve of 30ft. radius. C shows Shoe.

conducting contact with a peg projecting from 4in. to 2in. above the surface of the plate. The contact shoe commences to take current when the peg is at its full height of 4in., and pushes the peg down as the car progresses, till the peg is about 2in. above the plate, and then the peg sinks with a quick break to the flush level. The mechanical mechanism is then required to raise the forward peg to its 4in. while depressing what for the moment may be termed the contact peg 2in. The collector is long enough to make circuit with both pegs for a short time before the back peg breaks contact. The mechanical apparatus is placed in a cast-iron box to which the plate forms a cover. The box is to earth electrically. Between and connecting the boxes are Doulton's three-duct ware conduits, one duct carrying the cable from box to box, the other two carrying the connecting rods to the lever arms in the boxes.

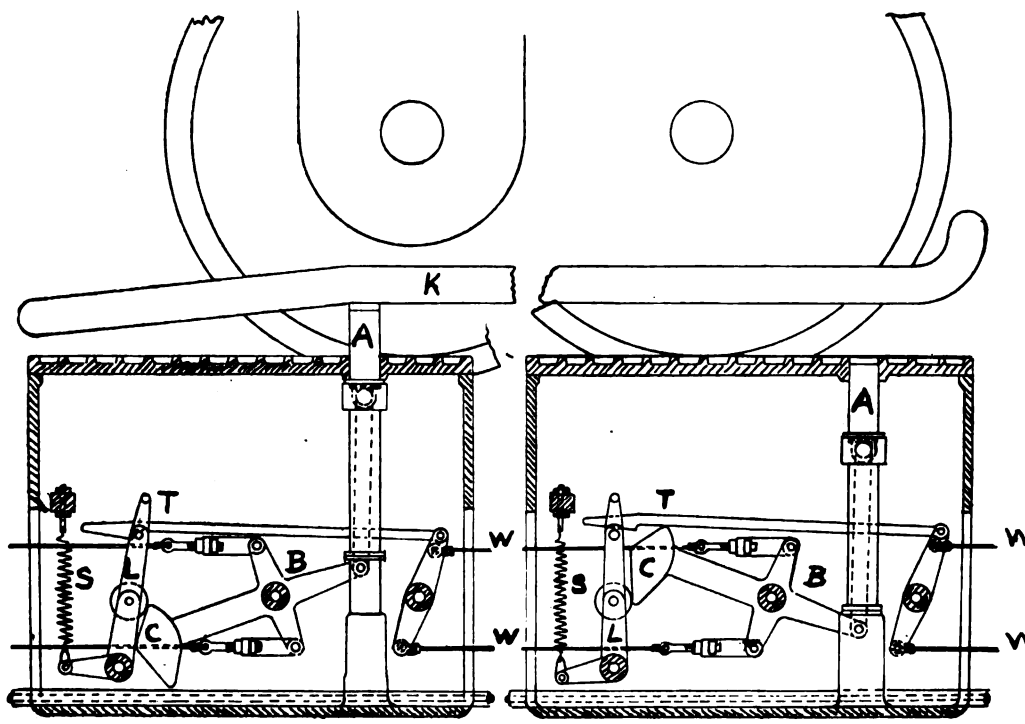

FIG. 3.—Section showing Mechanical Appliances in Anderson's System.

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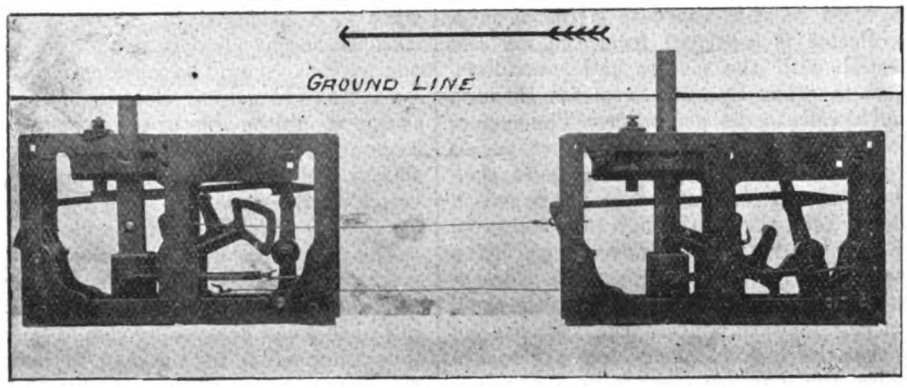
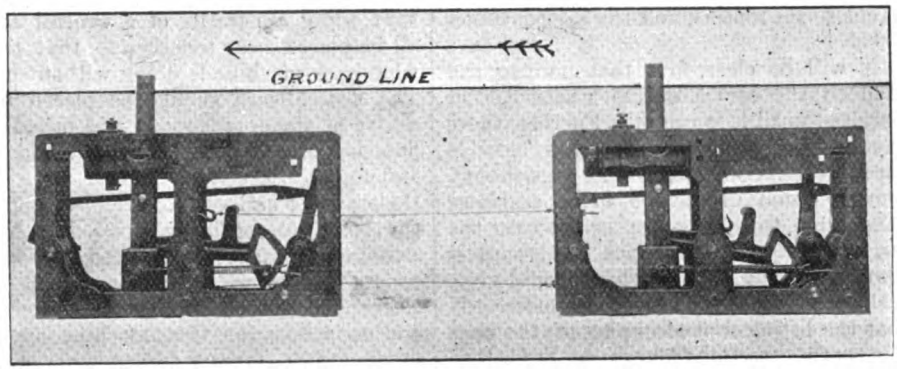
The top portion of each peg is made of phosphor-bronze or some other good and at the same time durable electrical conducting material, and connected to this is a spindle passing through the body of the peg, which is hollow, to a switch arm, fixed to the lower portion of the peg below the box lid, but efficiently insulated from it. As the peg rises, but well after the top portion of it is clear of the lid of the box, this switch arm comes in connection with a fixed brass contact piece mounted on a stoneware frame, which in its turn is clamped into oil-cups so as to ensure the insulation. These contact pieces are all connected with one another and one pole of the source of supply by means of an insulated cable, passing through all the boxes, and the centre duct of the stoneware conduit between the boxes. It is thus evident that as long as any peg is "up," its top insulated portion is in direct connection with the source of supply, but on being depressed its switch arm breaks connection with the contact piece and the next peg forward is in its turn energised. On the under side of the car, which is of the two-bogie type, is mounted a long rigid collector, shown at C in Fig. 2 and at K in section, Fig. 3, constructed of sheet copper riveted to a channel steel frame—the height of this collector above the roadway is such that the pegs when raised will make contact with it,

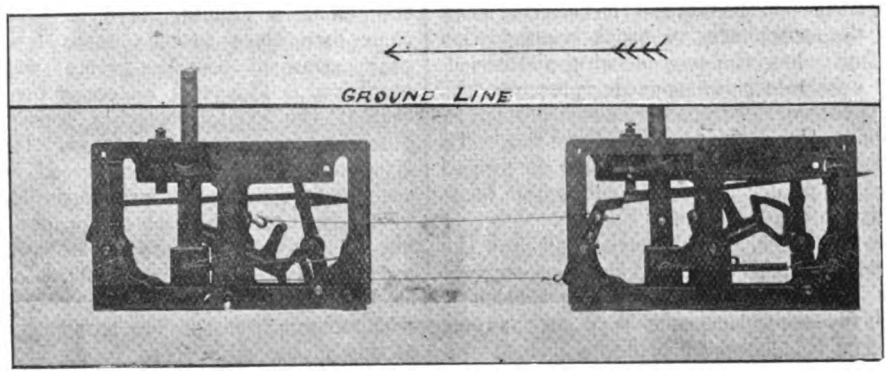
No. 1 Position of Pegs.



No. 2 Position of Pegs.



No. 3 Position of Pegs.



No. 4—Final Position of Pegs.

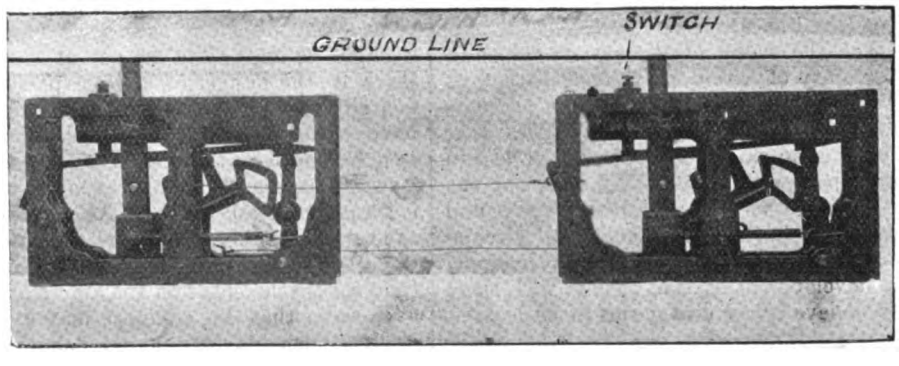


FIG. 4.

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and its length slightly in excess of the distance between two pegs, so that before leaving contact with one, it is already connected electrically with the next forward. The back end of this collector is continued in the form of a long "ramp," having a gradual slant from the level of the collector to within ½in. of the surface of the roadway sets. The ramp is insulated from the collector by a space of some 3in., but to maintain an even pressure on the pegs this space is filled in with alternate strips of mica and brass. The collector is insulated from the car and trucks, but connected with the motors and controllers, the return being, as in other tramway systems, through the wheels and bonded rails to the generator. The system of working is as follows: To start the car the first peg is raised by hand or mechanically. Electric connection is then established from the insulated conductor through the switch and peg to the collector, and thence through the motors to the line. Thus, the car commences to move forward, the slanting ramp presses over the raised peg, pushes it down, and breaks its electrical connection. This action at the same time raises the next peg forward, and as the switches on the pegs are so set that the one on the rising peg makes its connection before the one on the falling peg has broken it—and the collector, as before stated, is long enough to press on two pegs at once for a short time—there is no interruption of current to the motors, and the car continues its progress.

From the above it will be clear, first, that no peg can possibly be raised until the car is over it; second, that no peg can be energised until it is raised. Further, there is no danger of the ramp failing to depress a peg, as it is the weight of the car itself that really acts on the pegs, though a few pounds pressure is found in practice to be ample to do the work; at the same time, in order to get over the difficulty of stones, etc., lying on the track, the ramp is held down by a powerful spring action which would give, rather than raise the car before any such obstacles. It should be stated that the lifting and dropping of the pegs is a spring action in both directions (shown by S, C, B in sectional drawing), the dead point being when the peg is half up; this has the effect of maintaining a continual gentle pressure between the peg and the collector when up, and of causing the switch arm to break contact with a sharp spring motion when the peg is being depressed. There can be no uncertainty as regards pressing the peg home, when it is considered that the lowest portion of the ramp is only about ½in. above the top of the box. To enable the car to negotiate curves, the collector is hinged in the centre in such a manner that it is impossible for it to break contact with its peg sideways.

The sectional drawing, Fig. 3, given herewith will show the working of the system. It will be seen that the pressure of the shoe, K, forces down the peg, A, and this motion is transmitted through the connecting rods, W W, to the next box, raising the peg in that box, and bringing it into contact with the forward end of the shoe. The action of the spring, S, cam, C, and lever, B, will be seen from the drawing. The accompanying photographs show the four positions of the pegs (see Fig. 4).

It seems to us that the value of the system depends, firstly, upon the certainty of action of the pegs—that is, on the perfection of the mechanical part of the arrangement—and, secondly, upon the action of the electrical part of the system. There is no valid reason, so far as we can see, why the electrical part should not work well, but the effective combination of the two to stand the stress and strain of working in all weathers and under all circumstances will not be so easy a task as some critics imagine. We shall watch the development of this system with some interest, because we believe it contains germs of success.

Increased Speed in Telegraphy.—General Greely, chief of the American Signal Service, announces in his annual report that two Government officers, Prof. Crehore and Lieut.-Colonel Squier, have discovered a method of increasing the speed of transmission through submarine cables by the sine-wave system. In a recent experiment messages were sent and received over a line 1,110 miles long at a rate exceeding 3,000 words a minute.

CONTROLLING APPARATUS IN CENTRAL STATIONS.

BY R. DUNNING.

The arrangements for controlling the plant in central stations often leave a good deal to be desired. There are switches, valves, gauges, instruments, etc., all over the works, and in many cases there is not a man in the place, from the engineer downwards, who could tell straight off what each belonged to. Now, all the plant in a central station—engines, boilers, generators, steam and water pipes, pumps, etc.—should be considered as one complete machine, a machine for making electric light; and the engineer-in-charge should be able to tell how all the plant is working without having to run about the station. He should be able to feel the pulse of the station, as it were, from the switchboard, so that in case anything goes wrong he may see at once which item of the plant is in fault.

The great idea in a central station should be to make everything as plain as possible in order to lose no time in a breakdown, where every second may be of importance, and to this end everything should be arranged so that it is almost impossible for the men to make a mistake. They should not have to stop to think which is the right switch or valve, but should be able to decide at once.

The switches, of course, are a very important part of the controlling apparatus of a central station. They should all be placed near together so that the attendant can see what each machine is doing without having to move about. The switchboard should be placed near the wall at the centre of the engine-room, and raised some feet above the floor in order that the attendant may see all the dynamos and signal to the engine-driver more easily. No one but the engineer and switch attendant should be allowed near the board on ordinary occasions. All the main machine switches ought to be placed on one board. They are generally arranged on panels. Each panel is numbered to correspond to a machine, and contains the switch, ammeter, and main fuse for that machine, and the dynamos being numbered in large figures, easily seen from the switchboard, there is no fear of the wrong switch being opened or closed by mistake. In alternating-current stations the exciters should have a separate switchboard of their own close to the main board, with the switch gear arranged in the same way, and each switch numbered. This will be easier for the switch attendant than if the exciter switches were arranged on quite a different plan to the main ones. It is important that the attendant should know the speed at which the machines are running, and reliable speed indicators should therefore be attached to each, with the proper speed marked in red; but where alternators are run in parallel the best way is to have a good speed indicator fixed on the switchboard, or close to it, driven by a small synchronous motor supplied with current from the 'bus bars through a transformer, and as this motor will always rotate at the same speed as the alternators, and could be coupled direct to the speed indicator, it is a better arrangement than a separate indicator belted to each engine. It is a bad plan to have switches on or near the dynamos, as in case of a machine burning up it might be impossible to get at the switch; and besides, there is the danger of anyone passing the machine accidentally moving the switch. Of course, where the brushes have to be adjusted by hand, directly the machine is switched in, as in the case of the old open-coil arc machines, a switch on the machine does not matter so much—in fact, it is rather an advantage. All rheostats should be placed as near as possible to the switches they belong to, so that the attendant can adjust the resistance and at the same time watch the effect on the ammeter or voltmeter.

In order that the engineer may know the output of the electrical machinery, and its behaviour at any particular time, recording instruments should be used—each feeder or circuit should be provided with a recording wattmeter at the station end, there should be a recording voltmeter connected to the main 'bus bars, and recording ammeters are very useful on circuits where a constant current is required. These recording instruments are of great use to the engineer; they show him how the plant will respond to a sudden increase of load, and also how the men in charge of the different parts of it attend to their duties, besides

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indicating the presence of faults in the circuits, etc. The switch attendant should know when he opens or closes a switch how and why the particular result follows—not only that a certain result *does* follow a certain movement of the switch, and for this reason a large diagram of the electrical connections should be hung on the wall near the switchboard. The diagram might be drawn on a piece of thin sheet iron painted white, the more important connections being traced with different-coloured paints; it could thus be easily kept clean and alterations made when required. With a diagram of this description, combined with a card of emergency instructions, there should be little fear of a switch attendant making a mistake.

The engineer-in-charge of a central station should be provided with an office close to the switchboard and opening into the engine-room, in order that he may be at hand if anything goes wrong. He should have a set of standard instruments for testing the ammeters, voltmeters, steam gauges, etc., in the station, besides a set of indicators and gear, thermometers, draught gauge, speed counter, etc., for testing engines and boilers. His office should be connected by telephone with the clerk's office and also with the different sub-stations, if sub-stations are used, if not with one or two call offices in the town in order that the lamp trimmers and men working on the mains may report to him when necessary. Telephones to different parts of the station are of very little use; if the engineer can sound a loud electric gong in the engine-room and boiler-house, he will easily be able to give what few orders he requires by its use. Just outside the office a gauge should be fixed showing the steam pressure in the main steam-pipe, another gauge showing the draught in the main flue, and others for vacuum, water pressure, etc., if necessary; these gauges may be recording instruments if it is desired to have a permanent record of the readings.

The steam and water valves are a very important part of the controlling apparatus of a central station, and great care should be exercised in their arrangement and use. All valves in the works, down to ½in. drain valves, should be right-handed ones, as this prevents a great deal of confusion; they should be placed in easily accessible positions (in some stations valves are to be found in every out-of-the-way corner), every one numbered plainly, and in all but perfectly obvious cases they should have brass labels attached showing what they are and what they shut off. All valves ought to be opened and closed and the spindles oiled once a week, and once in six months or oftener the covers should be taken off and the valve seats examined, as it is most important that valves should be tight and at the same time work freely; and yet it is often the case that when a valve has to be closed very quickly, owing to the bursting of a steam or water pipe, or something of that kind, it takes all the strength of two men to close it slowly, thus turning what might have been only a slight accident into a serious breakdown. The engineer should have a diagram in his office showing all the steam and water pipes in the works, with the positions of the valves, which should all be numbered to correspond with the actual ones. This will save a lot of trouble when valves require repairing, etc.

Automatic devices are of very little use in a central station; many have been tried and fresh ones are brought out every day, but the general experience seems to be that they cannot be depended upon for long, although they may work perfectly when new, as the action of rust, dust, and dirt and wear is not taken sufficiently into account when designing these appliances. Besides this, the use of automatic machinery tends to make the men careless, as they get into the way of trusting too much to it, and neglecting precautions which they would otherwise take.

These matters may seem very trivial, but they are really most important to the successful running of a station, and it would pay central-station engineers well to spare no pains in order to make the controlling arrangements of their plant so simple that it would be almost impossible for a man to make a mistake, even in the greatest hurry. At present the majority of central stations are behindhand in this respect, and what engineer is there who could walk round his plant, and if he asked himself, "What would happen if I closed this valve or opened that switch?" could reply without any hesitation in every case? As far as the valves were concerned, he would probably find that he knew nothing about many of them.

INSTITUTION OF CIVIL ENGINEERS.

Presidential Address.

BY WILLIAM HENRY PREECE, C.B., F.R.S., PRESIDENT.

The election to the position of president is the highest possible reward which the institution can give to those who have endeavoured to serve it well and truly. I have often feared that my position as a specialist might have proved a bar to the attainment of my greatest ambition. It has come at last. I am very grateful, and I promise that I will continue to do my very best to merit your confidence and approbation. I am also proud, not alone for the sake of that branch of the profession to which I specially belong, but also because I am a member of the great civil service of this country. Twenty-eight of my 46 years of professional work have been spent in the service of the Crown. I can speak with some authority and experience when I assert that this service deserves a recognition for zeal, industry, and the conscientious determination to do its duty far greater than that usually accorded to it by Parliament, the public, and the Press. The jealousy and contempt so freely displayed for Government work are not justified by results. It is the fashion to decry the public service. It is probably a survival of that old feeling of oppression and dissatisfaction which the ruled always felt towards their rulers. The position is now reversed—the public is the master and the official is the servant. The public servant is not to be coerced by oaths or driven by whips or deterred by scorns. His labours should be sweetened by praise, and his successes acknowledged by a grateful recognition. Two of your vice-presidents belong, and some of your council have belonged, to this service. You, at any rate, are free from criticism, for you have testified to my zeal by giving me the greatest reward you can confer. My successors will be able to drive home the nail I desire to insert in the coffin of the traditional general and false belief in the efficiency of a great and growing public service.

I entered the institution as an associate in 1859, and am now in my fortieth year of membership. It is interesting to see the growth of the institution during that period:

ROLL OF THE INSTITUTION OF CIVIL ENGINEERS.

—	November, 1859.	October, 1898.
Honorary members	25	20
Members	332	1,946
Associate members	—	3,940
Associates	523	320
Graduates	14	—
Students	—	862
Total	894	7,088

The distribution of our 7,088 members over the globe is shown in this table:

DISTRIBUTION TABLE.

—	United Kingdom.		Ceylon and Burma.	South and East Africa, with Transvaal.	Australasia.	Canada, with British Columbia, Nova Scotia, and Newfoundland.	British Possessions—Miscellaneous.	United States.	Other countries.
	—	Non-resident.	India, with						
Hon. members	12	4	—	—	—	—	—	1	3
Members	555	790	162	50	140	45	25	65	114
Assoc. members	970	1,690	350	180	270	30	90	45	315
Associates	175	100	12	4	8	1	2	5	13
Students	275	417	60	20	40	5	20	5	20
Totals	1,987	3,001	584	254	458	81	137	121	465

Roughly, we can say that 71 per cent. are home members, 21 per cent. are colonial members, 8 per cent. are foreign members. It is not alone in numbers that growth is

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shown; it is more so in the business of the engineer. The field of the profession has extended in all directions by the advance of practical science and by a process of evolution and agglutination. The introduction of the steam-engine, the development of the railroad, the invention of the paddle and the screw, and the evolution of the ocean greyhound; the conversion of iron into steel, and the demand for ores; the opening of coal and oil fields, and the production of gas; the sanitation of our dwellings and our towns, and the demand for pure air and pure water; the applications of electricity and the annihilation of distance; the rifling of ordnance, the improvement of explosives, and the armouring of great fighting, floating, moving machines; the enormous growth of manufactures and their distribution over the face of the earth; the pursuit of wealth, the roving propensities of our race, and the industrial competition of nations—have all contributed to break up our profession into separate branches and into individual groups, with their separate organisations and with their independent homes. Thus we have the railway engineer, the mechanical engineer, the naval architect, the mining engineer, the sanitary engineer, the gas engineer, the hydraulic engineer, the electrical engineer, the chemical engineer, the marine engineer, species of one genus—the civil engineer, whose home is in this building, whose institution, like a good mother, tries to keep them all under the protection of her wings, and who is prepared to make any sacrifice to advance the knowledge of engineering, and to maintain the solidarity and reputation of the profession. The engineering conference held by the institution in 1897 was undertaken in the furtherance of this aim, with results so successful as to call for its repetition in the approaching spring of 1899.

Examinations.

Our great European rivals relegate the examination and selection of their engineers to their Governments, but we, under the guidance of our immediate past-president, have taken this load on our own shoulders; not before it was needed, for the competition of highly-educated engineers of other countries was becoming rather too evident. Loss of business is a potent force to effect reform. The reform itself in our case has materially strengthened the credentials of our institution.

Our task has been a difficult one, for while we recognise most fully that the practical training of the drawing office, of the shop and of works in progress are the true school for the engineer, we cannot help thinking that he ought to acquire that knowledge which is the basis of his profession and those exact methods of enquiry and of thought which lead to truthful deduction and to sound judgment, before he can satisfactorily begin his professional experience.

The foundation of engineering is science. Science is not only a knowledge of the facts of nature, but of the development of her laws. It is, in the language of Huxley, organised common sense. The man who determines to practice in the business of applying those facts and laws to add to the comfort and happiness of mankind must know something of the mental tools and weapons that mathematics and logic have placed at his disposal. His mind must be trained to habits of enquiry, and he should know something of the experience and teaching of the past. Hence, the institution, as the tutelary genius of the profession, has established a system of qualifying, not competing, examinations for admission into its ranks; not only to test the education and preparation of those who wish to recruit our numbers, and the qualifications of those who desire to improve their position in our classes, but also to enhance the standing of the modern engineer as the most scientific and advanced of all the learned professions. The result of the first examinations has been highly satisfactory. Out of 24 examined for studentship, three only failed to pass. Of 40 examined for associate membership, seven failed. Of 48 theses submitted in lieu of examination, five only failed to secure a satisfactory report. The popularity of the measure among even the examinees is shown by the entrance of 71 for this last October examination. The examination papers which have been set are by no means of an insignificant character, yet 86 per cent. of marks have been acquired on the whole examination.

Our ancient universities commenced their careers as mind-training establishments, with faculties of theology, law, and medicine. These were called, and still are known, as the learned professions, but subsequently arts was added, from which has sprung all modern science. Engineering as the principal outcome of this faculty has been the mother of scientific progress. A mere university training alone does not lead to invention and discovery. It is contact with the practical world, a knowledge of wants and defects, which excite discoveries and improvements. The modern method of research proceeds by making experiment subservient to hypothesis. Difficulties teach effects, effects suggest causes, a knowledge of causes leads to remedies, and finally to exact science. Practice, the home of difficulty, is thus the nursery of science. The engineer is far in advance of the pure scientist. Smeaton and Watt, Telford and Stephenson, Rankine and Kelvin, Whitworth and Froude, Regnault and Hirn, have established not only the profession of the scientific engineer, but they have laid the groundwork of science itself.

Technical Education.

The engineer extracts matter from the earth and transforms it into purer and more serviceable forms. He finds energy lying dormant or running to waste; he converts it into other active and useful forms. A knowledge of matter and of energy is the foundation of all his actions. This, combined with the power of thinking so as to enable the brain to direct and assist the hand, is the root of what is known as technical training. The modern engineer has immense advantages over his predecessors. He can commence his practical career with a university training, well charged with facts, wanting only that experience which practice alone will give.

There is a fashion in Great Britain for technical education just now. Enormous sums of money are being annually spent on secondary, intermediate, and more advanced education. It is well that it is so. It is well that the country has awakened from its conservatism and apathy, and that it is putting its schools in order. But is it doing so on a true issue, and are we distributing our money through the right channels? Our trade is suffering even in our own colonies from the competition of our Continental neighbours, who are said to be beating us by their technically superior hand labour. It is true we are suffering, but is this the true cause? It is rather from the superior commercial skill of the principals at home and the accomplished polyglot and well-trained traveller abroad, as well as from a financial system that is more moral and more sound than that rampant in England through the gross abuses of the Limited Liability Act of 1862. Our law courts are almost daily the scenes of the exposure of the modern spoiling of the Egyptians. A new industry is designed by some simple, well-devised, and economical process. Capital is required to develop it. In Germany, financial support is readily subscribed by the generous and enlightened policy of its banks. In England we require a syndicate, a pioneer company, and finally an appeal to the public for an enlarged limited company. The financiers, the lawyers, the brokers, as well as the original inventor, have to be satisfied, and this satisfaction grows very much with the state of the money market and the excitement for investment with the public. The industry is established, but with a terribly overloaded capital—overloaded by the harpies who have sprung from the operations of the Limited Liability Act. The same industry could be established in Germany with probably half the capital. Its manufacture would be supervised there with greater skill, and it would be developed as a business by better-trained agents. We are thus fairly beaten on our own commercial preserves.

Our educational methods have begun at the wrong end. We ought to teach the masters first and then the men. Moreover, we have to teach the teachers and those who have control of the purse-strings. The county councils of England are scarcely qualified as yet to discharge the very serious duty of properly dealing with a question so few of them understand—though many of them have tackled the matter manfully, especially the London County Council, through its Technical Education Board, on which a large

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proportion of co-opted experts have seats, who, by supporting existing institutions, have contributed towards the supply of teachers. But how are we to approach the masters? A fault once discovered is halfway to repair. It is difficult to remove the scales from the eyes of the man who has been successful in business and who knows not of his blindness; but the coming generation will be more enlightened, and the future masters better educated.

We are suffering from a lack of competent teachers. A teacher who has had no training in the practical world is worse than useless, for he imparts ideas derived from his inner consciousness or from the false teaching of his own abstract professor, which lead to mischief. In my own experience I have met with very serious inconveniences from this cause. The ideal professor of pure abstract science is a very charming personage, but he is a very arrogant and dogmatic individual, and, being a sort of little monarch in his own laboratory and lecture-room, surrounded by devoted subjects, his word is law, and he regards the world at large, especially the practical world, as outside his domain and beneath his notice. He is generally behind the age. These are not the men for technical institutes. Such teachers should possess the diploma of this institution.

Energy.

The great generalisation of modern days is the principle of the conservation of energy. Energy, like matter, can neither be created nor destroyed. Its form only can be changed. It is in its various transformations that it expends or absorbs work, and thus the engineer has to consider not only the various forms of matter, but the various forms of energy. He has to expend energy on matter in such a way as to supply the wants, improve the comforts, and add to the resources of mankind. He has not only to utilise the waste energies of nature, but he has to economise those that are in use so as to be able to apply them in the cheapest and most effective way. Every branch of engineering is thus dominated by the application of the great principle of work, which means the expenditure of energy, for energy is simply the capacity or property which nature possesses for doing work. The engineer must be an educated man, educated not necessarily so much in the languages, arts, and history of the past, as in the changes and properties of ever-present matter, and the forms and behaviour of never-failing energy—changes and transformations directed by his will, controlled by his knowledge, and applied by his hands. Tredgold's great definition wants modification. It should read, "the profession of an engineer is to apply the great principle of work to the use and convenience of man," and his title should be rather that of *energeer* than *engineer*.

Electricity.

Day by day we are startled with some new development of electricity. We have learned the truth of the aphorism that that which is sure to occur is the unexpected. It is not of arms and of man that I propose now to sing, but of energy in its most romantic form.

A happy accident in early life placed me at the feet of our electrical Gamaliel—Michael Faraday. My boat was launched on the waters of knowledge that flowed from the rocks of nature, opened by the strokes of the magic rod of that great master. The tide was taken at the flood, and having rolled on for nearly 50 years, it has led me to this chair. I learned from Faraday to regard electricity as the result of the play of the atoms and molecules of matter, that it was a mere form of motion, and that its influence through space was due to the existence and operations of a medium—since called the ether. Maxwell crystallised Faraday's views into mathematical language, and deduced the magnificent generalisation that light and electrical waves are of the same kind, moving through the ether with the same velocity, and differing from each other only in degree. Hertz proved the existence of these waves and measured their length, and Marconi has now applied them to the practical purposes of telegraphy. I have carefully watched every new electrical fact wrung from nature's storehouse without ever failing to find a simple mechanical explanation of their cause.

The term "electricity" has even been defined by Act of Parliament (45 Vic., cap. 56, 1882) as that form of energy which we make and sell. It can be measured with the minutest engineering exactness, and its effects are explicable on the simple dynamical and mechanical principles that underlie our profession.

Lightning.

The first practical application of the science of electricity was for the protection of life and property. Franklin in 1752 showed how to secure ourselves and our buildings from the disastrous effects of a lightning stroke. Very little has been done since to improve upon his plan. A lightning rod conference, upon which I served, met in 1878, and its report, published in 1881, remains an admirable and useful standard of reference. The principle advocated by Franklin was prevention rather than protection. If a building or a ship be fitted and maintained with good continuous copper conductors, making a firm electrical contact with the earth or the sea, and be surmounted well up in the air with one or a cluster of fine points, all the conditions that determine a charge of atmospheric electricity and a flash of lightning are dissipated silently away and no terrible discharge is possible. A mischievous and baseless delusion is prevalent that protectors actually attract lightning and may be sources of danger. Every exposed building should be fitted, but a well-protected dwelling-house is the exception, not the rule. Even when protectors are fixed, apathy leads to their imperfect maintenance. Their failure to act is always traceable to the neglect of some simple rule. Carelessness is the direst disease we suffer from. Telegraph and telephone wires which spread all over our towns and country are very much exposed to the influence of atmospheric electrical effects. Every instrument is now protected. Every telegraph pole has a lightning conductor. Accidents are rare, and the system itself is a public safeguard. In some countries, like California and South Africa, thunderstorms are very frequent and very severe, but their effects have been tamed.

The engineer has answered Job's conundrum: "Canst thou send lightnings, that they may go, and say unto thee, Here we are?" in the affirmative. I sat, on June 12 last, in a cable hut on the Welsh coast, near Nevin, with a telephone to my ear, and heard flashes of lightning in Ireland, Scotland, England, and Wales on the same afternoon. The sound emitted by a telephone receiver when a discharge takes place in the neighbourhood of a telephone circuit is distinctive and characteristic. It is a signal as clear and as comprehensible as the words "Are you there," or "Here you are."

Franklin's work has been beneficent. He showed successfully how to bring the lightning down from Heaven and how to dissipate its causes harmlessly away in the earth.

(To be continued.)

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

On Thursday, Oct. 25, the opening meeting of the fifth session of the Northern Society of Electrical Engineers was held at the Grand Hotel, Manchester. Mr. J. S. Raworth, the president, before commencing his address, said he regretted that during the past few months they had lost two of their most distinguished members—Dr. John Hopkinson (of world-wide fame, their first president) and Mr. Morton (the very excellent and esteemed manager of Messrs. W. T. Glover and Co). The council took the earliest opportunity they possibly could of meeting and passing resolutions of condolence with the relatives of the deceased gentlemen, and the secretary would send to them the letters sent with the object of getting their approval of the action of the council. The Secretary having read the letters referred to, the President commenced his address as follows:

The position he had taken up was one of considerable difficulty. He had entered upon a task which in its initiation seemed extremely easy, but which in its fulfilment he had found extremely difficult. The reason, he thought,

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would be obvious to them. The subject which he intended to bring before them that evening had a very wide scope; it was intended to cover the whole range of electrical practice and experience, and that fact alone would show them that he must necessarily to a very large extent fail, because no man had an experience of that width. He had, therefore, endeavoured so far as he possibly could to make, as it were, a skeleton upon which they would, he hoped, hang the fruits of their experience, and make that inaugural address worthy of his intention. In the first, he had chosen as the title of his address, "The Rapid Development of Electrical Engineering during the present Year." That society when measured by its numbers was small and insignificant, but measured by its activity, the energy and enterprise of its members, it was, he believed, the first electrical society in the kingdom, and it was because the members had been so very full of work during the present year that the council had found it extremely difficult to get the members to prepare and to promise papers for this session; in fact, so great was the difficulty that, although they were able by the assistance of members of council themselves to fill up succeeding dates, it was found quite impossible to carry out the intention of the council, that in future the first paper of the society should be read in October. It was simply because they made up their minds that they would carry out the intentions of the council that they held that meeting at all. It was not because he had a malevolent desire to inflict upon them any address. Knowing full well that all their instincts were scientific, and that the only way to excite their interest was to bring before them some new scientific development, or the prospect of such development, he found that evening that he had got a subject which was not in any sense scientific, but because most of them were fathers of families, or on the way to be such, perhaps, and because ways and means must naturally enter into the minds of every man in such a position, he thought they would not find it altogether uninteresting, nor the time vainly spent, if they were to devote half an hour to the consideration of what their prospects in life were. As he stated before, he could not do more than to form a framwork upon which they could hang up some item of knowledge in their experience. The inaugural address was one of the ordinary type, which was not to be subjected to discussion. He did not expect that the discussion would take acute form or a very determined form, but he hoped it would add something to their general knowledge. On Jan. 10, 1898, he addressed them on the prophetic aspect of the same question. He then told them that he had in his mind's eye an enormous development of electrical engineering in the year 1898. It appeared to him at that time that every one of the fields of their energy and enterprise was at a point when it was likely to move forward. It had arrived at that point at which at any moment any one of those directions might absorb the whole of their manufacturing power, and he endeavoured to show that although Continental countries were making great strides in the water-power production of electrical power for transmission there was no need to be anxious, because with cheap coal so close they at home were in a position to manufacture electrical power almost, if not quite so cheaply as they were able to do in Continental countries by water, except, perhaps, in those places where the water power could be developed at an abnormally low cost. The *Engineer* said that, as far as they could see, electricians were always promising to do something wonderful, but never did it; that electricity was a very expensive luxury, and that the time was far distant when we should be able to produce electricity at anything like the figures that we quoted. He thought that they would approve of his conduct in not replying to that criticism, for if the *Engineer* did express an opinion at all, that opinion was always wrong. In process of time, however, Mr. Hammond wrote his paper on the cost of generation and distribution of electrical energy. He showed clearly there to the *Engineer* that the cost of electrical energy had been going down during the past few years in a most marvellous manner, that it had actually descended to one-third of what it was, and that the *Engineer* in quoting figures against him knew nothing whatever of the subject. He first of all proposed to run lightly over the departments in which the development had been more or less strongly marked. They could easily recognise by looking over the synopsis that each one of those heads would give scope for a very considerable lecture, and in order that their hearts might not fail them, he might say that, although it was very difficult to fix the limit of a spoken address, he had fixed himself a limit which he would undertake not to exceed. In the second place, having gone over the departments in which those developments had been strongly marked, he proposed to glance at the principal influences which affected the rate of progress. That he thought was the most important matter that they had to consider, because once they knew what they were they might perhaps be able to do something for their own benefit. The very first thing that naturally arose to the mind was the department of electric lighting. He was not going to trouble them with many figures, but he had to give them a few, because they were so interesting that he did not think they would like to go away without knowing them. In the year 1896 the subscribed capital for companies was £5,800,000, and for municipalities just under two millions. In 1897 the companies went to £6,600,000, and municipalities £3,500,000. In 1898, companies jumped up by nearly two millions, and municipalities by a rather larger amount—*i.e.*, to £5,735,000—so that at the present moment the total amount of capital involved in electrical lighting was £14,142,000. A most important point was that in the years 1882-3, which were known as the years of the electrical boom, the total amount of capital subscribed was £14,743,000. If they had only taken care of the money which the public subscribed in those two years of the electrical boom, we should never have had to ask them for a single penny more in the whole of the 15 years which had since elapsed. Coming to the present year, they found that the activity in electric lighting was very pronounced. There were in 1896, 38 applications for provisional orders; in 1897, 55; in 1898, 84; the total orders in force being 343—100 held by companies and 243 by municipalities. There were works in operation owned by 57 companies and 75 local authorities, and 66 works were in course of preparation. He wished to draw attention to the important fact that 145 provisional orders had been granted concerning which nothing whatever had been done. There was no doubt but that in all those cases the ground was ready for the ploughshare. There was a point of interest which he had noticed in analysing those figures: he found that out of every £100 applied for the purposes of electric lighting, £37 went to the manufacture of plant, and £34 per cent. to the manufacturer of mains. Manufacturers of plant made all the noise and held all the meetings, and, as far as he could see, the manufacturers of cable made all the profit. In 1897 the total number of units sold was 60,125,000, and a curious point about that was that the whole of that current could have been produced by no more than 20 1,000-kw. sets working during factory hours. The whole service of this country, if it had been stored in the same way as gas, could have been produced by 20 1,000-kw. sets, but the actual amount employed was not less than 72,000 kw. The human mind always found a difficulty in dealing with small or large figures. The moment they got into millions it seemed as though the mind could not quite grasp what was talked about. They might think that because we had got 14 millions in the electrical industry, that we had pretty well absorbed all the capacity of the English shareholder. But compare electricity with gas: the total capital employed in gas was 76 millions, and they spent as much every year upon making their gas as the whole total subscribed capital of the electrical industry—*i.e.*, 14½ millions.

The next point to consider was that of electric propulsion. As he had told them last Christmas, they had in all about 133 miles of tramway working. Owing to parliamentary preliminaries to be gone through and the plans to be got out, and the capital to be subscribed, there had been very slow progress. They had only got a matter of about 40 miles added to what they had last Christmas. There were under consideration at the present moment 39 miles by municipalities and 45 miles by companies. In the session of 1898, five electric railway Bills were passed, 17 tramway Bills for local authorities and 10 for companies,

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and 11 provisional orders, in addition to which light railway Bills had been granted for 140 miles of line. That, he thought, looked fairly healthy, but the most remarkable fact was that the impression made upon their minds was not anything like so startling as that which they could get on looking down those four pages of *Lightning* containing the results of electric supply undertakings, but when they came to actual figures they found that the amount of subscribed capital was £14,400,000, being about £270,000 more than the subscribed capital for electric lighting. How did that come about? Where was the money going to, and where had it gone? He thought it was very difficult to answer the question; it was partly owing to the initiatory expenditure on schemes and partly owing to the large and expensive undertakings which were being carried out in London to connect the suburbs with the City by means of underground tunnels. Every mile absorbed nearly half a million pounds, so that the amount of capital subscribed for that alone had gone very much to swell the figure of £14,400,000. The unfortunate part about it was that the money did not go into their pockets, or, at least, only a very small percentage of the money subscribed for underground railways ever reached the pockets of electrical engineers. It went to the engineers of Westminster, or to the contractors for underground work. There were one or two other developments in propulsion which he had to speak about, but which were not quite so hopeful from their point of view as those which he had already mentioned. The first was the propulsion of boats, and, as far as he knew, the only active company was the Immisch Company, on the Thames, and which owned a large number of launches, having a capital of £10,500, and which paid a small dividend; he himself was one of the directors. He was looking forward to that class of propulsion developing somewhat in the future. Electric launches were tried on Lake Windermere, and they were probably aware of the fact that the undertaking was a comparative failure. He wanted to disabuse their minds that that failure was due to the shortcomings of the electrical portion. It was entirely due to the human element. The undertaking had been badly planned, and was badly fixed by nature, so that the boats had to go several miles to be charged, and several miles back again to their work. The consequence was that the actual available net charge was below the paying limit. The next point which he would bring before their notice was the electric cab. He wished he could tell them that the electric cabs were going to be a great success. Their number had been very greatly increased, and he understood they worked very well, and as far as passengers themselves were concerned, he believed they gave every satisfaction. How the accumulators were working he could not tell.

The next point was the electrical distribution of power. The present year had been very remarkable and a very important year to them from the point of view that the Lords' and Commons' Committee had been appointed to sit upon the general question of electrical distribution of power. First of all, they passed two Bills: the Chelsea, to enable them to purchase compulsorily a site within their own area—that was an enormous step in advance of anything that had been previously done. The next one was the Metropolitan Company's Bill to enable them to lay mains outside their area, and to bring current in. That was a still further and a more drastic change. It enabled a company supplying a given area to put its generating station right outside that area, and to get wayleaves across the territory of adjoining authorities for its mains to enter its own area. Then the joint committee passed its opinion as follows upon the general principle of the distribution of power. First, they expressed the opinion that powers should be granted for the supply of electrical energy over an area including districts of numerous local authorities on conditions differing from those imposed by the existing Acts. Differing, meant better. Secondly, they expressed the view that the provisions of the Electric Lighting Acts for the purchase by local authorities were inapplicable in the case of an undertaking supplying energy in bulk at a high voltage. Those expressions would prove most valuable in the coming session of Parliament. The Bills now before the House were the General Power Distributing Company, which they knew was going to take a large area in the neighbourhood between Nottingham to Sheffield, an area of about 2,000 square miles; and the Midland Electric Company for Power Distribution, whose area was in the Black Country, and who had a capital of £200,000 on paper. Those two were two magnificent schemes. Whether they were well thought out and going to pay he was not prepared to say, but they owed a debt of gratitude to them because they squeezed out of the Lords' Committee those two very important concessions. They had in their midst, as it were, a scheme which he thought would commend itself, not only to them, but to all electricians and engineers throughout the country as being perhaps the most practical and the best development of this idea that has yet come out. He referred now to the Trafford Park Estate scheme. That was an undertaking that had been favoured by Messrs. W. T. Glover and Co., who were promoting it, and so far finding the money for it. The object was to supply power in bulk for driving all the factories, lighting the factories, and doing everything else except education on the Trafford Park Estate. That was a perfectly feasible scheme. It was one on which every engineer could form an opinion from the commencement, and it would be the nucleus of a much larger development. The engineers to the scheme had told him that they originally looked upon his figures of the price at which electrical energy could be manufactured and sold with considerable doubt. They set to work and worked out those figures upon their own lines, and for their own satisfaction, and they found that the results of his calculations and theirs came out sufficiently close for all practical purposes. He wished them good luck, and he hoped that it would develop into a great power scheme. There was at the same time that scheme called the Highland power scheme of Scotland, of which, however, he could give them no further information, except that he wished it God-speed. As to the general distribution of power in factories, that was making very satisfactory progress. He had a note respecting the electrical chemical industry—that was one of those things which he did not understand, but he believed it was making very good progress. It must be patent to everyone of them that the Castner-Kellner process of making alkali by electrical energy had proved so far a success. He hoped that it was an actual and permanent success, so that there would be a prospect of such business opening up to them. One other point came to his notice, and that was the new process of reducing ore by powdering aluminium to an impalpable powder, making it up with ore, and igniting the mass electrically, when a chemical energy would be immediately let loose and propagated through the whole mass, and heat would be generated nearly equivalent to that of the electric arc. The immediate effect was the reduction of the metal operated upon. If that invention proved a success, it would open an enormous field for the use of aluminium, and consequently for the use of electric current.

He ought now to consider what were the causes which were working towards the exclusion of the use of the electric current, or in any sense regarding it. They knew perfectly well whenever an electric lighting station was put down and worked well or badly its consumers increased, the revenue increased and the profit increased; and the most natural thing which he could do was to give them a few figures to show what that development amounted to. He had taken as illustrations four stations which had suffered very little from alterations in price—viz., City of London, Newcastle, Kensington, and Chelsea, and he found that with those, with the exception of the year 1894-5, when the increase in the City of London was 48 per cent., the increase from year to year had been about 25 per cent. The year 1895-6 was a phenomenal year. The City of London increased 43 per cent. and Chelsea 41 per cent., but both of these places were subject to peculiar circumstances. The extension of Chelsea had been almost entirely depending upon the rate at which the builders spent their money. However, they might take it, he thought, that the natural increase, apart from any excitation, was somewhere about 25 per cent. The next point was one of much more importance to them—that was, the question of how far the cost of plant and the cost of working affected their

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business. A few years ago (about five or six) the cost of a 100-kw. plant, rope driven, was £1,600 to the public. Now the price for a direct-driven plant was about £1,300 to £1,400, but, in the meantime, either our faith or ideas had grown so much that no longer did we talk about 100-kw. sets. Last year all the enquiries were for 300-kw., this year they were for 600-kw., and he understood Manchester had gone to 2,500-h.p. To show them how far the average tendency of to-day was worth, a 600-kw. plant was worth about £6,000, and, compared with the same output of the smaller machines of years ago, six plants of 100 kw. each would cost £9,600, so that there was a saving of £3,600. If they put on to the top of that the saving in switchboards, land, foundations, and buildings, they came to the fact that at the present day the cost of plant should not be more than about 60 per cent. of what it was five or six years ago. He thought to a very large extent their efforts had been stimulated to take those big leaps by the clear understanding which they had got in their minds, that all those enormous wastes which were supposed to accrue from running engines at half load could be obviated by a good vacuum and automatic expansion. With reference to the working of stations, they knew more about that than he did. It was worth while putting upon record the fact that whereas four or five years ago they did not think it at all an extravagant thing to spend 5d. upon getting a unit, now they had 14 stations whose total costs, not meaning the absolute cost of the unit, was under 2d. That was very interesting, and a very important fact for them. In Edinburgh the cost had just come under 1¼d., and in Manchester it was about 1¼d. He would like to give them an illustration of how that reduction in cost affected their business. As the cost came down the demand increased. The moment they got the prime cost to such a point that they could sell to the ordinary consumer at a price which was obviously to him less than the price of gas, they would sweep in the whole number of possible consumers which they supply.

The next point was parliamentary procedure. They knew perfectly well that when they had a goal before them they always had the Act of Parliament or provisional order of which they had to run the gauntlet. There was not a great prospect of their getting much amelioration in that line, but they might get some, and the action of the Lords' and Commons' Committee threw a ray of light in that direction. If only the Light Railways Bill proved to be a success they hoped that also would help them. The difference between the Tramways Act and the Light Railways Act was that whereas in the Tramways Act it was necessary to get the consent of the local authority, in the Light Railways Act they were not required to get the permission of the local authority, but could go before the committee and argue the thing out. When an engineer went to a local authority to have electric lighting introduced after years and years of waiting and offered to aid them, they immediately began to treat him as an enemy and not as a friend. They would notice that he had got down on his list of principal influences which affect the rate of progress an item marked "D," under the heading of the "Avarice of Municipalities," and he had limited it to this narrow word "avarice" because he did not want to go into the discussion of the question as to whether from political reasons it was an advantageous thing for municipalities to take over and manage their business. Neither did he wish to suggest that town councils were more avaricious than they were. He took it that they were all about the same. They all wanted to get what they could, but there was a great difference in the way in which avarice was exercised. For instance, one avaricious man set to work to conserve his property, desiring to have something over and above what he had spent, in order that he might invest it satisfactorily. Another looked forward to building up year after year a very great interest which would eventually make him a rich man. If town councils were to look upon their property with envious and avaricious eyes, and then to take it over from them and manage it worse than they had done, they could not look upon them as public benefactors. If, on the other hand, they took over those properties, or commenced by acquiring them before the companies got them, and managed them so well that the demand for electric light grew at a far greater rate than it did in our hands, then of course they would be benefactors, and they all desired to uphold them by all manner of means. He had looked about to see if he could find any evidence as to how those people did manage their business. He looked through the results of electric lighting, but they were very contradictory, and on the whole favourable. Many of the municipalities in the kingdom had got splendid engineers at a very low price, and so they ought to do well. That did not satisfy him, and he thought he must go back to something which had been in existence for a longer time. He came across two large volumes, which were the Board of Trade returns of the gas undertakings in the United Kingdom, one representing companies and the other municipalities. There are 208 municipalities owning gasworks, and 433 companies owning gasworks. When they come to look at the gasworks' figures which have been before the world many years, they come across some very particular examples of municipal management. He had a perfectly open mind, and he found this, that it was almost impossible to find, for purposes of comparison, any large cities or towns supplied by companies, because those were the cream of the whole business, and had been swallowed up by municipalities. For instance, there was Liverpool, Sheffield, South Metropolitan Gas, and Plymouth being supplied by companies, and, on the other hand, they had got four other towns (Birmingham, Leicester, Wigan, and Manchester) who were supplied by the municipalities. He used to live in Manchester, and he looked upon Manchester at that time as being magnificently managed to be able to sell gas at 2s. 3d. per thousand cubic feet. They had, however, only to go through the tunnel and over the hill to Sheffield and they could get gas at 1s. 10d. per thousand cubic feet, although there was little difference in the price of coal. Liverpool paid 2s. 5d., but it distributed to its shareholders £110,892 profit, whereas Manchester only made £68,000 profit, of which they handed over only £40,000 to go to the benefit of the rates. There was another town—Leicester—yet they only got their gas at 2s. 4d., and made a profit of only £18,000 a year out of it. Plymouth, which was no better situated for getting coal than Leicester, had a very much smaller output, with a revenue of £87,000 per year, against Leicester's £184,000. Leicester made £18,000 profit, and Plymouth £13,000 profit out of the 7d. less price. Then, again, coming to a smaller town, Wigan, with a revenue of £56,000, against £87,000 for Plymouth, and where they were far better off for coal, they charged 3s. 1d. per thousand, as against 1s. 9d., and only made £5,000 as against £12,000. That was curious if they took all the facts into consideration. There were the loans to be taken into consideration. Manchester's total profit was £110,000, equals 6d. per thousand; Sheffield £79,000, equals 9d. per thousand. They would notice that Sheffield made 9d. per thousand while charging 1s. 10d., against Manchester 6d. charging 2s. 3d. He then took two neighbouring towns as an example: Stoke-on-Trent—revenue £17,933, profit £5,000, charging anything between 2s. 9d. and 3s. 6d.; the Potteries Company—revenue £40,000, profit £9,000, price 2s. 3d. per thousand. On going through the complete books he found that there was only one municipal undertaking who charged its consumers as low as 2s. per thousand, whereas six companies charged 2s. and less. In the next comparison they were equal—26 municipalities charging 2s. 6d. and under and 26 companies. He considered that if they wanted to get the best results they would certainly have to go to the companies to get it.

Electric traction was being pushed on by private enterprise, and he hoped that this active private energy of theirs would not be entirely strangled by municipal capital. There was one point which was always before them, and that was foreign competition. He was not afraid of it—in fact, it appeared to him that at the present moment it was a good thing that it was possible to get plant from America, because had it not been for that fact the electrical enterprise would have been suffering from great strangulation. Speaking from his own knowledge alone, the Central London Railway Company had ordered, he believed, seven sets of 1,400 h.p., the Metropolitan three of 2,500, and the County of London two sets of 1,000, all manufactured in the States and sent over here; but he knew that if they could have been made in

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this country in the time, the order would not have been given to the States. It came down to this fact, that the Americans were not competing with them at their prices; they were only supplying those orders which could not be done in this country. The last item on the synopsis, as it was getting very late, he would skip altogether; they knew perfectly well what it meant. They simply ought to educate a man who had money to provide them with it without so much coaxing.

X-RAYS IN WAR.

An interesting demonstration of Röntgen ray field practice was lately given by the ambulance section of the 1st V.B. Royal Warwick Regiment. The ambulance party was assisted by a section of combatants, and also by the ambulance section and machine-gun party of the 1st V.B. South Staffordshire Regiment. The manœuvres took place at Wardend, a suburb of Birmingham. Bullet and bayonet wounds were assumed, and dressing applied accordingly, but the chief interest lay with the supposed bullet wounds. The arrangements completed, the "invalids" were placed in the ambulance wagon and driven to the hospital tent, where the experiment to which so much interest was attached was carried through. In the case of the bullet wounds, spent bullets had been slipped within the bandages, and Dr. Hall Edwards essayed the task of finding them with the aid of the Röntgen rays. He had provided himself for the purpose with a portable coil, which was made and designed throughout to stand rough usage and any kind of climate by Messrs. H. W. Cox, Limited, of 10, 11, and 28, Cursitor-street, Chancery-lane. Before carrying out the experiments, the apparatus was carried to the ground in an ambulance wagon, and in order to give it a good jolting was driven over two fields; nevertheless, it worked to perfection, as will be seen by the radiograph taken. Several patients were dealt with, one having a bullet in his ankle. The Crookes tube was brought over the injured part, and a black envelope containing a film was placed underneath, and the electric current was switched on for 2½ minutes. The film was then developed, with the result shown (Fig. 1). The demonstration was interesting, as it proved that the difficulty of transport which has been laid so much stress upon by the War Department) can easily be overcome, and it is possible to secure excellent results in the field. Dr. Hall Edwards was congratulated upon the success of his experiments by all the surgeons present, and it was unanimously agreed that the application of X-rays to military surgery had been demonstrated possible and of the greatest usefulness. Fig. 2 shows the complete portable set, whilst Fig. 3 illustrates the method of its use in the field. We are indebted to the *Graphic* for the illustrations.

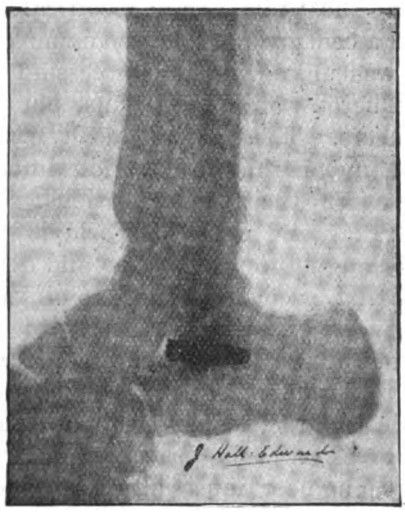

FIG. 1.—Radiograph of Bullet.

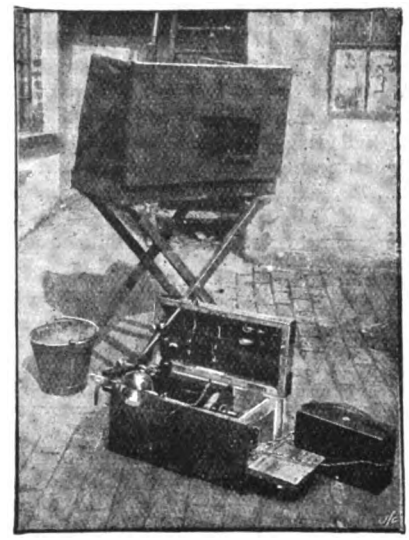

FIG. 2.—Portable X-Ray Set.

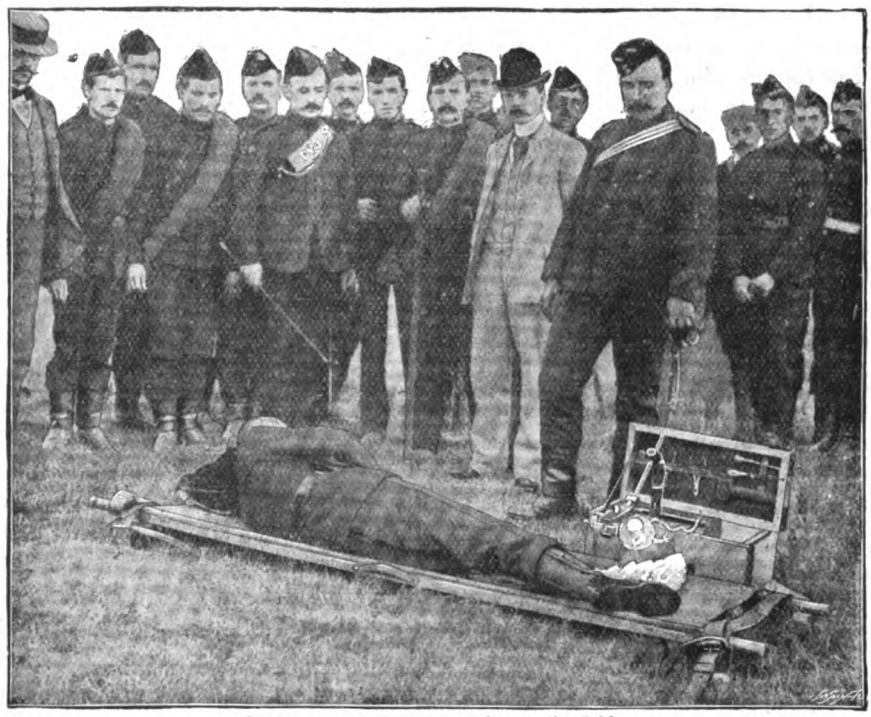

FIG. 3.—Radiograph being taken in the field.

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INSTITUTION OF CIVIL ENGINEERS.

It is meet and right that the great parent institution of all engineering societies should open the ball of the winter session. Its cosmopolitanism, if we may venture to twist the exact meaning of the word, is nowhere better shown than by its list of past-presidents. They evidently have not been selected from any one particular branch of engineering work, but the most eminent is chosen, no matter the branch he represents. In the present year of grace Mr. W. H. Preece, F.R.S., a gentleman who has loomed very largely in the forefront of all that pertains to electrical work, has been elected president. This election is not only an honour to the individual, but is distinctly an honour to the profession of electrical engineers. A quarter of a century ago the very name " electrical engineer " was unknown—the profession was non-existent. There were electricians, but not electrical engineers. These people dealt with electric energy in homœopathic doses, and almost needed microscopes for their investigations. Gramme changed all that, and now the world is permeated with men belonging to a profession and dealing with an energy that seems destined to invade every industrial operation, and, in fact, to dominate the work of the world. In his inaugural address on Tuesday last, Mr. Preece, as might have been expected, dealt largely with electrical matters; in fact, the address takes the form of a thesis to prove that " every engineer must ultimately become an electrician, and electricity will be the most general, the most useful, and the most interesting form in which he applies the fundamental principles of energy to the wants, the comforts, and the happiness of mankind." Outside this part of the address, however, various asides were mentioned, each of which might well form the subject of a long essay. We should not hesitate to break a lance over Mr. Preece's dictum, that it is the fashion to decry the public services not being justified by results. In a way it is true that the services are the servants, and the voters of the kingdom the masters. It takes a very long time in some cases for the master to obtain the attention of his servants. Our experience of the Post Office, outside the Telegraph Department, may be unique, but we emphatically declare that its rules and regulations are worse than silly, and that it does not mend its way without absolute compulsion. But these controversial matters can slide. The value attached to the rubbing of shoulders, to the intercommunication of professional information by the reading and discussion of papers, and by the publication of *Transactions*, is shown by the position of the institution when its president first joined and its position now. Then it numbered 894 members all told; now it numbers 7,088, an increase of 6,194 members in about 40 years, or an average annual increase of some 155 names. It must be remembered that these gentlemen band together solely for the interchange of technical ideas. With finance the society has little or nothing to do, though attention was called in the address to different methods of exploiting new things which obtain in Germany compared with the methods pursued here. This is a subject of the

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greatest and gravest importance, and its teachings will have to be driven home in the minds of business men. Mr. Preece says practically any new departure, however promising it may be, is in the hands of company promoters, and that usually, if it survives the initial stages of exploitation, it enters, say, the manufacturing stage with a capital greatly too large. The members of a syndicate, the financiers, the lawyers, and the brokers all have a pull, as well as the original inventor, before real business begins. The capital which goes into the pockets of these gentlemen is mostly deadweight, of the mill-stone order round the neck of the drowning man. The president tells us they do things better in Germany, and that the banks are more ready to assist the struggling inventor. That may be, but if the whole question be examined it will be found that here, as well as in the generalisation about the public services, the president goes a little too far. It is difficult to convince even a German bank in the initial stages of development, and it is at this point the task of the inventor is herculean. A greater curse than the financier is the professional inventor, the man who as soon as he hears of a new departure—that is, as soon as someone else puts an idea into his head that would never have been found there of its own accord—tries all possible combinations to come round the invention of the first inventor, and so to ride to riches and success upon brains other than his own.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL TELEPHONES.

SIR,—In reply to your article relating to this subject, will you permit me to answer one point in your criticism, which is, that some towns would be injuriously affected by a general enabling Act.

There are many small towns in Norway, Sweden, Finland, Holland, Denmark, and Switzerland, with exchange tariffs as low as 27s. up to £3, which have been yearly paying good dividends, and also in Great Britain—Douglas, Isle of Man—with a £5 tariff.

Why, therefore, should any town be *injuriously affected* by a general enabling Act, which will give municipalities power to supply telephones beyond their municipal areas? In towns with small populations it pays abroad; why should it not pay here at £4 or £5—that is, double as much as is charged in above countries? If a sparsely-populated country like New Zealand pays for all outlay and interest, besides leaving a large profit, at a £5 tariff, surely in a thickly-populated country like Great Britain it should produce an immense revenue.—Yours, etc.,

ANTI-MONOPOLY No. 2.

FOREIGN COMPETITION.

SIR,—We ask for permission to call attention through your columns to a disadvantage under which we, as English inventors and manufacturers in England of electricity meters, suffer in having to compete with foreign meters made abroad with all the advantages of long hours and low wages.

Notwithstanding the fact that Parliament has decided that in all Government contracts there shall be a clause that, where practicable, all goods supplied under them shall be of British manufacture, and that this clause has been adopted by a majority of municipal corporations, yet there still remains a number of municipal contracts under which foreign-made meters are not excluded, though the English manufacturer is additionally handicapped by the requirement that for all his goods the trades union hours and wages shall be followed, thus leaving, so far as price and profit are concerned, a still greater advantage in the hands of the foreigner. We think it is only necessary to call attention to the matter for municipal authorities and consulting engineers to bring their tender forms into line with those of the Government, for it is a recognised principle, at least as regards goods paid for with public money, that the competition of cheap foreign labour should not be encouraged.

It must be understood that we do not at all object to the competition in meters of foreign inventors; we only ask that their inventions, if sold in England, should be made in England, and should thus contribute, as ours do, to the support and encouragement of native industry, and to the relief of our municipal rates and Imperial taxes.—Yours, etc., (For Chamberlain and Hookham, Limited)

ARTHUR CHAMBERLAIN, Director.

THE THOMPSON-WALKER TRAMWAY SYSTEM.

[We have received a letter from Mr. E. Holland about our article on this subject, which we promptly forwarded to the gentleman who represented us on the trial car. The letter was returned by him, but through faults in the postal arrangements has not reached us. We hope to give the letter next week, but the following was the gist of its contents. As regards the proportion of the contact studs, Mr. Holland points out that the arch of the roadway between the tramway lines is responsible for a large part of the projection noted. The roadway between two successive contacts is lowered only ¼in. below the surface of the studs. Mr. Holland, who was driving the car at the time the newspaper was laid on the studs, says that he picked up the contact again, and that the car was not pulled up by the broken contact. During the week we have also had some private correspondence with Prof. S. P. Thompson on the subject of the thick earth conductor, which earths the stud should the switch fail to break. This we find to exist in various forms in the switch boxes on the Willesden line. In the ordinary way the contacts are earthed through the shunt, but the subsidiary contact effectually prevents the maintenance of a live contact after the car has passed from over it. As regards the newspaper question, our representative writes that the car stopped in such a short distance after the broken contact that he concluded its momentum only was acting, and that contact was not remade till the car had come to rest. His point was that paper, rags, or even greasy mud may often break the contact, and that the accumulators on the car are a *sine quâ non*. He also adds that it would have prevented all mistakes if Mr. Holland had taken the car to the end of the line as usual.—ED. *E. E.*]

OBITUARY.

The death of Josiah Latimer Clark, F.R.S., which occurred suddenly at his town residence, 31, The Grove, Boltons, early on Sunday morning last, makes a notable breach in the line of the surviving pioneers of applied electricity. Born in 1822, at Great Marlow, he was at first engaged in industrial chemistry, but commenced railway surveying in 1847, and was appointed assistant engineer for the construction of the Menai Straits tubular bridge, under his brother, Mr. Edwin Clark. He subsequently became engineer-in-chief and consulting engineer to the Electric Telegraph Company, and thus became connected with the first attempts to make electric telegraphy an accomplished fact. Many telegraphic details which are familiar to us at present were originally due to his inventive genius; the double-cap insulators for overhead wires come within this class. At the same time, it is not only electricity in its practical aspects which has been benefited at his hands; theoretical

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science also owes him a debt of gratitude. Thus some of the earliest experiments on the effects of self-induction must be ascribed to him, whilst a paper of his read before the British Association meeting at Manchester in 1861, led to the appointment of the well-known committee on electrical units. But perhaps the achievement of his which is best known at the present day, was the invention of the so-called Clark cell as a standard of E.M.F. In 1860 he entered into partnership with Sir Charles Bright, and many of the enterprises carried out during the ensuing 10 years were under their supervision, as consulting engineers. In 1868 was published the since well-known work, "Elementary Treatise on Electrical Measurement," which did much to make Mr. Clark's name more widely known. The "Electrical Tables and Formulæ," by Clark and Sabini, appeared in 1873.

Mr. Clark was a partner in the late firm of Clark, Muirhead, and Co., and was up to the present time the head of the firm of Clark, Stansfield, and Co., the well-known dock engineers. Mr. Clark was deputy-chairman of the St. James's and Pall Mall Electric Light Company, and as a partner in the firm of Clark, Forde, and Taylor had to do with the manufacture and laying of some 100,000 miles of cable in various parts of the world. One of the founders of the Society of Telegraph Engineers (now the Institution of Electrical Engineers), he became the fourth president of that body in 1875, delivering an inaugural address that contained an interesting account of the early history of the electric telegraph. He was elected a member of the Institution of Civil Engineers in 1858, and a Fellow of the Royal Society in 1889.

FOLKESTONE CENTRAL STATION.

At the invitation of the chairman of the Folkestone Electricity Supply Company, Mr. Alderman Spurgeon, J.P., a number of gentlemen interested in the work gathered together on Wednesday last to inaugurate the formal opening of the central station. As it is our intention to deal at greater length with the technical details of this station, we shall now merely refer to the proceedings of the day. Arriving at the station somewhat earlier than the time of the formal opening, we were enabled by the courtesy of the resident engineer, Mr. T. Hesketh, to carefully examine the installation so far as it is completed. To show the eagerness of the company to get to work, we may state that a wooden shed was erected in which to place the first set of plant, and around this the permanent station was erected. If our memory serves, the first supply commenced about March this year, and at the present time some 8,700 8 c.p. lamps are wired, and between 20 and 30 arcs. The plant consists of three Davey-Paxman "Economic" boilers, supplying steam to three Davey-Paxman Peache's engines, the engines being directly connected to Parker dynamos. The supply is on a three-wire system, with 420 volts between the outers. D.P. batteries are installed in the battery-room. The switchboard is by Edmundsons, Limited. After the guests had arrived, they were conducted through the station, and the apparatus described. Returning to the dynamo-room, the Mayor of Folkestone turned on steam to the large 270-h.p. engine, and all went merrily. Subsequently the guests adjourned to lunch at the Burlington Hotel, and certainly if they did not enjoy themselves, it was from no fault of the hosts, for we never remember to have seen a more hearty and generous desire to show welcome. Of course, after lunch various toasts were proposed and responded to, but we may summarise the important statements in a few words. It was shown that electrical work at Folkestone had had to weather some very stormy seas, that the authorities had finally allowed a private company to undertake the work, and that the outlook for the company was exceedingly satisfactory. Indeed, it seems that the authorities have gradually been converted to the value of electric light supply, and are inclined to work harmoniously with the company.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

MONDAY, NOV. 7.

Royal Institution.—At Albemarle-street, at 5 p.m., general monthly meeting.

Society of Engineers.—At Royal United Service Institution, at 7 30 p.m., "The Preparation of Rhea Fibre," by Perry F. Nursey, past-president.

TUESDAY, NOV. 8.

Institution of Civil Engineers.—At 8 p.m., "The Extraction of Nickel," by Prof. W. C. Roberts-Austen, C.B., F.R.S., Assoc. Inst. C.E.

THURSDAY, NOV. 10.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., "Rotary Converters," by Prof. Silvanus P. Thompson, D.Sc., F.R.S.

FRIDAY, NOV. 11.

Physical Society.—At Burlington House, at 5 p.m. (1) Discussion on Mr. A. Campbell's paper on "The Magnetic Fluxes in Meters and other Electrical Instruments," to be opened by Prof. W. E. Ayrton, F.R.S.; (2) "On the Propagation of Damped Electrical Oscillations along Parallel Wires," by Prof. W. B. Morton, M.A.; (3) "On the Properties of Liquid Mixtures," by R. A. Lehfeldt.

Chemical Society.—At the Hôtel Métropole, dinner in honour past-presidents.

SATURDAY, NOV. 12.

Institution of Junior Engineers.—At the King William-street Station of the City and South London Railway, at 3 p.m., inspection of the extension works of the company.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE III.

(Continued from page 531.)

Under these conditions the induction factor is smaller in proportion as the resistance is greater. In this particular case, the induction factor for 100 amperes in the magnet winding was 172, and the horizontal pull on 33in. driving wheels was 1,460lb. If the internal resistance had been reduced, say to 0·39 ohm, the induction factor might have been increased to 184 for 100 amperes, giving a horizontal pull of 1,560lb. for 100 amperes; these motors would thus give the specified pull at full speed, but nearly 7 per cent. more pull for 100 amperes, so that the increase in the internal resistance, so far from increasing the tractive effert at the moment of starting, actually decreases it. It thus appears that it is important to reduce as much as possible the internal resistance of the motors. We are therefore obliged to use a starting rheostat of such a resistance that, when placed in series with the motor at rest, the current may not exceed the safe limit. It is easy to determine what the resistance of the first step of the rheostat must be. Suppose that the safe current as fixed at 60 amperes, and that the tension of the line is 500 volts. The total resistance in the circuit at the moment of starting must then be 8·34 ohms, so that if the resistance of the motor itself is, say, one ohm, that of the rheostat must be 7·34 ohms. As the motor speeds up this resistance may be taken out, the current meanwhile being kept constant at 60 amperes. During this process the acceleration will be constant. If we know the induction factor for 60 amperes, we know the total horizontal pull with driving wheels of given diameter. If we know the resistance to motion, we can deduce the tractive effort available for acceleration, and hence the acceleration. When the starting rheostat is "all out" the motor will speed up by itself, and the current rapidly diminish in the way we have already seen.

We now come to the case where we have two motors to deal with, as, for instance, in a railway car. The two motors will, of course, be running at equal speeds, and the loads on the motors will be equal. There are three possible methods. The motors may be run permanently in parallel, so that each motor will act as a single motor controlled with its own starting rheostat in the way we have just been discussing. Secondly, the two motors may be connected permanently in series, and controlled with a single rheostat. Thirdly, the motors may be connected first in series and then in parallel. I propose briefly to discuss these methods and to compare them.

To fix our ideas, let us take a definite instance. Suppose

* Cantor lectures, delivered before the Society of Arts.

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that we have a railway car weighing 40 tons, and that it has to travel at 30 miles an hour, the resistance to motion at that speed being expressed in terms of torque at the main driving axles, and equal to 200 inch-pounds per ton of load. Suppose, further, that the driving wheels are 33in. in diameter, that the motors are gearless, so that the velocity ratio is unity, that the tension of the line is 500 volts, and the internal resistance of each motor 0·4 ohm.

Confining our attention, in the first instance, to the case where the two motors are to be connected in parallel throughout, we find that in order to drive the car at the specified speed with the given resistance to motion—the latter being equivalent to a horizontal pull of 242lb. per motor—the induction factor must be 96, and the corresponding current 30 amperes. If the current from the line is limited to 200 amperes, the current per motor, when the two are in parallel, will be 100. Assuming the frictional resistance to motion to remain the same at all speeds, we shall have 70 amperes available for acceleration. Now each motor has to accelerate 20 tons, hence the acceleration will be 0·41ft. per second per second. The starting rheostat must have a resistance of 4·6 ohms on the first step, and the current of 100 amperes per motor can be held constant for 100 seconds. At this point the speed of the car will be 41ft. per second, and the distance travelled 2,075ft. The form of the acceleration curve is shown in Fig. 16. The acceleration is constant up to 41ft. per second, the starting rheostat here all out, and

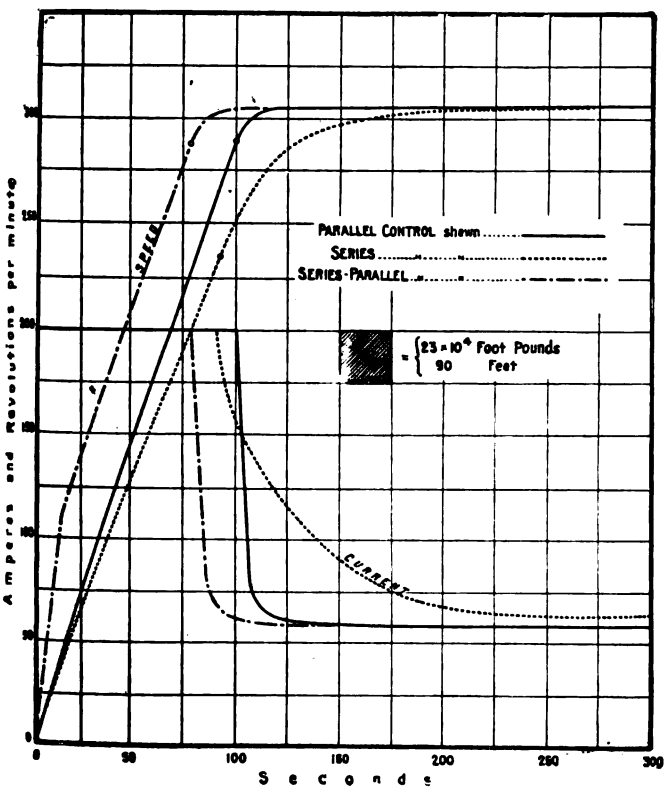

FIG. 16.

the full speed of 44ft. per second is soon reached. The current curve is also shown in this figure. As soon as the rheostat is all out the current begins to diminish very rapidly; the current given in the figure is that required for the whole car, including both the motors, so that the current at full speed is 60 amperes. If we consider the car to be "started" when a speed of 29·5 miles per hour—*i.e.*, 43ft. per second—has been attained, we see that this will have been accomplished in 107 seconds from the moment at which motion commenced. By finding the area of the current curve up to this point, we ascertain that the total consumption of energy required to start the car by this method of control is 753×10^4 foot-pounds.

We now come to the case where the motors are to be connected throughout in series. In comparing this case with the first, we see that the tension at the terminals of the motors is now only 250 volts. In order to make up the specified speed the induction factor must be much lower, the calculated value being 44. The current per motor is now 200, the full current from the line. The current required to overcome friction is 64 amperes, leaving 136 amperes for acceleration; the acceleration is 0·37ft. per second per second, the rheostat is all out in 91 seconds, and the speed is then 33ft. per second. The car will be "started" in 160 seconds, and the energy required to start is 972×10^4 foot-pounds. The acceleration and current curves for this method of control are shown in Fig. 16, so that the behaviour of the car may be compared with that with the parallel method of control. The difference in the form of the current curves is very marked, and fully accounts for the large increase in the energy consumption with the series method. The starting rheostat is "all out" at a much lower speed, and the motors take much longer to attain the final speed than with the parallel method. The final current is also larger, being 64 amperes, as compared with 60 for the parallel method. Altogether, we see that this method compares badly with the parallel method of control, as far as the question of starting is concerned, and that it is rather less efficient at full speed for equal ohmic resistances in the motors.

In the locomotives on the City and South London Railway, the motors are permanently connected in series. Diagrams of current and acceleration have already been shown you in Fig. 15. Those of you who wish to go further into this subject than is possible in so short a course of lectures, would do well to read carefully the paper giving a description of this railway in the *Proceedings* of the Institution of Civil Engineers, vol. cxii., and also an account of the Liverpool Overhead Railway in vol. cxvii. of the same *Proceedings*. The point to which I invite you to give the closest attention is the discussion that followed the reading of the papers. You will there see that the question was raised as to which were the more efficient locomotives—those used on the City and South London Railway, or those on the Liverpool Overhead Railway. The test of efficiency was held to be the horizontal pull exerted by the locomotive for a given current, 100 amperes, from the line. This was quite reasonably taken as a fair basis of comparison, since the total horse-power of the locomotives was nearly the same in the two cases. When, however, the actual figures were quoted, it appeared that one of the Liverpool motors could pull over two of the South London motors when equal current was passing in all three. This was taken as conclusive proof that the Liverpool motors were the best. A leading engineer told me subsequently that he had actually seen the experiment made, and that it convinced him of the superiority of the Liverpool motors.

In reading the report of the discussion, you should note the confusion of thought present in the minds of many who took part in it. The question at issue was the efficiency of the locomotives, but the test submitted was the hauling strength of the motors. Now, the Liverpool locomotives had each two motors designed to drive the train at full speed when connected in parallel, while the South London motors had to drive the train at full speed in series. From what you have seen, you will at once recognise that the induction factor of the Liverpool motors must be more than twice that of the South London motors, so that for equal current per motor one Liverpool motor must give more than twice the pull of one London motor. The case is, in fact, identical with that which we have just been discussing, for you saw that when all other conditions were the same, with the data we assumed, the induction factors were 96 and 44 respectively, so that for equal current per motor one parallel-connected motor would give 2·18 times the pull of one series-connected motor. You see, then, that the pull exerted by each motor is no criterion of the efficiency of the locomotive as a whole, because with 100 amperes from the line the current per motor in the Liverpool motor would be half that in the London locomotive, so that the total pull exerted by the locomotive would be nearly the same. The matter was still further complicated by the fact that the diameter of the driving wheels was not the same in the two cases, being 33in. in the Liverpool locomotives, and 27in. on those of the South London line. This would give an advantage to the latter, and would oblige us to make a correction if we wished to obtain accurate results of the comparison.

I must now ask you to follow me into a brief description of the third method of control that we have to consider—namely, that of the well-known "series-parallel" arrangement. In this method the two motors are started in series, and subsequently thrown over into parallel connection. I shall take the same data as in the other two cases. You see that since the car has to move at full speed with the motors in parallel, the induction factor must be the same as in the first case—namely, 96. But now we have a striking difference from either of the two cases considered already. The induction factor is the same as in the parallel method, but at the moment of starting the current is the same as in the series method—namely, 200 amperes per motor. The total torque is therefore much greater than in either of the other methods, and the acceleration is as much as 1·0ft. per second per second, nearly three times that with the series method, and more than twice that with the parallel method. This is a great advantage, and if it could be maintained it would enable us to effect an immense saving, both in time and energy. We can, however, maintain this state of things only so long as we can keep the current constant at 200 amperes. We shall, of course, have our starting rheostat, and the resistance must be taken out as the motors speed up. Calculation shows that the resistance will be all out at the end of 15 seconds, and that the speed of the car will then be only 15ft. per second. The motors must then be

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switched over to parallel connection with sufficient resistance in series with each motor to keep the current per motor down to 100 amperes. The car will then speed up as in the parallel method, and will be "started" in 87 seconds with an expenditure of 605×10^4 foot-pounds. These results are plotted in Fig. 16. This method is evidently better than either of the others, the gain being made on the step during which the motors are in series with one another. This step, however, lasts only for 15 seconds, so that the advantage of the series-parallel method of control is limited by the time during which the motors can be held in series connection. We might have allowed the motors to speed up as much as possible while connected in series. The car would then attain a uniform speed of 17 miles an hour, and we might throw the motors over into parallel connection at any moment. Fig. 17 gives the current and acceleration curves that we should get in such a case. The notch in the current curve shows where the motors are speeding up in series.

There is a practical objection to allowing the motors to speed in series. The acceleration of the car on the parallel step is, as we have seen, 0·41ft. per second per second. Now, if the car is allowed to attain a uniform speed with the motors in series, there will be a sudden shock when the motors are thrown

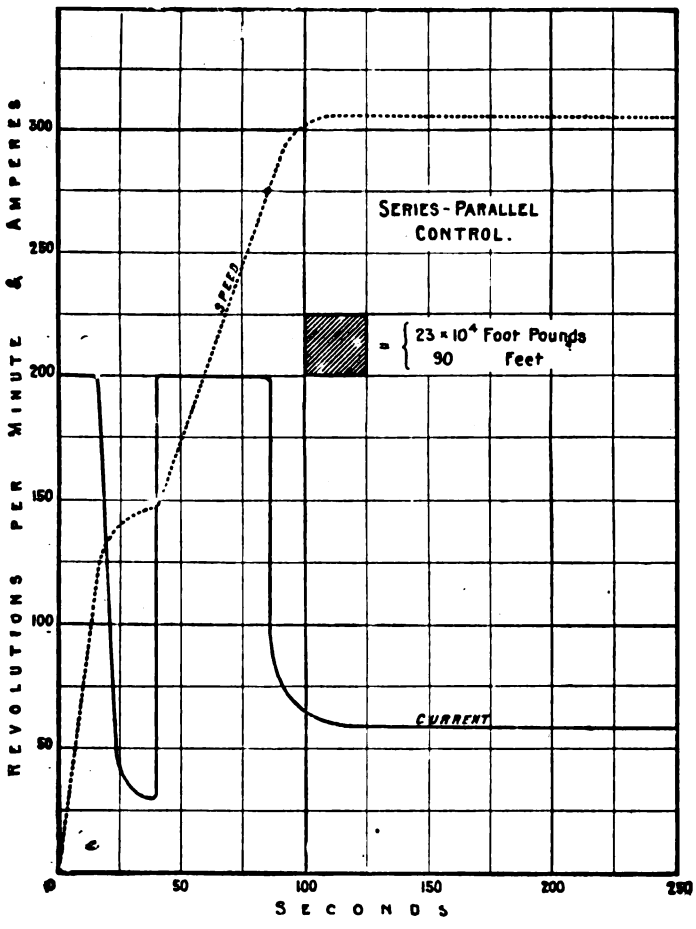

FIG. 17.

over into parallel connection. This shock may be frequently observed when the motorman on a car equipped with a series-parallel controller does not switch over to parallel at the right moment. You will readily see how to find the proper moment for switching over. It must take place so that there is no shock—*i.e.*, so that the change in the acceleration is gradual. The motor must therefore be allowed to speed up in series until the acceleration is the same as that on the parallel step; if the motors are then thrown over there will be no shock. In Fig. 17, if the straight part of the acceleration curve on the parallel step were drawn as a tangent to the curved part on the series step, we should obtain the same result. I think it will be obvious to you that the longer the motors are allowed to run in series, the greater will be the loss of time involved. The best results are attained if the motors are thrown over without shock; in the case we are now considering the car would then be started in 80 seconds, with an expenditure of 562×10^4 foot-pounds. Fig. 18 shows the distance travelled by the car in any given time with the three different methods of control. For short runs the series-parallel method enables us to cover much greater distances in a given time than either of the other methods; but as the distance to be travelled becomes greater, the proportional advantages of the series-parallel diminishes.

There is one way of connecting the series control that I have not alluded to. If, instead of taking 200 amperes per motor on the series step we had taken only 100, the current from the line would have been halved during the process, and the current per

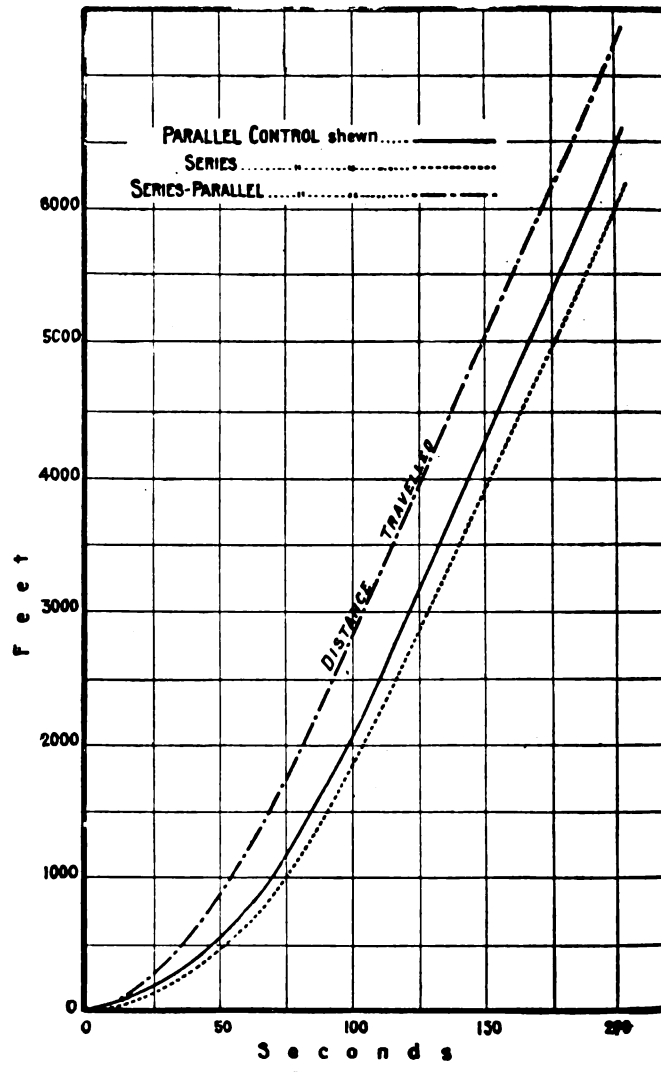

FIG. 18.

motor would remain the same throughout. The acceleration would thus be the same on both steps, and the distance covered in a given time would be the same as with the parallel method.

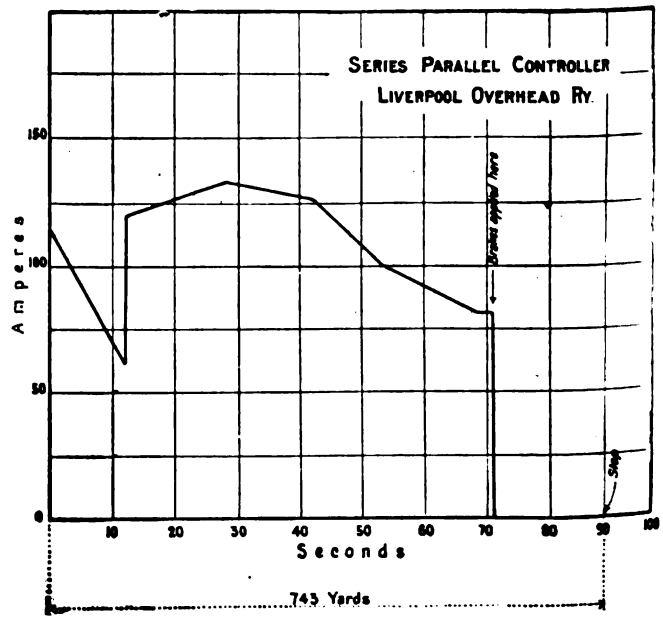

FIG. 19.

The advantage of this way of connecting up a series-parallel controller is that there is a large saving of energy on the series step, and the motors have to carry only half the maximum current required by the method described previously. In cases

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where the whole distance travelled is very short, and the brakes have to be applied very soon after, or even before, full speed is attained, the advantages just enumerated outweigh the benefit gained by passing twice as much current through the motors during the series period. The action of the controller on the City and South London line is well illustrated in Fig. 15, which I have already shown you. The starting rheostat is held in for nearly 30 seconds. The form of the current curve as the motors speed up is well shown. Fig. 19 gives the current curve obtained on the Liverpool Overhead Railway. The notch in the curve represents the period during which the motors were speeding up in series, after which they are thrown over into parallel. More accurate observations would, no doubt, show that the curve during the series connection was not so straight as shown in the diagram.

(To be continued.)

ELECTRIC INSTALLATIONS FOR LIGHTING AND POWER ON THE MIDLAND RAILWAY, WITH NOTES ON POWER ABSORBED BY SHAFTING AND BELTING.*

BY W. E LANGDON, SUPERINTENDENT OF THE ELECTRICAL DEPARTMENT.

(Concluded from page 565.)

The power absorbed in driving shafting and belting is probably greater than is often thought to be the case. In

* Paper read before the Institution of Mechanical Engineers.

TABLE II. *(Abstracted).*—POWER ABSORBED IN DRIVING MAIN SHAFT, COUNTERSHAFTING, BELTING, AND LATHES (BOTH LIGHT AND WHEN WORKING). MAIN SHAFT 98FT 4IN. LONG, 2IN. DIAMETER, HAVING 12 BEARINGS, EACH 4⅜IN. LONG, AND ORDINARILY DRIVING 19 BELTS.

Number.	Machine. Description.	Power absorbed. Main shaft and countershafting (light).	Main shaft, countershafting, and machine (light)	Main shaft, countershafting, and machine (loaded).	Work done, metal cut away. Weight. Total cut.	Cut per minute.	Traverse.	Time occupied.	Total revolutions of metal cut per minute.	Power absorbed. Main shaft.	Countershafting.	Machine.	Cut.	Total.	Per ounce of metal cut.	Per ounce of metal cut per minute.	Remarks.
		Watts	Watts	Watts	Oz	Oz.	In.	M. S.	Revs.	Watts	Watts	Watts	Watts	Watts	Watts	Watts	
1	9½in. screw-cutting lathe	327	381	545	2½	1·07	3⅛	2 20	250	272	55	54	164	545	218	509	A
2	6in. lathe	354	409	654	2¼	1·12	3	2 0	394	272	82	55	245	654	290	584	
3	5in. lathe	327	409	545	2¼	0·96	3	2 20	393	272	55	82	136	545	243	567	
4	6in. saw	327	354	490	1¼	0·50	—	2 30	1,827	272	55	27	136	490	392	980	C
5	¼in. drill	354	354	381	¼	0·08	—	3 0	310	272	82	—	27	381	1,524	4,950	
6	Grindstone	—	354	545	—	—	—	2 30	100	272	—	82	191	545	—	—	G
7	Buff	327	354	436	—	—	—	2 30	1,300	272	55	27	82	436	—	—	B
8	10in. screw-cutting lathe	409	436	490	2¼	0·96	3	2 20	190	272	137	27	54	490	218	507	A
9	1in. to 2in. drill	360	436	708	4¼	1·70	—	2 30	156	272	88	76	272	708	166	416	A
10	6in. screw-cutting lathe	327	354	545	2	1·71	3	1 10	272	272	55	27	191	545	272	317	A
11	6in. lathe	381	436	545	2¾	2·36	3	1 10	380	272	109	55	109	545	196	230	
12	6in. lathe	409	436	599	2	2·40	3	0 50	362	272	137	27	163	599	299	246	
13	5½in. screw-cutting lathe	354	371	436	2½	1·00	3	2 30	300	272	82	17	65	436	174	436	A
14	5in. lathe	354	409	545	2½	1·03	3	2 25	362	272	82	55	136	545	209	524	A
15	¼in. to 1½in. drill	360	436	490	¼	0·11	—	2 15	220	272	88	76	54	490	1,960	4,454	

A = 2 belts from main shaft to countershafting
C = cut five pieces of 1in. round gunmetal rod
No variation noticed in volts or amperes, when belt transferred from loose to fast pulley
G = ground ⅜in. sq. tool. No countershafting
B = buffed three square inches of brass.

Notes on the Experiments.—Main shaft and countershafting, 15 sets, absorbed 794 watts; ditto and 15 machines (light) absorbed 1,778 watts; ditto ditto (loaded) absorbed 2,500 watts—that is, all tools were at work, as shown in the table; main shaft, with all countershaft belts resting on shaft, absorbed 518 watts; 19 belts resting on shaft when revolving absorbed 246 watts. The belting running when driving any individual tool under test was only that required for driving this particular tool alone. Speed of motor at 110 volts was 500 revolutions per minute; speed of main shaft was 128 revolutions per minute. Lubrication in each case was with No. 1 oil. All holes were drilled with Morse twist drills; the same tool was used in each lathe when comparing the watts absorbed for different depths of cutting or different rates of traverse, and the angle of the tool was maintained the same throughout. With three times the rate of cutting the motor slowed down from 500 to 470 revolutions per minute. Ammeter readings were never steady; this was due to the "flap" of belt when running, which caused a variation of about 12 per cent. in the current. In each case a rod of gunmetal 1in. diameter was reduced to ⅜in. diameter. Weight of metal removed per minute $= \frac{\text{Weight removed}}{\text{Time}}$

Watts absorbed per ounce of metal removed $= \frac{\text{Total watts absorbed by cut}}{\text{Weight removed}}$. Watts absorbed per ounce removed per minute $= \frac{\text{Total watts absorbed by cut}}{\text{Weight removed per minute}}$. Thus, taking No. 1 as an example, 545 total watts absorbed by the cut, divided by 1·07oz., of metal removed per minute, gives 509 watts as the power absorbed per ounce removed per minute.

TABLE III.—TESTS BY 9½IN. SCREW-CUTTING LATHE WHEN DRIVEN BY SHAFTING AND BELTING, AND WHEN DRIVEN DIRECT BY SMALL LUNDELL ELECTRIC MOTOR OF ½ H.P.

Mode of driving.	Work done, metal cut away. Number of cuts.	Weight removed. Total.	Per minute.	Traverse.	Time occupied.	Revolutions of metal cut per minute.	Power absorbed. Total.	Per ounce of metal removed.	Per ounce of metal removed per unit.
		Oz.	Oz.	Ins.	M. S.	Revs.	Watts.	Watts.	Watts.
Shafting and belting propelled by Elwell-Parker motor.	One	3¾	1·66	3	2 15	135	981	262	591
	Two	6	2·66	3	2 15	135	1,035	172	389
	Three	9¾	4·33	3	2 15	135	1,188	122	275
Direct by Lundell motor.	One	3¾	1·66	3	2 15	135	342	91	206
	Two	6	2·66	3	2 15	135	508	85	191
	Three	9¾	4·33	3	2 15	135	616	63	143

When running light, Elwell-Parker motor, shafting and belting, and lathe absorbed 7·5 amperes at 109 volts = 817 5 watts.
" " " Lundell motor and lathe . . . . . " 1·8 " 116 " 207·8 "

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the workshops attached to the electrical department of the Midland Railway the construction of large electrical apparatus is not dealt with. In Tables II. and III. will be found data of the power absorbed by tools and shafting, which have been carefully obtained at the author's request by Mr. Holt, the foreman of the shop. Some 15 tools are driven from a main shaft, which is 98ft. long, 2in. in diameter, and has 12 bearings, each 4⅜in. long. It is necessarily supplemented by countershafting required by the various tools; the countershafting varies in length and in section. The main shaft is driven by belting from an Elwell-Parker motor, erected some years since. To drive the main shaft alone, quite free from all belting, requires an expenditure of 272 watts. To drive it with 19 belts resting on it, but free from the tools, absorbs 518 watts, or nearly ¾ h.p. To drive the main shaft plus the countershafting absorbs 794 watts, or something more than 1 h.p. To drive a 9½in. screw-cutting lathe (No. 1) light, while all other machines and belts are at rest clear of the shafting, requires 381 watts, and the power absorbed when the machine was loaded—that is, when the tool was turning down a bar of gunmetal at the rate of 1·1oz. per minute—was only 545 watts, or at the rate of 495 watts per ounce of metal removed per minute, or, in other words, the lathe running light consumed 381 watts, and the work done 164 watts. By gearing an electric motor of low efficiency direct to the same lathe, and setting it to precisely the same description of work, the power consumed was at the rate of 214 watts per ounce per minute. In each case the greatest care was taken to insure equality in the cutting power, shape, and cut of the tool, and one cut only was made.

Table III. affords comparative results for one, two, and three cuts effected by the same lathe when driven from shafting and when driven from a small motor, both being geared down to the same speed of lathe. Turning to the work dealt with by the same (No. 1) lathe when making three cuts simultaneously, each of the same character as the previous single cut, the following were the results: When driven by belting — power, 1,188 watts; metal cut, 9·75oz.; time occupied, 2·25 minutes, being an average of 275 watts per ounce of metal removed per minute. When driven by motor direct—power, 616 watts; metal removed, 9·75oz.; time occupied, 2·25 minutes; average, 143 watts per ounce per minute. Multiplying the watts by the time occupied in doing the work in each case, the relative value is found to be: one cut, by belting 2,207 (Table III.), by motor 769, ratio 3 to 1; three cuts, by belting 2,673 (Table III.), by motor 1,386, ratio 2 to 1.

The results furnished are unavoidably of a somewhat limited character. They would no doubt have been more interesting if obtained from larger tools, capable of doing heavier work. Under such conditions it is probable that the waste of power in shafting and belting would not be so great in relation to the work done. Still, it is clear that an extensive loss does take place, and that this may be reduced by driving each tool or machine direct from an electric motor. If every foot of the shafting and every machine connected with it were constantly at work without intermission of any kind, the difference would not be so marked; but this is just what does not happen. Shafting is extended down a long shop, and scores of tools are driven by it; whether they are all at work or not, the shafting has to be kept running. This entails a certain initial loss. With large tools or machines absorbing over 1 h.p., there can be no question of the advantage derived from driving direct by electricity.

Discussion.

Prof. A. B. W. Kennedy said that the paper of Mr. Langdon had originally been prepared as a pamphlet for distribution at the Derby meeting, but that he and others who had seen it agreed that the valuable information should be presented to the institution as a paper. In reading the first part of the paper, Prof. Kennedy said he had noticed that at Derby the load was not so intermittent in character as the author led one to infer. From the total output in watts and the maximum load of 1,430 amperes the daily average worked out at six hours' full load, which was very much better than that obtained in any electric light station. He asked Mr. Langdon to give them, if possible, in his reply the total efficiency of the transmission to the hydraulic pumps at Leeds. The tables given at the end of paper as to the power required to drive the shafting, countershafting, and tools at the Midland workshops were most valuable to any engineer who had to design electrical equipments for factories. The ratio between the useful work done by the tools and the total work showed how much could be wasted in shafting. He found that, adding up the power used in cutting when all the tools were at full work, it came to 2,025 watts, and that by adding the power required to drive the main shaft, the countershafts, and the machines when not cutting a total of over 4,000 watts was obtained. Thus the ultimate possible efficiency, which was not obtained in practice, was only 50 per cent. In the speaker's paper read before the Institution of Civil Engineers some two years ago he had said that generally it did not pay to introduce electrical driving where less than 15 per cent. was wasted in driving of countershafting. Mr. Langdon's figures showed how frequently the losses were much higher than this. Even when small powers only are required it often paid to do away with shafting.

Mr. A. T. Walker said the author's description of the plant at Leeds was a great tribute to hydraulic power. Although they had electricity with which to work electric lifts, hydraulic lifts had been adopted, and the force pumps were driven by electricity instead. He proceeded to criticise the arrangements, saying that the electric motors seemed to be much too powerful for the work to be done. Thus, the motors were capable of giving 23 b.h.p., while only 11½ h.p. was required from the pumps.

Mr. W. H. Patchell referred to the boosting and compensating arrangements at Derby. The author described two series machines driven by a shunt motor, whereas the work could be equally well done with two machines only, or by one machine with a double winding. Mr. Patchell agreed with Prof. Kennedy that the London load curves had a much lower load factor than that of the railway station plant at Derby. The electric pump used for the hydraulic lift at Leeds was not designed in a suitable form for boiler feeding. For instance, when one cylinder alone was working, a nasty jar would be produced on the feed pipes. A steam-engine for driving a feed pump gave very good regulation in this respect, but the inefficiency, particularly at light loads, added greatly to the coal bill. In regulating an electrical feed pump, such a wide range could not be obtained. He had recently designed an arrangement for driving electric fans, in which the two motors were placed in series when only a small output was required, and in parallel for full load working. The result was most satisfactory.

Mr. Schonheyder criticised the design of the relieving gear on the electric pump at Leeds. If the cam wanted to raise the valves, as would frequently happen on the working stroke when there was a pressure of 700lb. per square inch on the top of them, the force required would damage the gearing. He had designed a somewhat similar arrangement some years ago, but had interposed springs in the rod which lifted the valves. These springs were compressed if the cam acted on the power stroke, and then lifted the valves when the pressure above was removed.

Mr. Druitt Halpin said that the question between electric and hydraulic lifts in hotels was not determined only by their respective convenience.

Prof. Robert Smith remarked that his working out of the total efficiency of the machine tools in the paper gave only 30 per cent., whereas Prof. Kennedy made it 50 per cent. The method by which the figures were obtained by the author was not a rigidly accurate one, because a direct measurement of the power at the cutting edge of the tool was not obtained. Prof. Smith had devised an arrangement for measuring this accurately, and had tried it on the lathes used for cutting steel ingots. These often took a cut 1½in. deep, with a feed from 1/16in. to ¼in. In one case, where the depth of cut was ·345in. and the feed ¼in., a shaving about 5ft. to 6ft. long, and with a section of about ½in. by ⅜in., was taken off in one minute. The force on the tool was 21,000lb., which gave an expenditure of 50 foot-tons per minute, or about 3 h.p. to 3½ h.p.

Mr. H. G. Harris said that the great question in electrical driving was that of capital cost. The cost of the motor required to drive a lathe in small sizes was so great as to be prohibitive. With larger machines the case was different, but he was not at all sure that the capital cost of equipping a factory with electric motors was always justified.

Mr. Tremlett Carter remarked that the efficiency of steam-driven mills was often under 20 per cent., and he knew of many cases in which 70 to 80 per cent. of the total power generated was wasted in shafts and belting. He deplored the want of a standard practice in electric driving for factories, and thought that some definite conclusion as to when it paid to use separate motors for each machine should be arrived at.

Mr. H. Lea said he had made some measurements on five double-ended polishing spindles. These ran at 200 revolutions, and were driven by belts off a common countershaft. The belt pulleys on the spindles were 2in. diameter. He had used an electric motor in the place of the engine, and found that it took to drive the countershafting and spindles 6 e.h.p. when no work was being done, and 9 e.h.p. when the buffs were being used. He then tried electric motors running at the same speed with the polishing arrangements mounted directly on the shafts. Each double-ended spindle only took ¾ h.p. or, say, 4 h.p. for the five. Taking the annual cost per horse-power at £10, that would show a saving of £50 per annum, which capitalised at 10 per cent. represented £500. The five electrical polishing spindles cost £150, so that a material saving was effected.

Mr. Jeremiah Head thought that the discussion was restricted too much to the question of power lost in shafting and belting. The great field for electrical distribution of power was in large works extending over considerable areas. In such cases a distribution of steam from a common boiler plant to each workshop or

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solated boilers and steam-engines were much less economical than electric motors driven from a common generating station. In Messrs. Richardson's works at Hartlepool no less than 27 different engines had been replaced by electric motors in the way he had described, and the annual coal bill had been reduced one-half in consequence.

Mr. H. R. J. Burstall considered that, where small machines had to be driven, grouping of a number on to a shaft driven by one motor was the best arrangement. The higher efficiency of the motor then used made up for the loss in the shaft.

Mr. J. H. Wicksteed said he was recently considering a case where about £10,000 worth of machine tools was being laid down in a factory. The annual coal bill with shafting and countershafting would be £500. He estimated that to put in an electrical plant, using the same engine, would cost £20,000. This meant an extra capital charge for £500 per annum. The speaker said, however, that the extra work got out of the machine tools because they were run at the correct speeds was worth more than this sum. With belt driving, the power lost through slipping belts was considerable, but the time lost by the machines in consequence was even more important.

Mr. W. W. Beaumont said he had recently had an opportunity of inspecting the methods in use in America. In one factory in particular, he noticed that the small automatic tools were driven in groups. He was particularly struck with the works of one large car-building company, which had adopted electrical driving in all its shops.

Mr. W. E. Langdon, in reply, thanked those present for the kind way they had received his paper. He proposed to answer the points raised fully in his written reply. He thought the electric power provided for driving the pumps at Leeds was rather high. The arrangement of boosters at Derby had been designed by Mr. Sayers, and had always worked satisfactorily. More simple methods of effecting the same object might have been designed since then. An hydraulic lift had been used at Leeds for architectural reasons, as a suspended lift would not have looked well in the centre of the staircase.

The meeting concluded with a hearty vote of thanks to Mr. Langdon for his valuable paper.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

112. What difference is made in the efficiency of a given alternate-current transformer by raising the frequency of the primary current from 50 to 100 complete cycles per second? P. T.

113. How can you determine the watts lost from eddy currents in the armature of a direct-current dynamo?—X.

ANSWERS.

Question No. 106.—When is it financially profitable to add condensing plant to non-condensing engines?

Best Answer to No. 106 (*awarded* 10*s.*).—Whether there will be any profit in adding a condenser to a non-condensing engine depends on several conditions. First of all, the engine-house must be in a position where a large quantity of circulating water can be obtained for nothing; it must be situated near the sea or close to a lake or river, as it would never do to use town water for condensing, except on a very small scale; the cost would be prohibitive. As a general rule we may state that it will be profitable to add condensing plant to a non-condensing engine when the interest on the first cost of the plant, added to the annual cost of running it, comes to a less sum than the amount saved per annum in coal and water by working the engine condensing.

Now, under ordinary conditions we cannot expect to add more than 15 per cent. to the power of an engine by turning it into a condensing engine. For instance, by adding a condenser to a 500-h.p. engine we should increase its power to 575 h.p. without using any more coal, and if the engine consumes 2½lb. of coal per indicated horse-power per hour, we shall save 187½lb. of coal per hour, so that, if the engines are always run condensing, we can take 15 per cent. of the total annual cost of coal and water as the annual saving to be expected by using condensing engines. Against this saving we must put the interest—at, say, 4 per cent.—on the total cost of the condensing plant, which includes condensers, air and circulating pumps, valves, pipes, foundations, fixing, etc., and to this must be added the annual cost of the steam required for driving the circulating and air pumps, cost of oil and waste and of repairs and cleaning, and, if the condensing plant is to deal with more than about 2,000 h.p., an extra man will be required to look after it, and his wages must be put against the saving effected by condensing

It will thus be seen that before condensing plant is added to non-condensing engines the various costs should be carefully calculated, as condensing is by no means always profitable on land—for small plants it is rarely so—unless the cost of coal is very high or a boiler pressure of less than 100lb. per square inch is used; and the exhaust steam from non-condensing engines need not be wasted: it may be used to heat the feed water, to feed boilers by means of an exhaust injector, or for various other purposes. Of course, there might be cases where the necessity for adding another boiler or engine could be obviated by putting down condensing plant, and by this means the power of a station could be increased when there was no room to put in an additional engine or boiler. Large engines should always be made so that they can be converted into condensing engines, as this adds very little to their cost and saves a good deal of trouble if it is decided to put down condensing plant.

It will probably be found that for plants of under 1,000 h.p. it will not be profitable to put down condensing plant, unless the cost of coal is very high or the steam pressure very low, but it is profitable for large plants if the condensing apparatus is well made and efficient; at the same time the advantages of condensing decrease with the use of higher steam pressures and a greater range of expansion in the engines.—R. S.

Answer to No. 106 (*awarded* 5*s.*).—The answer to this question is so many-sided, according to the basis on which it is considered. I take it that the question refers more particularly to electric lighting stations. Probably the best basis on which it should be considered is its ultimate effect on the total costs of the units developed by the engines in a non-condensing station. On referring to a table of costs for electricity works established in the United Kingdom, we find the coal bill bears a proportion of from 15 to 30 per cent. of the total costs. If, now, we introduce condensing plant into a non-condensing station which has a coal bill bearing a ratio of, say, 15 per cent. of the total costs, we know that on the average a saving of 20 per cent. will be effected in the coal bill. This brings the coal bill down to 11 per cent of the total costs, supposing other things remain the same. Hence, by putting in condensing plant, the coal bill is reduced from 15 to 11 per cent., but against this must be set off the increased capital necessary for the condensers. It must also be remembered that where no condensers are used an "exhaust steam" feed heater is generally used, which alone effects a saving of 10 per cent. in the fuel. The case now stands thus: with no condensers but exhaust feed heaters, 10 per cent. saved; with condensers and no feed heaters, 20 per cent. saved—net result, 10 per cent. gain in favour of condensers.

The load factor of the engines has also some effect on the saving in fuel by using condensers. The nearer an engine works to its full load the greater does the saving appear. Suppose an engine using steam at 100lb. boiler pressure and cutting off at either 25, ·5, or ·75 of the stroke. When a condenser is added we find we can reduce the point of cut-off to ·2, ·4, and ·56 respectively in order to do the same work as before. Since the saving is proportional to the point of cut-off, when the speed remains constant we find the savings come out to 20, 20, and 25 per cent. respectively for the three cut-offs. Hence, it is financially profitable to instal condensers when the load factor is good, or where the output of the station is rapidly increasing, for this means that for some of the engines a better load factor will be found. It is advisable to instal condensers in every case. The only other consideration is,

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of course, the necessity of a plentiful water supply.—S. J. M.

Answer to No. 106 *(awarded* 5*s.*).—This is a question to which sufficient attention is rarely paid, and in many stations much waste goes on. Whether the addition of condensing plant will pay for the extra outlay incurred, including wear and tear, power and fuel required, depends a good deal on local conditions—whether water can be had cheaply, price of fuel, etc. If the water has to be pumped, it involves a small additional expense annually for the power required. If a good cheap supply of water is available, it is decidedly a financial advantage to add condensing plant. In designing a station this important point should be carefully considered by the engineer, and to a great extent determine the selection for a site. In stations where fuel is dear, costing, say, from 15s. to 25s. a ton, an important reduction in the consumption of fuel and an increased evaporative efficiency results from condensing the steam.

It is estimated that to add a condenser to an existing engine generally means, if properly carried out, a gain of 25 per cent. in steam consumption. In many of the London electric lighting stations condensers of various types have been added to the formerly non-condensing steam plants, and where no water is available large feed-water heaters are employed, but with these a large portion of the exhaust steam is wasted. It is rather a difficult matter to get water cheaply in London and other large cities, and sometimes space for surface condensers is not available. However, to allow steam to escape uncondensed is a great source of loss. Exhaust steam contains a large quantity of latent heat, and heat is expensive. It is little use to try to reduce the coal bill if no effort is made to economise heat when generated. The fact that so many factory and mill engines are of the condensing type proves the financial benefit derived from condensing the exhaust steam.—F. BRUTON.

Question No. 107.—In an installation where you want to raise the voltage of part of the output of a 100-volt shunt-wound dynamo for charging cells, is, say, a 40-volt shunt-wound dynamo the best method of doing so? If so, is there not some likelihood of booster reversing should the voltage of cells be very low when starting to charge same?

Best Answer to No. 107 (*awarded* 10*s.*).—In answering the above question, it will be best to consider, firstly, the cause of reversal; and secondly, the methods adopted to overcome same. It will be assumed that the arrangement for consideration is as in Fig. 1. Here we have two

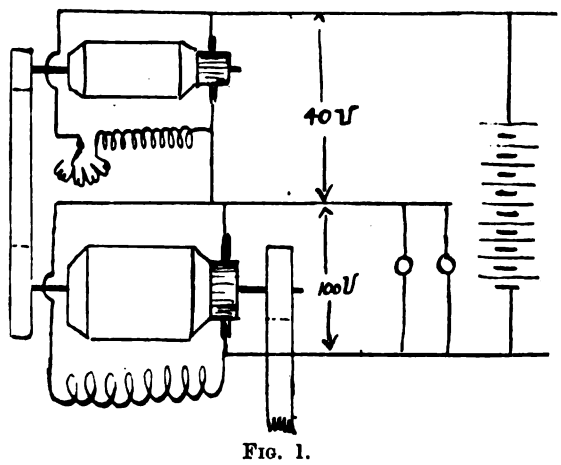

FIG. 1.

shunt-wound machines—one to give 100 volts, and a smaller one to give 40, to raise the voltage of *part* of the output of the large machine. Both are so connected that the voltages add, making the total 140—a voltage requisite for fully charging a 100-volt battery. The figure shows the machines each self-exciting, and the smaller or auxiliary dynamo driven off a pulley from the large dynamo, the latter being driven by an engine or by some other prime mover. When giving cells their first charge, or when charging them after they have run very low, the voltage required at the terminals of the battery to drive the maximum charging current through is very low, and approaches 100 volts rather than 140. The volts are reduced usually by weakening the magnetic field of the auxiliary dynamo, as shown in Fig. 1. The amount of weakening required in the case under consideration is so great that the magnetic state of the magnets becomes *very unstable*, and the magnetising effect of the armature, which is carrying the constant charging current, is sufficient to entirely overpower the magnets and magnetise them in the opposite direction. This explains the cause of reversal, with its associate troubles.

The following remedies are more or less efficacious in overcoming this reversal:

1. *Separately exciting* the magnets of the auxiliary dynamo from the terminals of the large dynamo. This gives *stability* to the field, which cannot be reversed only by a magnetising force greater than itself.

2. Dividing the reduction of the volts between the two machines by using a resistance in each shunt.

3. This is an embodiment of (2), and consists of placing two separate windings on the same armature—one for 100 volts and the other for 40 volts, as shown in Fig. 2. The

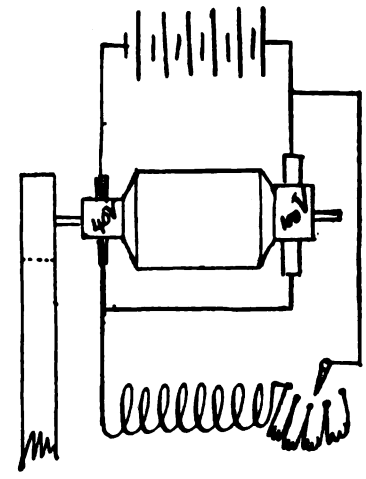

FIG. 2.

variation is obtained as in the case of an ordinary shunt dynamo, and affects both voltages at the same time. If the charging output is fractional of the total output, then during charging periods the machine is running lightly loaded, and the effect upon the magnets of the armature magnetisation is lessened. The objection to this method is that charging and lighting cannot be simultaneous; the reason is obvious.

4. By winding a larger gauge wire on the magnets, so that a strong field can be obtained at a lower voltage, reductions in voltage being obtained by lowering the speed. This appears an expensive method, as under normal conditions a shunt resistance must be always in circuit.

5. By using a booster transformer, a function of the regulation being the alteration of the amount of *series* resistance in the feeding or primary circuit, arrangements of which will be found in the columns of this section of this paper some weeks back.

6. Instead of the above, a small dynamo and motor coupled together, the range of charging voltage being obtained by varying the speed of the motor and the field strength of the dynamo.

Finally, the occasion of the cells running so low can be made so rarely that under these circumstances and that of giving first charge to cells, it is recommended to use a resistance in *series* between the dynamo and battery. This arrangement is the safest, and the extra loss in power and expense is counterbalanced by the removal of *all* inclination to reversal.

It will be seen that the gist of the above remedies is to obtain a good range of voltage without reducing the field strength or introducing armature reaction to a great extent.—CELLS.

Answer to No. 107 *(awarded* 5*s.).*—Generally speaking there are three methods of charging cells from a machine at the same time that it is supplying current to the mains. These are: (*a*) by increasing the voltage of the machine itself, and using charge and discharge switches; (*b*) by arranging the cells into different groups for charging and discharging, and regulating by means of resistances; (*c*) by means of a booster.

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(*a*) The arrangement in this case is somewhat as follows: In Fig. 1, D is the dynamo, designed to give a voltage some 40 per cent. greater than that of the mains, the pressure on the latter being kept constant as that of the cells rises by moving the discharge switch, S, nearer the other end of the battery, roughly, making a difference of two volts for each contact. The current going through the regulator is the sum of the currents going into the main part of the battery and out into the mains. When all the regulators have been charged, the voltage of the machine is reduced, while the charge and discharge switches are brought on to the same contact, and finally the switch, P, is closed and the regulators short-circuited. The advantages of this system are, that it is extremely simple and the outlay involved in it is small. Its disadvantages are, that with it regulation is not particularly good, especially when the attendant is about to start, or to cease charging the regulators. Owing to the different rates of charging of the regulators and the main battery, the life of the cells is often very much impaired, it being very difficult to get the same number of ampere-hours into each cell, with the consequent liability to unequal capacities, and finally reversal.

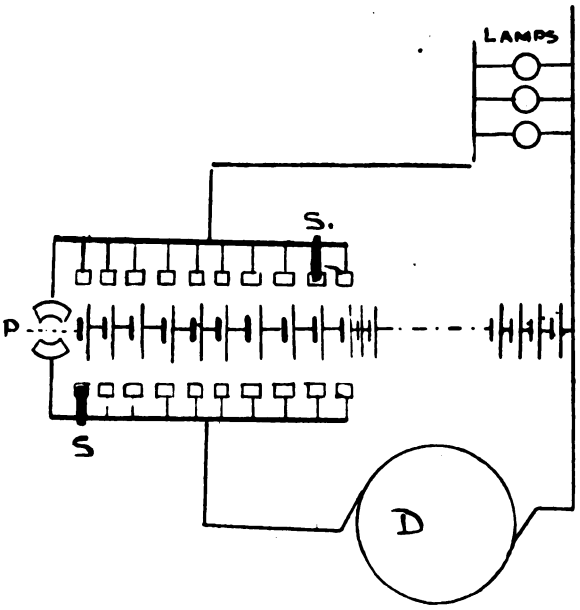

FIG. 1.

(*b*) In this system the cells are split up into a greater number of groups for charging than for discharging, the correct voltage being obtained in each case by means of resistances. The arrangement is somewhat as in Fig. 2. D is the dynamo with 100 volts between its terminals; then the number of cells in the battery would be about 56. For discharging, the switch, X Y (which is of the throw-over type, with three contacts above and four below), would be put into the top contacts, *a* and *c* joining the ends of the battery to the mains, and *b* connecting cells No. 28 and 29. In charging, the switch would be taken out of the top set of contacts and put into *d*, *e*, *f*, and *g*, thus splitting the battery into two halves and charging these two halves in parallel across the mains. The correct pressure in each case is obtained by varying the resistances in the rheostats, R and R_1, but in the case of discharge it will be seen that R_1 is cut out of circuit, being unnecessary. The advantages of this arrangement are that there are no regulating cells to charge; the battery gets charged as a whole, thus increasing its life and obviating the tendency to overcharging which so often takes place with (*a*). Its disadvantages are that it is wasteful, owing to the loss in the resistances. Its flexibility is not so great as with regulators, owing to the excessive number of contacts that would be required in R and R_1, for with comparatively small loads—say one ampere—the drop in the rheostats is quite negligible, and practically the voltage of the mains is that at the terminals of the battery. This arrangement is more preferable with multiple-wire systems, since the difference between the number of cells in each group in charging and discharging is reduced the greater the number of groups. For instance, in a two-wire system with 60 cells: in discharging, 60 cells, charging two sets of 30 cells; with a three-wire system the arrangement would be: discharging two sets of 60 cells, charging three sets of

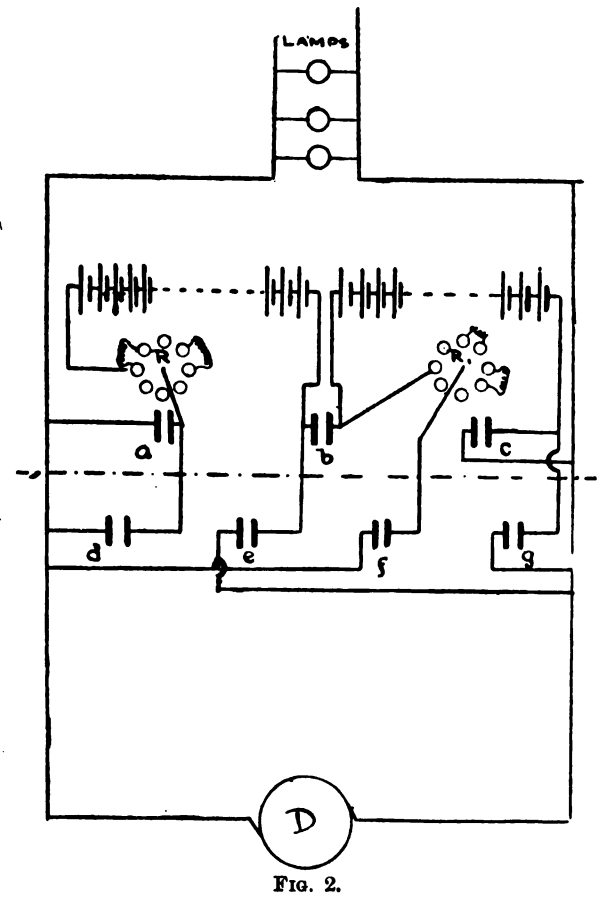

FIG. 2.

40 cells, the difference between a group at charge and discharge thus being 30 cells in one case and 20 in the other.

(*c*) In the third system in which the current going through the battery is raised in pressure by means of an independent machine or booster, the arrangement is as in Fig. 3, in which D is the dynamo and B is the booster,

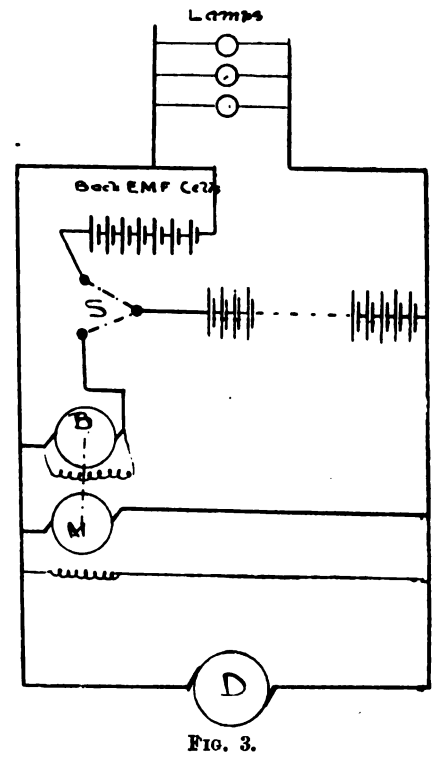

FIG. 3.

driven by a small motor or from an extension of the shaft of D. In discharge, the throw-over switch, S, is put on the top contact when the battery is connected directly across the mains, the correct pressure being obtained either

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by a discharge regulating switch or by a number of back E.M.F. cells, preferably the latter for reasons named above—viz., that the whole of the battery gets discharged to the same amount. In charging, the booster is started and its voltage adjusted, so that added to that of the mains it will just exceed the terminal pressure of the battery. The throw-over switch is then put on the lower stop, when the battery will start charging at a low rate. The voltage of the booster is then raised till the desired rate of charge is obtained. Its advantages are that with it the cells receive much better treatment than with either (*a*) or (*b*), thus augmenting their life, and the regulation of the pressure on the mains is superior to either of the other two methods. Its chief disadvantage is its higher capital outlay. In selecting any of these systems, the conditions of each individual case would be the chief guide, but with a moderately large battery, when the depreciation losses for (*a*) and the losses in the resistances for (*b*) would be considerable, then the booster system is preferable.

With regard to the second part of the question, it certainly is possible for the booster to reverse if due precautions are not taken. Taking the case of a self-excited shunt-wound booster, if the voltage of the battery had dropped to 98 volts, and that of the mains was 100, in starting the booster, if the pressure at its terminals were three volts, then the total volts forcing current into the cells would be five. Let this cause a current of, say, 50 amperes, then the drop in the booster armature due to this current flowing, if its resistance were, say, ·1 ohm, would be five volts, so that the pressure at the terminals of its shunt would be 0, and finally it would be excited in the opposite direction, thus causing a back E.M.F. to the main current, a balance being eventually arrived at when any increase in the booster voltage causes the total current flowing to decrease to such an extent that the drop of volts in its armature decreases at the same rate that its voltage increases. This reversal only applies in the case of self-excited machines; if excited off the mains, then no such thing would occur.—F. B. B.

PHYSICAL SOCIETY.

At the ordinary meeting of this society on Oct. 28, 1898, Mr. Shelford Bidwell, president, in the chair,

A paper was read by **Mr. W. R. Pidgeon** on "**An Influence Machine.**" The machine, which was exhibited, consists of a pair of glass discs rotating in opposite directions upon a spindle. They are partially covered on one face with narrow radial sectors of tinfoil, each provided with a small brass knob. This face of the disc, including its sectors, is then coated with insulating wax, leaving only the knobs projecting through the wax. Two earthing brushes pass through two insulated fixed inductors, and support them. The inductors are kept charged by exploring points connected to each, and placed so as to collect electricity from the revolving discs. By means of brushes the sectors on each of the discs are successively earthed at the moment they pass the fixed inductors—*i.e.*, at the moment that their capacity is a maximum—and they are made to deliver up their charge to the main collecting brushes at the moment when they are electrically farthest from the inductors—*i.e.*, when their capacity is a minimum. Hence, if there is no loss of electricity in the process, the potential at the collecting brushes is proportionately high. Each sector of a particular disc, as it moves away from its inductor with rising potential, induces a corresponding potential on the sectors opposed to it on the second disc. This action is cumulative. The thick coating of wax restricts leakage to the small area of the contact knobs, so that surface effects of dirt and moisture are minimised.

Captain J. H. Thomson, R.A., said that apart from its electrical merits, the machine possessed advantages in mechanical construction. He thought there was still room for improvement in this respect. The countershaft should be done away with, and ball bearings should be introduced. The inductor was a distinct improvement. He thought the efficiency might be increased by adding other inductors. Platinum-iridium was the best material for brushes of such machines.

Prof. Ayrton asked what efficiency was obtained with modern influence machines in general.

Captain Thomson had found that when running a machine by a motor about 80 cent. of the power was wasted in mechanical friction; of the remaining 20 per cent., a great deal was lost as electrical leakage.

Prof. S. P. Thompson thought it had been pointed out by Mr. Wimshurst that influence machines did not work well unless there were at least two thicknesses of glass between the inducing and induced conductors. That was why Mr. Wimshurst put his sectors on the outer faces of the glass discs. Mr. Pidgeon had departed from this. The advantage of the narrow spacing of the sectors was not very apparent.

Mr. Wimshurst (abstract of communication): Waxing the discs reduces leakage, and increases the output; the wax coating virtually doubles the number of plates. Inductors contribute a further increase to the output. In 1883 Mr. Wimshurst tried thick coatings of shellac, and also, duplicating the glass, with in some cases sectors upon the second glass to increase the capacity. The output was increased, but the construction lost simplicity. The indifference of Mr. Pidgeon's machine to dirt and dust was a most valuable result.

Mr. Pidgeon, in reply, showed a set of secondary inductors such as Captain Thomson had just proposed. They improved the output by about 15 per cent., but they were troublesome to keep in order, for they increased the tendency to "reverse."

Dr. S. P. Thompson then repeated an experiment discovered by Prof. Righi on "**A Magneto-optic Phenomenon.**" It was originally described in *Roma, R. Accad. Lincei*, atti. 7, ser. 5, 1898. A substance absorptive of light is submitted to a powerful magnetic field between the pole-pieces of an electromagnet. The pole-pieces are drilled so that a beam of light from an arc lamp can traverse the gap *along* the magnetic lines. A polarising prism is placed between the arc lamp and the electromagnet. After having passed through the magnetising apparatus, the beam thus polarised is examined by an analyser. The analyser must be turned to "extinction" before the magnetising current is turned on. If this is done, brightness is restored at the analyser as soon as the magnetic field is established. The substance absorbing the light in the gap may be nitric oxide fumes, or an ordinary spirit lamp sodium flame. The second effect to be noticed is that when the emergent beam is examined there is a splitting of the lines. Righi explains this by supposing that when light of frequency n is brought into a magnetic field and passed *along* the lines of the field, it is split up into two sets of circular waves, a right-handed and a left-handed set, one of which sets is accelerated and the other retarded. There are now two frequencies, n_1, n_2 one a little higher and the other a little lower than n. But since the analyses is adjusted to extinguish n, there is brightness for n_1 n_2. Normally, nitric oxide absorbs green, and red is observed; but when the magnetic field is set up, blue-green light is seen at the analyser, for there are now two different kinds of light being absorbed, one of higher and one of lower frequency than the normal, and what is observed is the complementary spectrum. Again, if a tube of sodium is warmed to a point far short of that which would cause it to emit visible rays, and the vapour is passed into the magnet gap, at the moment when the magnetic field is set up the D line becomes visible in the observing spectroscope—*i.e.*, the emission spectrum is obtained of a substance which is not actually emitting light.

Mr. Blakesley said that no doubt the analyser was used at the position of extinction for convenience merely. In other positions the eye would be overwhelmed with light.

Mr. Albert Campbell then read a paper on "**The Magnetic Fluxes in Meters and other Electrical Instruments.**" He has recently undertaken the measurement of the magnetic fluxes and fields in certain instruments to determine the order of magnitude of the flux density. In other cases the *total* flux is measured; and in the tests on meters the power lost in the various parts of the instruments is determined. For the measurement of B, the ordinary ballistic galvanometer method is employed, with an exploring coil. But, for alternating fluxes, two special methods are adopted, in the first of which the exploring coil is in series with a heating coil associated with a thermopile; in the second, a telephone is connected in series with the search coil and a potentiometer resistance strip. A constant current is sent through the strip from the main alternate-current circuit supplying the meter or other apparatus. The telephone and search coil therefore forms a shunt to that circuit at the strip. The search coil is put into position in the field to be tested, and the strip is then adjusted to give silence in the telephone. All these methods are described in detail in the paper, and very important deductions are made especially as regards the influence of the earth's field on instruments generally assumed to be independent of the earth's H. In a few cases, diagrams are given of the fluxes in magnets, showing exactly what proportion of the total flux is effective at the gap.

Dr. S. P. Thompson suggested that as the paper was of great significance to all who were interested in the design of electric meters and other measuring instruments involving a knowledge of magnetic fluxes and their variation, an opportunity should be given for their full discussion.

The **President** proposed votes of thanks, and adjourned the discussion of Mr. Campbell's paper to the next meeting on Nov. 11.

LEGAL INTELLIGENCE.

THE CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED, AND THE CAMBRIDGE UNION.

The hearing of the appeal case of the Cambridge Electric Supply Company against the union assessment for rating purposes was resumed in the Outer Temple, London, on Saturday, the 29th ult.

Mr. Rawlinson, Q.C., having opened the case for the respondents, **Mr. W. G. Cooke**, rating surveyor, stated that he considered the life of electric lighting machinery was at least 40 years, and that a sum representing four-ninths of 1 per cent. annually was a reasonable and sufficient amount to allow for depreciation; this length of life and depreciation would apply to all classes of machinery. Respecting cables, he looked upon them as if they

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were a pane of glass, and if they broke down they would need to be wholly renewed out of revenue, as they could not be repaired. Under these circumstances nothing should be allowed for depreciation.

Mr. Barnett, an engineering valuer, stated that he had examined the works. He considered 20 years was a reasonable life, but his opinion differed from that of Mr. Cooke. He thought £300 per annum was ample depreciation on a capital of £45,000, or two-thirds of 1 per cent. He had seen the works, and thought there was not £500 worth of spare plant, cables, or material on the premises. He was asked was he aware that there was at least 12 drums of cable in stock on the day of his visit, worth from £40 to £50 apiece, alone representing more than the sum he stated. He said he had not seen them. He also considered that a hypothetical tenant should be quite satisfied after paying £2,100 rent if he made £500 a year profit.

Mr. A. H. Preece was asked what he considered a fair life for electricity undertakings, and he thought about 25 years. Asked did he consider Lancashire boilers at 200lb. pressure would last that time, he said he considered they would. Indiarubber cables he gave a life of at least 15 years, and transformers up to 100 years. It was pointed out to him that companies such as the Westminster allowed 3½ per cent. on their capital for depreciation, although they had no rubber mains, and that Manchester and other large towns allowed more. In the face of this fact he agreed with the previous witness that £300 was quite enough for depreciation on £45,000.

Mr. Rawlinson addressed the Recorder on behalf of the respondents, and **Mr. Ryde** replied for the company.

The learned Recorder reserved his decision, and promised to deliver judgment on Dec. 1.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Warsaw.—Tenders are invited for transforming and working by electricity the present horse trams. Particulars are to be obtained from, and tenders addressed to, the Municipal Authorities.

Middlesbrough.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Nov. 29.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Dec. 1.

Bucharest.—Tenders are invited for 60,000 kg. of zinced steel wire, for the Post and Telegraph Department, where particulars may be obtained. Tenders, addressed to the Department, are to be sent in by Nov. 5.

Bucharest.—Tenders are invited for 16,000 small insulators, for the Post and Telegraph Department, where particulars, etc., may be obtained. Tenders, addressed to the Department, are to be sent in by Nov. 9.

Leatherhead.—The Urban District Council intend to sell the lease of their electric lighting order for a number of years. Details may be obtained at the office of the Clerk to the Council. The offer is open until Nov. 21.

Hornsey.—The Urban District Council are prepared to receive tenders for the supply of electric lighting plant and its erection at the Council's central public library. For particulars see our advertisement columns. Tenders by Nov. 7.

Barrow-in-Furness.—The Corporation invite tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches, and fittings. For particulars see our advertisement columns. Tenders by Nov. 14.

Knowle.—Tenders are invited for the supply and fixing of two engines and dynamos, equal to an output of 24,000 watts each, etc., for the County Lunatic Asylum, Knowle, near Fareham. Tenders by Nov. 10. Further particulars appear in our advertising columns.

Paris.—Tenders are invited for about 31 miles of cable (paper insulated), in two lots, and about 28 miles of indiarubber-insulated cable. Specifications, etc., are to be obtained from, and tenders addressed to, the Post and Telegraph Department, rue de Grenelle 103, Paris.

Cuenca (Spain).—Tenders are invited for the establishment and exploitation of a telephone system in the town. The deposit required is £20, to be raised to £40 within 30 days of acceptance of contract. Particulars, etc., are to be obtained from, and tenders addressed to, the Civil Government of the province of Cuenca.

Cork.—Tenders are invited by the Cork Electric Tramway and Lighting Company for proposed offices adjoining the power house, Albert-street, Cork. Specification, etc., may be inspected at the offices of Mr. Robert Walker, P.P.S A., architect and C.E., 17, South-mall, Cork, with whom sealed tenders are to be lodged by Nov. 14.

Hanley (Staffs).—Tenders are invited for the erection of a refuse destructor. The building in which the destructor is to be placed, or the brick chimney shaft, is not included in the contract. Further particulars, together with copies of the plan of two suggested sites, may be obtained on application to Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley, by Nov. 15.

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of transformers and accessories. Specification, form of tender, and general conditions can be obtained at the offices of Mr. A. H. Preece, A.M.I.C.E., 29, Victoria-street, S.W. Tenders, sealed and endorsed "Tender for Transformers," must be delivered at the office of Mr. W. H. Whitfield, clerk, Council Offices, Wimbledon, by 5 p.m. on Nov. 7.

London, E.C.—The East Indian Railway Company being desirous of introducing electrically-controlled block instruments on their system, invite proposals from makers only for the supply of (for single line) 18 instruments for nine blocks; (for double line) 80 instruments for 41 stations and six spare instruments. Tenders will be received up to 1 p.m. on Nov. 23, and particulars can be obtained on reference to Mr. A. P. Dunstan, secretary, Nicholas-lane, London, E.C.

Nottingham.—Tenders are invited by the Electricity Committee for the erection of a new electricity station in Talbot-street, Hanley-street, and Wollaton-street. The works will consist of an engine-room 148ft. long and 38ft. 6in. wide, a boiler-house 185ft. 6in. long and 31ft. 6in. wide, chimney 180ft. high, stores, boundary walls, etc., and the whole of the works are to be completed by July 9, 1899 Specification, etc., may be obtained at the office of Mr. Arthur Brown, M.I.C.E, city engineer, Guildhall, Nottingham, on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by Nov. 4.

Edinburgh.—Tenders are invited by the Magistrates and Council for the following works in connection with their electric light station in McDonald-road: (Contract No. 1) boilers (marine type) and mechanical stokers; (2) engines and dynamos. In contract No. 2 it is a condition that the firms tendering must have constructed machines of the very largest size for use in this country, and that the engines are made either by Messrs. Willans and Robinson, Rugby, or by Messrs. Belliss, Birmingham. Specifications, etc., can be obtained from the Resident Engineer, Dewar-place, Edinburgh, upon payment of £2. 2s. for each specification, to be returned on receipt by the Council of a bona fide tender. Specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by Nov. 14.

Bilston.—Tenders are invited by the Bilston Urban District Council for the construction of a line of telephonic communication between the Bilston waterworks pumping station at the Bratch and the town hall at Bilston, with the necessary receiving and transmitting instruments, and also the setting up of electric recording apparatus in the reservoir at Goldthorn Hill, with communication wires from the recording apparatus to the pumping station at the Bratch, and also to the town hall, Bilston. Plans may be seen at the office of Mr. Baldwin Latham, M.I.C.E, engineer for the works, 13, Victoria-street, Westminster, S.W., and also at the office of Mr. John D. Wassell, clerk, Town Hall, Bilston, and the form of tender may be obtained on application to the Engineer or to the Clerk on deposit of £5, which will be returned to all persons making a bona fide tender. Tender by 29th Oct.

RESULTS OF TENDERS.

London, N.—The Edmonton Board of Guardians have accepted the tender of T. Medcalf, Limited, Bradford, at £2,460, for installing the electric light at Edmonton House.

Gloucester.—The City Council have accepted the tender of Messrs. J. Gurney and Sons, Gloucester, at £7,676, for the buildings required for the proposed electricity works.

Burnley.—The Electric Lighting Committee have accepted the tender of the Burnley Ironworks Company, Burnley, at £400, for steam-piping; also the tender of Leach's, Limited, Burnley, at £50, for mechanical stokers.

BUSINESS NOTES.

Exeter.—The profit from last year's electric light is stated at £1,203.

Hythe.—The Town Council have decided to apply for an electric lighting order.

Chichester.—The city surveyor is preparing a report on lighting the city by electricity.

Stretford.—A public meeting to consider the electric light scheme will shortly be held.

Brighouse.—The new terms to consumers of electric light will come in force by Jan. 1, 1899.

Wrexham.—Steps are being taken to have the tramway from Wrexham to Rhos worked by electricity.

Cheltenham.—The Town Council have decided upon large extensions of their area of electricity supply.

Kingston (Surrey).—A low-tension electric main will be laid in Crescent-road as soon as another consumer is obtained.

Newington.—The Vestry have decided to advertise for a resident engineer at the Vestry's electrical works, at a salary of £250 a year.

Southgate.—A special committee meeting of the whole Council was held on Tuesday to discuss Mr. Skelton's report on electric lighting.

Warrington.—Mr. Preece has been requested to prepare a scheme for the lighting of the borough, and to submit his report as soon as possible.

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Hampstead Electric Supply Company, Limited.—The share certificates are now ready to be exchanged for bankers' receipts and the allotment letters.

Brigg.—A committee has been formed by the Urban District Council to enquire into the cost and feasibility of introducing the electric light into the town.

Southampton.—The Council have decided that no expense on electric traction in any form should be incurred until a committee bring forward a complete scheme.

Queenstown —The Commissioners have given notice of intention to transfer their electric lighting order to a company for 21 years. The price is stated at £360.

Brentwood.—The Parish Council intend to strenuously oppose any company or individual attempting to obtain a monopoly for supplying the town with electric light.

Buxton.—The Board of Trade have approved of the introduction of the electric light into Buxton, but apparently the Urban District Council are taking no action in the matter.

Plumstead —The Vestry have approved of the draft provisional order for the supply of electric light and power, and the draft advertisement of intention to apply for such order.

Loughborough.—The Bill which the Corporation have decided to bring forward for the acquisition of the gasworks includes powers to borrow moneys for electrical undertakings.

Heywood.—The Town Council have resolved to request Mr. George Kemp, M.P., to oppose the passing of the electric lighting syndicate's private Bill through the House of Commons.

Arbroath.—The Gas Corporation have decided to apply to the Board of Trade for a provisional order authorising them to supply electricity for public or private purposes within the burgh.

Monte Video Telephone Company.—The annual meeting of this Company was held on Monday at Winchester House, Mr. H. Ward presiding. The report for the year ended July 31, referred to in our last issue, was adopted.

Retford.—The Town Council have decided to apply to the Board of Trade for a license to supply electricity under the Electric Lighting Act, 1882, for public or private purposes within the district of the borough of Retford.

Dudley.—The purchase of the Dudley and Wolverhampton tramway by the British Electric Traction Company, Limited, to which frequent reference has been made in these columns, is now practically an accomplished fact.

Whitehaven.—The General Purposes Committee of the Town Council have decided to promote a Bill in Parliament for the purpose of dealing with the question of extending the electric lighting area to the borough boundary.

Carlisle —A sub-committee has been appointed to inspect and report on systems of electric traction installed in other towns, and more particularly where the system of overhead electric traction is in use. Additional arc lamps are wanted in certain streets.

Brockholes.—Messrs. J. Mitchell's (of Brockholes) tender for the supply of electric light at Brockholes-lane and Smithy-place to Gynn-lane bottom has been accepted. The estimate shows a difference of nearly 7s. per lamp in favour of electric lighting.

Kirkcaldy.—The Town Council have agreed to make an application to the Board of Trade, under the Electric Lighting Act, 1882, for powers to authorise them to supply electricity for public and private purposes within the area of the municipal burgh of Kirkcaldy.

Tenders.—Fifteen firms recently submitted tenders on a clearly defined specification for the lighting of one of the suburban theatres in the south of London. The amounts varied nearly 200 per cent. on the bottom price, which was just over £5,000, while the highest bid was £14,000 odd.

Western and Brazilian Telegraph Company.—The directors, after placing £8,000 to the reserve fund, recommend a dividend at the rate of 5s. per ordinary share, or £3. 6s. 8d. per cent. per annum, free of income tax, for the six months ended June 30 last, carrying forward £1,428.

Hereford.—The Electricity Committee have submitted to the Town Council a report in which they express their belief that the establishment may be in working order in time to supply light by the beginning of next winter, and that the undertaking will ultimately prove a remunerative one to the citizens.

Bath.—The Electric Lighting Committee have resolved to ask the Works Committee to ascertain particulars as to the working of the electrical tramcars in such cities as have adopted the system, and to ask the Surveying Committee to appoint a certain number of members of their committee to meet them.

Bermondsey.—At a special meeting of the Vestry the following recommendation of the Electric Lighting Committee was carried: "That application be again made to the Board of Trade for a provisional order, authorising the Vestry to supply electricity for public and private purposes within the parish."

Kensington.—The Vestry's notice of application for a provisional order to produce, store, and supply electricity within the parish of St. Mary Abbotts, Kensington, at certain wharves and premises belonging to them in the parish of Hammersmith and in the parish of Chelsea has been published.

Grimsby.—The sealing of the agreement between the Great Grimsby Tramways Company and the Town Council, carrying out resolutions passed on Aug. 26 by the Committee on Electric Lighting, has been postponed pending further negotiations regarding the division of profit and length of lease.

Lye.—The Urban Council intend to proceed with their application for an electric lighting order. It is stated that the private company which intended to apply for a similar order has withdrawn from the field. Notice will shortly be given of an application to construct an electric line through Lye and Cradley.

Liverpool.—The City Council have formally confirmed the recommendation, already reported by us, that the Tramways Committee be authorised to carry out the construction of a double line of electric traction from the Dingle to Aigburth-vale with the overhead trolley system, at a cost of not exceeding £25,000.

Brentwood.—The Parish Council have instructed the Lighting Committee to ascertain particulars regarding the cost of establishing and maintaining a system of electric lighting. The Council intend to strenuously oppose any company or individual attempting to obtain a monopoly for supplying the town with electric light.

Personal.—We are informed that Mr. Claude W. Hill has resigned the post of manager to the Phœnix Dynamo Company, of Bradford.—At a meeting of the Birmingham Municipal Technical School Committee, on Monday, Mr. Thomas Reed, of Dundee, was appointed to the post of head teacher of the engineering department.

Islington.—The Electric Lighting Committee is to report to the Vestry on the cost of providing the electric light from Highbury-corner along Canonbury-road and the New North-road, in order that the Islington installation may meet the electric lighting system being at present carried out by the Vestry of Shoreditch as far as the boundary of that parish.

Dundee.—At a recent meeting of the Markets and Baths Committee of the Town Council a report on the installation of electric light in High-street, Lochee, was submitted, showing that the installation had been completed and was working successfully. The report was approved of, and it was agreed to erect another lamp in High-street, Lochee.

Belfast.—The electrical engineer having submitted an estimate of the cost of laying mains from the station to Mountpottinger junction—his figures being: on one side of the route £2,178, on both sides £3,477—he has been instructed to ascertain what demand for current there is likely to be in the district, and what the mains referred to would supply.

Winsford.—The Urban Council have been discussing the question of lighting the district by means of electricity. It was reported that the first installation to light the whole of the main streets would cost £7,700. Notice was given of a motion that application be made to the Board of Trade for a provisional order granting powers to the Urban Council to undertake public electric lighting.

Lincoln.—About four miles of cable have now been laid, and the light will be available in a few weeks. To meet the demands of the citizens the City Council finds it already necessary to extend the mileage to about 10 and the power from 5,000 to 18,000 8-c.p. lamps, and decided on Wednesday to apply to the Local Government Board for power to borrow an additional £10,000 for electric light purposes.

Tobermory.—Preliminary steps have been taken in connection with the proposed installation of the electric light at Aros House. Mr. Stirling, electrical engineer, Glasgow, is superintending the arrangements at Drumfin. The water power is abundant, and obtained from a waterfall within the Aros Woods. A connection is to be made to supply the light to the manager's house and Baliscate House, about a mile distant.

Newcastle.—At the City Council meeting on Nov. 9 the new Improvement Bill, to be promoted in the next session of Parliament, will come up for discussion. The Corporation intend to seek powers to construct and work tramways; to establish at the Manors a station for the production of electrical energy for tramway and street-lighting purposes; to establish a telephone exchange: to make various street improvements, etc.

Stone.—The Urban District Council have received a letter from the British Electric Traction Company, Limited, stating that owing to the attitude of some of the local authorities the Potteries Electric Traction Company, Limited, were unable at present to carry out a complete scheme, and it was therefore not proposed to proceed with their application, under the Electric Lighting Acts, for an orders for powers within the area of the Council.

Atherton.—The District Council have approved the proposal of the Lancashire Light Railways Company, Limited, to construct a light electric railway from the terminus of the St. Helens tramway system to Bolton, and will support the same subject to the arrangement of such provisions as may seem necessary for the protection of the Council's interests so far as they are affected, and for the accommodation of the inhabitants of the Council's district.

Leeds.—The new line from Meanwood-road, at its junction with Cambridge-road, along Woodhouse-street to Hyde Park, has now been completed. A trial car was run over the track on the 28th ult. A regular service of cars will be inaugurated within a few days. The line forms a section of the tramways to be laid in Victoria-road, Cardigan-road, and St. Michael's road, Headingley, as well as in Burley-road, Burley-street, and forward to the city.

Glossop.—At a special meeting of the Town Council a discussion took place as to whether or not a resolution passed by the Council on June 29 last, applying for a provisional order to supply electricity for the borough, should be rescinded. Finally, it was decided that the Council should apply for the provisional order.

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Notice of motion was given to discuss on Nov. 9 whether the Corporation should transfer the order to a private company or not.

Formby.—The Lighting Committee of the Parochial Committee have under consideration a letter from Mr. A. B. Blakey, electrical engineer and contractor, in which it is stated that he is prepared to bring out a private supply company to supply electricity to Formby and the district, and offers to submit an estimate for supplying 100, 200, or 300 street lamps with current from the mains per year, keeping them in repair, supplying new lamps as required, and lighting same.

Slesford.—At a meeting of the Tradesmen's Association held on Monday last a report of the Lighting Committee, which recommended a scheme of electric lighting for the town, was adopted, and it was also resolved to ask the Urban District Council to appoint a sub-committee to go fully into the matter with the Lighting Committee with a view to the Council adopting the scheme, and that in the event of the Council declining to do so, efforts should be made to form a company to carry it out.

Buenos Ayres.—La Capital Tramways Company, Limited, has, the *Financial Times* is informed, now 14¾ miles of tramways in Buenos Ayres operated by electricity, the section between Comercio and the Government House, Plaza de Mayo, recently under conversion from horse to electric traction, having been successfully inaugurated on 27th ult. La Capital (Extensions) Tramways Company, Limited, successfully inaugurated their electrical passenger service out to the Nuevo Chicago on Sept. 11 last.

Barnsley.—Colonel W. Langton Coke, Local Government Board inspector, held an unopposed enquiry on the 28th ult. into the application of the Corporation for power to borrow £25,000 for the purposes of electric lighting. It was stated that the buildings are estimated to cost £4,678. Provision would be made to serve a tramway system should it be desired, and the feeder mains would have a capacity for 20,000 lamps of 8 c p. The plant would be able to be doubled at a cost of £2,000 on plant and £500 on buildings.

Enclosed Arc Lamp Patents.—We are informed that the Jandus Arc Lamp and Electric Company have retained leading counsel and experts for the action they are prosecuting against Messrs. Beanland and Perkins in connection with the "Ajax" arc lamp. The decision of the Court in the present action will soon be made known, but as it will probably be considered of sufficient importance to be taken to the House of Lords, the final decision cannot be expected for some time. The company will not, however, grant any further license after the first hearing of the case.

Rochdale.—At the last meeting of the Guardians a resolution to the effect that the Board accept the tender and specification of Mr. Thomas Barton, of Blackburn, for the electric light installation at the workhouse on condition that the Local Government Board sanction the cost being met by a loan, to be repaid in 10 years, gave rise to a rather noisy debate. On a show of hands being taken the proposition was referred to the Electric Lighting Sub-Committee for further consideration, and the committee were empowered to call in an engineer to advise them in regard to the tenders.

Rhyl.—The Council have passed the following resolution: "In the face of notices of intended applications for electric light for Rhyl served upon the Council, and recognising that the time has arrived for the Council to take action themselves to supply the district with electric light, the General Purposes Committee be empowered to engage an engineer for taking immediate steps to formulate a scheme, combining provision for a dust destructor, with power also to engage legal assistance as may be necessary for compliance with the Act and the rules with respect to applications to the Board of Trade for a provisional order under the Electric Lighting Act, 1882 and 1888."

Twickenham.—In addition to the application of the Drake and Gorham Power and Traction Company, Limited, for a provisional order enabling them to run an electric railway from Richmond Bridge through Twickenham to Hounslow, the District Council have received notice from the London United Tramways Company, Limited, of their intention to apply for an order under the Light Railways Act, 1896, to construct and work certain tramways (extensions of their electric tramways system) within the jurisdiction of the District Council of Twickenham. The London United Tramways Company have already power to run electric trams through Brentford to Hounslow, and the overhead wire system is to be used on that line.

Hammersmith.—The special committee of the whole Vestry having considered the application of the London United Tramways, Limited, for consent to use a system of electric traction, have reported as follows: "That before the Vestry is prepared to consider the application of the London United Tramways, Limited, for consent to the use by the company of a system of electric traction upon their tramways in this parish, the company should, without prejudicing any future action of the Vestry, undertake to pay to the Vestry the amount of the expenses incurred in opposing their Bill in the last session of Parliament; and that the company do deposit plans with the Vestry showing the system proposed to be adopted." This has been agreed to by the Vestry.

Croydon.—The Lighting and Electricity Committee have considered an application to be informed at what price motorcars might be charged with current at the electricity station, and have resolved to charge 9d. per unit for the supply of such current. At a recent meeting held under the auspices of the Committee to Promote the Municipalisation of the Croydon Tramways, to consider and aid the movement undertaken by that committee, the following resolution was carried: "That seeing the advantages that have accrued to other towns as a direct consequence of the municipalisation of their tramway services, and believing that the profits on streets laid out and maintained at the public cost should belong to the public, the meeting is of opinion that the tramways of Croydon should be both owned and worked by the Corporation on behalf of the town."

Yarmouth.—At a special meeting of the Town Council on Monday a scheme of municipal electric trams, and the consequent promotion of a Bill for obtaining the necessary parliamentary powers during the forthcoming session, was agreed upon. The amended scheme of the borough surveyor, arrived at by cutting out certain sections and dropping some routes, and estimated to cost £41,000, exclusive of the cost of extending the present electrical generating station to meet the requirements that would fall upon it, has been decided upon. The tram route comprises eight short sections through central parts of the town, and a double line along the Marine-parade. The total length of tramway will be 3¾ miles, and the Corporation will supply motive power from its own generating station. The overhead trolley system of traction has been adopted. The electric trams, it is anticipated, will earn sufficient revenue to defray working expenses, interest charges, and capital repayments, and will also contribute to the reduction of the rates.

Southend.—The Town Council have agreed to apply to the Light Railway Commissioners for an order authorising the Council to construct light railways. The following routes have been agreed upon: a line to Prittlewell from the Middleton Hotel (High-street being omitted); a line from North road to the Cricketers; a line from Leigh to Southchurch Church; and a line from Southchurch-road to Marine-parade *vid* Southchurch-avenue. During the discussion of the matter at the last Town Council meeting, it was said that there would be a reduction of the rates each year by a considerable amount, the extent being the free profit of each year's working, which their officers estimated at £2,000, but which was more likely to reach £5,000, or an 8d. rate. The tramways would enable the Council to work the electric lighting order at a saving instead of at a loss to the rates. By having electric illumination for shop displays and otherwise there would be a saving of the loss which now resulted through the consumption of gas. A saving of £500 would be made in lighting the pier.

Bordeaux Tramways and Omnibus Company, Limited.—At an extraordinary general meeting of this Company, held on Wednesday at Winchester House, Lord Richard Broune in the chair, the following resolution was passed: "That the action of the directors in selling to the Compagnie Française des Tramways Electriques et Omnibus de Bordeaux, in conformity with the obligations imposed on this Company by the Municipality of Bordeaux, all the assets of this Company, and in selling the shares given as the consideration for this sale to the Thomson-Houston Company for the price stipulated by the preliminary agreement, be and is hereby approved, and that the sale of the undertaking and property of the Company on the terms of the agreement or arrangement embodied in the three letters dated July 12, 1898, referred to in the resolution of the Company passed and confirmed at extraordinary meetings thereof, held respectively July 22, 1898, and Aug. 8, 1898, as modified by the provisional agreement of Sept. 27, 1898, referred to in the circular to the shareholders dated Oct. 19, 1898, be and the same is hereby approved and confirmed; and that the directors be and are hereby authorised to do all such things as may be necessary for carrying the same agreement or arrangement as so modified as aforesaid into effect, or with such further modification as the directors may think fit."

Catalogues.—We have received from Mr. Henry Pynegar, London, his latest list, which contains specialities in machine tools, cranes, pumps, locomotives, and hydraulic machinery; also plant and appliances for the use of electric light and power, telegraph, and railway contractors. We especially notice Hermuey's patent pulley block. Mr. Pynegar is agent for Messrs. James Spencer and Co., Hollinwood, near Manchester; Messrs. Lee Howl, and Co., Limited, Tipton; Messrs. Nasmyth, Wilson, and Co., Limited, Patricroft; and Mr. J. W. Mitchell, Rawtenstall.—The latest list of Messrs. A. J. Beaumont and Co., of York, contains specialities for theatre, stage, cinematographs, and all other scientific purposes, such as projectors, various kinds of automatic and hand-fed arc lamps for stage and lantern use.—We have received from Messrs. Johnson and Phillips a collection of price-lists, reprints from electrical papers, etc., illustrating their work in England and abroad. Amongst them are views of the motors at the Sheba Mine, and of the generating stations and plant at many of the English corporations; also illustrations showing the Johnson and Phillips dynamo connected to various kinds of engines. As a rule, prices are added, and we think it would be a great advantage if the loose sheets were held together in one binding. At present the sheets most valuable for reference are almost sure to be removed by interested parties, and the value of the collection as a whole is in this way reduced.

Clerkenwell.—At the last meeting of the Vestry the Works Committee reported that they had very carefully considered the question of dealing with the paper, etc., which is sifted from the dust. The present furnace is in a very defective condition, and likely to collapse at any time They were of opinion that it is desirable to erect a small destructor that would deal more effectually with the combustible matter sifted from the dust, and at the same time to be able to burn the market refuse which is now barged away. The approximate quantity of refuse to be dealt with is 5,106 tons per annum. They (the committee) had invited tenders and designs from Messrs. Beaman and Deas, J. Baker and Son, and the Horsfall Destructor Syndicate, Limited.

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The following were the tenders: Messrs. Beaman and Deas (not including roof), £1,097; Messrs. Baker and Son, £1,089; and the Horsfall Syndicate, Limited, £1,640. The present cost of barging the market refuse and soft core away is about £310 per annum. This amount would be saved, less about £60 for removing clinkers, making a net saving of £250 per annum, and this amount would probably be increased by a sale of at least part of the clinkers. They (the committee) begged to recommend "That, subject to Messrs. Baker and Son entering into the necessary agreement, and giving satisfactory guarantees, their tender of £1,089 for a two-cell destructor, to consume not less than 9,000 tons per annum, be accepted." The Horsfall Company offered to put the present furnace in repair for £100. The report was agreed to.

Waterloo.—A draft agreement has been arrived at between the Council and the directors of the Liverpool Overhead Railway Company with a view to them running an electric tramway from Seaforth to Great Crosby on the following lines: (1) arrangements to be conditional upon (1) the company obtaining the necessary parliamentary powers, and (2) the company coming to an agreement with the Great Crosby District Council; (2) the Council to grant a lease of the authorised tramways; (3) the Council to do all work connected with the road and rails (including the foundation for posts, if any), but subject to the reasonable approval of the company; (4) the company to provide electrical equipment (except the foundation for posts, if any), rolling-stock, carriage sheds, etc., subject to the reasonable approval of the Council, and to work the lines; (5) the roadway to be maintained by the District Council, all other maintenance to be done by the company; (6) the company to pay a rent to be agreed upon; (7) the company to pay the costs of the Council's provisional order not exceeding £500; (8) the company to provide as a minimum a service of cars every 10 minutes for nine hours of each weekday, and every 15 minutes for six hours on each weekday, Sunday service to be agreed upon; (9) the fares not to exceed those authorised by the provisional order, provision, however, to be made for penny stages; (10) Council's costs of and incidental to the agreement to be paid by the company; (11) the Council to give any consent that may be required to lay tramlines along the new road on the north side of the railway.

Hull.—The Finance Committee of the Corporation have resolved upon the borrowing of £16,000 for electric lighting generating plant, etc. It appears that a serious hitch has arisen in connection with the reconstruction of the Hessle-road system of the Hull electric tramways on account of some dispute between the contractor and the Corporation. With regard to the measurements, the city engineer is under the impression that there must be some mistake in the measurements of the work, a mistake which, the contractor claimed, told seriously against himself. The payments have hitherto been made upon the measurements sent in by the contractor himself, and the contractor had always accepted the measurements of the city engineer. It is rumoured that there is something more in this, however, and the Works Committee has been empowered to take such steps as they might consider desirable to secure the completion of the tramways work and the completion of the Hessle-road paving. The *Leeds Mercury* says the Works Committee have decided to take definite action in the way of ordering the work to proceed. By this action the Corporation become larger "contractors" for themselves than they have hitherto been. They will complete the Hessle-road section, and if the weather remains anything like favourable they will go forward with the Anlaby-road section, so that the work may be completed in time for the Yorkshire Agricultural Show of next year. Whether the remaining roads will be undertaken by the Corporation remains to be seen.—Mr. R. H. Bicknell held an enquiry on Tuesday into an application by the Corporation for power to borrow, among other amounts, £26,000 for electric light extension, and £4,103 for a refuse destructor in West Dock-street. There was no opposition to any of the proposals.—A proposal was before the Guardians at their last meeting to light the workhouse by electricity. Nothing was decided.

Manchester.—On Monday three representatives of the Manchester Corporation—namely, Mr. Alderman Southern, chairman of the Telephone Committee, and Messrs. Copeland and Brocklehurst, members of the committee—accompanied by Mr. Talbot, the town clerk, had an interview at St. Martin's-le-Grand with the Postmaster-General. The object of the deputation was to ascertain, if possible, the attitude of the Department in relation to a competitive telephone service. During the discussion which took place, the following questions were put to his Grace, to which he promised that a specific reply in writing should be forwarded: "(1) Does the Postmaster-General propose to take action for establishing Post Office competition in Manchester? (2) In the event of the first question being answered in the negative, is it practicable for the Postmaster to grant a license to the Mutual Telephone Company, Limited, under sufficient guarantees for the Corporation having the exclusive right to purchase their undertaking, and upon other conditions satisfactory to the Corporation? (3) In the event of a negative answer to questions 1 and 2, the following questions arise: To enable the City Council to determine whether to establish a telephonic service of its own, it is necessary to be informed to what extent the Postmaster-General intends to give effect to the recommendations contained in the Select Committee's report, especially under the following heads—(*a*) by introducing a public Bill for enabling the Postmaster-General to grant provisional orders to enable the local authority to lay down and work telephones in its own district and the districts of other authorities within a specified area; (*b*) to enter into an agreement that the Post Office will purchase the land, buildings, and plant of the new undertaking in 1911; (*c*) to assist the Corporation to obtain a suspension of the sinking fund and allow payment of interest out of capital for, say, three years, in order to avoid an undue burden upon the rates; (*d*) definition of area to be of sufficient extent and to embrace the large towns near Manchester." His Grace, in reply, intimated that the Post Office did not intend to grant any further licenses to private companies. As regards the future policy of the Post Office, however, he could not say anything. The report of the Select Committee was presented at the end of last session, and in some way or other the opinion of Parliament would have to be taken upon it when Parliament meets, but he could not say what the Government would do, or anything which would be a sort of *quasi*-pledge. The deputation, having thanked the Postmaster General, then withdrew.

London County Council.—The Finance Committee's report on loans contains recommendations as follows: (1) *re* Newington Vestry loan (repayable on instalment system) of £10,000 for electric lighting purposes: that, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Newington for a loan of £50,000 towards defraying the cost of the installation of the electric light in the parish be granted at present to the extent of £10,000, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3 per cent. per annum, payable quarterly on Jan. 31, April 30, July 31, and Oct. 31 in each year, and the principal being repaid by equal annual instalments on each Oct. 31 (the first instalment being payable on Oct. 31, 1902), within a period of 42 years from the date of the loan; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund. (2) *re* Shoreditch Vestry loan (repayable on annuity system) of £10,470 for electric lighting purposes: that, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Shoreditch for the advance of £11,609, balance of a loan of £22,949, to defray the cost of the purchase of land and the installation of electric light in the parish, be granted, to the extent of £10,470, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3 per cent. per annum, calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed—as to £5,360 within a period of 50 years, as to £4,790 within a period of 42 years, and as to £320 within a period of 30 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund. In each case a clause is added to the effect that it be notified to the Vestry that as they have elected to spread the whole of the initial cost of the proposed additions and extensions of the electric light installation over 42 years, the Council will decline to give its sanction to the raising of any loan to replace any of the plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all replacements and renewals required during that period out of a sinking fund to be provided for that purpose or from maintenance account.

Kensal Town.—At the last meeting of the Chelsea Vestry a report of the Electric Lighting Committee on the proposed electric lighting of Kensal Town was carried. We extract the following from the report: "After careful consideration of the question, the committee feel that any statutory powers for lighting Kensal Town by electricity should, if possible, be in the hands of the Vestry as the local authority, and not in the hands of a private company. The committee, therefore, recommend as follows: (*a*) that application be made to the Board of Trade for a provisional order authorising the Vestry to supply electricity for public and private purposes in the Kensal Town portion of the parish, and that the common seal of the Vestry be affixed to the necessary memorial to the Board of Trade; (*b*) that all other necessary steps be taken to give effect to this resolution, in accordance with the rules made by the Board of Trade, under the Electric Lighting Acts, 1882-1890. The surveyor, in a reprint of that portion of his report, dated Oct. 30, 1897, which dealt with the question, stated, *inter alia*, 'The most suitable low-pressure system would be the "three-wire" system, by means of which a great saving in copper is effected, as compared with the simple parallel system, and efficient regulation of the pressure by means of feeders is possible in a district of the size of Kensal Town, without the use of transformers or motor-generators. The very lowest cost of such an installation would be: site, £3,500; buildings, £6,000; boilers, machinery, and electrical apparatus, £10,000; mains and feeders laid complete, £12,000; provisional order, fees, instruments, and incidental expenses, £4,500—total, £36,000. The annual cost of working such a station when it is in thorough working order, with a fair load, should not exceed 4·5d. per unit sold—that is, of course, making no allowance for repayment of capital. After some years working, the number of watts sold annually might possibly be: public lamps having two 16-c.p. incandescent lamps in place of existing gas-burners, 90,000 units; public buildings, 8,500 units: shops, 20 at 480 units, 9,600 units; private houses, 60 and 120 units, 7,200 units; various buildings, 4,700 units—total, 120,000 units; 98,500 units to public lamps and buildings, at cost of production, say 4½d. per unit, £1,846. 17s. 6d.; 21,500 units to consumer at 6d., £537. 10s.—total, £2,384. 7s. 6d.; cost of production of 120,000 units at 4½d., £2,250, leaving a profit on working

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of £134. 7s. 6d. There is, however, nothing allowed for interest on capital, and as regards the public street lamps, the substitution of two 16-c.p. incandescent lamps for the existing gas-burners causes an increase in the annual expenditure of £1,150. the cost of electric current (apart from lamp renewals) being £1,688, against £530 now paid for gas. This in itself is a serious annual addition to the Vestry's lighting bill."

St. Marylebone.—Last Monday, at a meeting of the members of the St. Marylebone Vestry, the report of the Electric Lighting Committee, recommending "that the committee be empowered to enter into preliminary negotiations with the Metropolitan Electric Supply Company for the purchase of their undertaking in this parish and to report to the Vestry," Mr. Brooke Hitchings, C.C., the chairman of the committee, moved the adoption of the report, and in doing so said that it was a recommendation that the committee unanimously agreed to. It was very desirable in that parish that the electric light monopoly should be broken. The committee had done all it possibly could to break the monopoly. They would remember they had a provisional order granted them by the Board of Trade, but unfortunately the Committee of the House of Commons threw out the Bill. The money that had been spent had not been lost, for they had wrung concessions from the Metropolitan Electric Light Supply Company that more than paid the ratepayers. The committee asked for the fight to be continued. Should they be unable to obtain powers for electric lighting, then they had to do what other parishes had done, to buy out the company. In Liverpool and Sheffield the companies had been bought out. With regard to lighting and watering he held that both should be in the hands of the municipality, and not in the hands of a monopoly. If they could purchase such a monopoly at a rate that would yield them a large profit, and enable them to light their streets and supply the ratepayers at a lower rate, then they should do so, and not wait till 42 years had expired, when under the Act they could take such over. He maintained that it would be to their advantage to purchase the Metropolitan Electric Supply Company's undertaking. Mr. T. W. Baker seconded the recommendation. Sir Edwin Galsworthy, D C L., J.P., said that he thought that Mr. Brooke Hitchings was wrong in stating that concessions had been wrung from the Metropolitan Electric Supply Company, because he said that other parishes were to have similar concessions. He would ask the Vestry to mind what they were doing in giving the committee the power which was asked, or else they would be landed into a great expense. He questioned whether the Vestry had the power to purchase the company's undertaking, and then another question arose whether the company could sell to the Vestry. The committee, when they had got their provisional order, should have gone and negotiated with the company, or now should wait till they had another provisional order. He moved as an amendment, "That the committee be empowered to ascertain from the Metropolitan Electric Supply Company whether the company are prepared to sell the whole or part of its undertaking to the Vestry, and if so on what terms; further, that the committee should report to the Vestry." Mr. Edward White, L.C.C., seconded the amendment. Mr. Crook approved of the report. Mr. Sutherland said that he thought the ratepayers desired the electric lighting in the hands of the Vestry. The outlay, he admitted, would be great, but it should not be forgotten that they would be spending their money wisely. They should allow the committee to go to the company and show that the Vestry were prepared to pay a fair and reasonable sum for their undertaking. Mr. B. Shaw, L.C.C., supported the recommendation. Mr. Martin Morris said that the Vestry was abused for the action that it took in granting permission to the company coming into the district rather than adopting electric lighting itself, but he thought the Vestry did well in the action it took. Mr. Brooke Hitchings said that he hoped the Vestry would not delay in this question. With regard to the power of the Vestry to purchase, the Board of Trade reserved to itself the power of transferring on terms to vestries. On a vote being taken the amendment was lost. Mr. Stringer moved another amendment, that the question be postponed until an opportunity had been given to the Vestry to reconstitute the Electric Lighting Committee. Mr. S. Chick seconded. Mr. Anglim said he would urge Mr. Brooke Hitchings either to withdraw from the committee or sell out his shares in the company. Mr. Dennis said that Mr. Brooke Hitchings offered to resign his position or sell out his shares. Mr. Brooke Hitchings was doing all he possibly could to get for the Vestry its own electric lighting. Mr. John Lewis supported the amendment. Mr. Brooke Hitchings said that he had disposed of his shares in the Metropolitan Electric Supply Company. He had done his best on behalf of the ratepayers. The amendment was lost by a large majority. The recommendation was then unanimously agreed to.

PROVISIONAL PATENTS, 1898.

OCTOBER 24.

22315. A method of and improvements in apparatus for electrically indicating time. Cornelius Edward Kelway, 111, Southwark Bridge-road, London.

22334. Combined engine and dynamo, which may also be used as a motor and pump or compressor. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Charles Clifton Cowan and Marcy Lelland Whitfield, United States.) (Complete specification.)

22335. Improvements in connection with branch lines from strong currents for preserving the insulation. Castle Smith, 1, Mitre-court-chambers, Fleet-street, London. (Lucian Gottscho, Germany.)

22344. Improvements in electric arc lamps. Hippolyte Delavan and François Felix Brérat, 7, Quality-court, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 24, 1898, being date of application in France.) (Complete specification.)

OCTOBER 25.

22383. Improvements in closed-conduit electric traction. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

22396. An electrical fishpond (improved). John Fitt Morris, 57, Glebe-road, Middlesbrough.

22419. Improvements in telephone transmitters. Max Byng, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

22434. A new or improved device for regulating the tension of continuous electric currents. Démétrius Monnier, 70, Chancery-lane, London. (Complete specification.)

22442. Improvements in electric discharging apparatus for use in the manufacture of waterproof cloth. Charles James Beaver and James Edgar Baxter, 322, High Holborn, London.

22449. Improved combined brake-pipe and electrical coupling for railway trains. Adamson George Wild, 46, Lincoln's-inn-fields, London.

22461. Improvements in primary batteries. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Herman Jacques Dercum, United States.) (Complete specification.)

OCTOBER 26.

22486. Improved means of electric communication between the passengers, guard, and driver of railway trains. Thomas Wilson, 115, St. Vincent-street, Glasgow.

22523. Improvements in conduits for electric tramways. Michael Holroyd Smith, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22537. Improvements in or connected with electric push buttons. Gustave Markt, 166, Fleet-street, London.

22545. Improvements in automatic telephone exchanges. William Phillips Thompson, 6, Lord-street, Liverpool. (The Strowger Automatic Telephone Exchange, United States.) (Complete specification.)

22547. Improvements in appliances or apparatus for automatically replacing fuses in electric light and power installation. Samuel Harrison, 6, Lord-street, Liverpool.

OCTOBER 27.

22569. Improved "self-replacing" indicator for bells, telephones, or other apparatus. Ernest Norris Webb Hume, 7, Trinity-square, Borough, London.

22584. An improved telephone index. John Francis O'Brien, 4, St. Ann's-square, Manchester.

22586. Pneumatic silent-speaking apparatus for telephones. Fredrick John Neal, 234, New Kent-road, London.

22599 Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Caryl D. Haskins, United States.) (Complete specification.)

22600 Improvements in incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (George B. Painter, United States.) (Complete specification.)

22601. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry C. Spinney, United States.) (Complete specification.)

22603. Improvements in prepayment electricity meters. Francis Maddison Long and Ernest Schattner, 55, Chancery-lane, London.

OCTOBER 28.

6991a. Improvements in index needles or pointers for electrical and other indicating or measuring instruments. Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Date claimed under Patents Rule 19, March 22, 1898.) (Complete specification.)

22664. New or improved appliances for use in securing the copper bonds or conductors in electric tramway rails. Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, 2, John-street, Bristol. (Complete specification.)

22683. Improvements in couplings for electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

22686. Improvements in magnetic brakes. Sydney Pitt, 24, Southampton-buildings, Chancery-lane, London. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert und Co., Germany.) (Complete specification.)

22697. Improvements in apparatus for regulating the intensity of electric currents. Henri Denis Wibratte and Albert François Lanaspèze, 6, Bream's-buildings, Chancery-lane, London.

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22699. Improvements in dynamo and electric machines. William Brooks Sayers, Henry Alexander Mavor, and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

22700. Improvements in the manufacture of tubes or conduits or the like, more especially intended for containing electric cables or conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

OCTOBER 29.

22728. Improved means for effecting the collection and transmission of high-potential electricity. Benjamin Howarth Thwaite, 29, Great George-street, Westminster, London.

22729. Improvements in methods having for their object the electrical propulsion of tramway cars and other vehicles and in apparatus therefor. Benjamin Howarth Thwaite, 29, Great George-street, Westminster, London.

22762. Improvements in the method of and apparatus for indicating and arresting the speed of electric tramway cars and the like vehicles. Charles Edward Binns Holt and Arthur Joseph Taylor, 10, Piece Hall-yard, Bradford.

22768. Improvements in methods of and apparatus for increasing the volume of sounds from telephonic or phonographic instruments and transmitting such sounds to distances. Horace Leonard Short, 65, Chancery-lane, London.

22777. An improved light distributor or reflector for electric incandescence lamps. Camille Feldmann. Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22799. New or improved method of and means for switching on and off the electric current in surface contact systems for electrically-propelled vehicles and safety "cut-out" for same or other surface contact systems. Francis Henry Davies and Robert Stanley Draycott, 31, Southampton-buildings, Chancery-lane, London.

22802. Improvements in or connected with reflectors for incandescence electric and other lamps. Louis John Steele, Sir John Blundell Maple, Bart., and John Verity, 4, South-street, Finsbury, London.

22803. Improvements in or connected with incandescence electric lamps. Louis John Steele, Sir John Blundell Maple, Bart., and John Verity, 4, South-street, Finsbury, London.

22805. Improvements in arc lamps and in carbons for same. Thomas Cooper John Thomas, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1897.

22444. Machinery or apparatus for transmitting motion from electric motors to other machinery. William Percy Drabble and Frederick Edmund Bracewell (executors of the late Joseph Whitworth Hulse).

22717. Interruptors for electrical circuits, more particularly applicable to induction coils. Phillips.

23097. Electrical conductor or cable. Nisbett.

24419. Telegraphic transmitting instruments. Draper and Gaye.

24884. Electro-deposition apparatus. Harris.

25245. Method for varying the speed of electric motors or the electromotive force of dynamo-electric machines. Lake. (Cantono.)

25412. Electrical resistances. Gambrell and Harris.

25582. Electric lighter for gas and petroleum motors. Henry Marie Leon Crouan.

25599. Electricity meters. Chamberlain and Hookham, Limited, and Holden.

25647. Manufacture of globes and shades for electric and other lamps. Dunlap.

28458. Electrically-controlled submarine mines. Hoffmann.

28839. Trolleys used on overhead wires for electric traction. Wood.

29062. Apparatus for the manufacture of electric cables. Smith and Granville.

29069. Syntonic telegraphy. Lodge and Muirhead.

30447. Supplying electrical energy to railways worked by alternating currents. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

1898.

3806. Apparatus for making and breaking electric circuits at predetermined times. Swoboda.

11604. Electro-metallurgic production of iron, steel, and their alloys with chromium, tungsten, nickel, manganese, and the like. Stassano.

13274. Generators for use in systems of electrical distribution. The British Thomson-Houston Company, Limited. (Steinmetz.)

17161. Automatic electric switches. McMillin.

17583. Electric batteries. Bugg and Darling.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Return for week Ending	1898.	Corresponding week 1897.	Increase or decrease	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Oct. 29	4 068	3,587	+ 481	—	—
Blackpool and Fleetwood Tramroad	,, 29	262	—	—	12,943	—
Bristol Tramways and Carriage Co.	,, 28	2 819	2,570	+ 248	—	—
City and South London Railway	,, 30	1,000	1,018	- 18	17,277	16,539
Dover Tramways	,, 29	190	117	+ 73	7,175	—
Dublin U.T., elec. cars	,, 28	375	†283	+ 92	9,072	6,456†
Dublin S.D. Electric Tramways	,, 28	823	482	+ 341	17,730	12,217
Halifax Corporation Tramways	,, 26	248	—	—	4,693	—
Liverpool Overhead Railway	,, 30	1,407	1,364	+ 43	—	—
South Staffordshire Tramways	,, 28	664	628	+ 36	27,224*	27,476*

* Receipts since Jan. 1. † Horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	15½-16½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10 10½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1½ 1¾
—— Non. Cum., 6 per cent. Pref.	2	2-2½
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9½-10½
——	6	5½ 6½
—— Pref. Half-Shares	1	1½-1¾
—— " "	5	4½-5
Charing Cross and Strand	5	11-13
—— 4½ per cent. Cum. Pref.	5	6½ 8½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	115-116
City of London, Ordinary	10	23½-24½
—— 90,001-100,000	10	23½-24
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-133
City and South London Railway, Consolidated Ordinary	10	70-72
—— Ordinary	3	2½-2¾
—— 4 per cent. Debenture Stock	100	126-130
—— 5 per cent. Pref. Shares	10	14½ 15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord. No. 30,000-40,000	10	13-13½
—— " "	6	10½-11½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1¾ 2
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	101-105
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	3	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1-1½
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	8½ 9½
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22-25
—— 4 per cent. Debentures	100	102-105
Kensington and Knightsbridge Ordinary	5	13-15
—— 6 per cent. Pref.	5	7½-8½
London Electric Supply, Ordinary	5	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	16-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-105
Notting Hill Electric Lighting Company, Limited	10	15-16
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7½-7¾
—— £4½ Shares, New	4½	6½-7
Oriental Telephone and Electric Company	1	1-1½
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,810	5	6-6½
Royal Electrical Company of Montreal	1½	156-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2½-3
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	8½-9½
—— 4 per cent. Deb. Stock, Red.	100	103-107
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104-105
Waterloo and City Railway, Ordinary	100	110-111
Westminster Electric Supply, Ordinary	5	14½-15½

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NOTES.

The Rontgen Society.—The president of this society has issued invitations for a conversazione to be held at the St. Martin's Town Hall, Trafalgar-square, on Monday, Nov. 21. There will, of course, be extensive demonstrations of X-rays, and the time allowed for inspection of them, and for other more social duties, will be from 8.30 to midnight.

Tinplate and Wire Work.—The Worshipful Company of Tinplate Workers (*alias* Wireworkers of London) has called a conference to consider how the company can promote the interest of the crafts it was formed to foster in the old days. For this purpose representatives of the leading manufacturers in the tinplate-working and wireworking trades are invited to meet the court of the company on Nov. 17 at the Guildhall, in the City, at 4.30 p.m.

Institute of Marine Engineers.—At the eighth annual dinner of the Bristol Channel Centre of the Institute of Marine Engineers on Oct. 29, Mr. M. W. Aisbitt received the Denny gold medal for the best paper on marine engineering contributed during the year. Mr. Aisbitt's paper dealt with screw propeller shafts, and Sir Edward Reed, who made the presentation, said he had read it through twice, an honour which he rarely paid to any paper.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 7th inst., Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding. The special thanks of the members were returned to Mr. John B. Carrington for his donation of £25, and to Mr. Charles Scott Dickson, Q.C., Solicitor-General for Scotland, for his donation of £100 to the fund for the promotion of experimental research at low temperatures.

Commutator Lubrication.—In an article in the *Elektrotechnischer Anzeiger*, October, 1898, H. Bartels gives an account of the advantages obtained by using a special compound for lubricating the commutators of dynamos. It is claimed that using this compound the brushes may be maintained stationary whilst the load of a dynamo is varied without any production of sparks. The brushes and commutator, after working for a considerable time, present polished surfaces. The nature of the compound is not disclosed other than to the extent that finely-powdered graphite forms a constituent. Only a very thin layer of the compound is employed.

Colonial Telephones.—How far we are behind the times in telephone matters was shown by the Hon. E. H. Wittenoom, Agent-General for Western Australia, and recently Minister for Posts and Telegraphs in that colony, who, in his lecture at a meeting of the Royal Colonial Institute, held at the Whitehall Rooms, stated that in Western Australia the charge for private customers was £5 per annum for a distance of about 1½ miles. This gives the subscriber the run of the whole town. Considering the difference in the amount of salaries, wages, and cost of material as compared with England, this compares with about £3 per annum in London.

Paper Poles.—Our contemporary *Electricity*, of New York, announces that telegraph and telephone poles are now being manufactured out of paper. The pulp from which these poles are made has mixed with it borax, tallow, and other ingredients. It is then run into a mould with a central core and comes out as a hollow tube of the proper diameter and length. Before being erected the poles are given a coat of paint or varnish, which makes them waterproof and very durable. If so desired, they may also be made fireproof by being saturated with a solution of alum water. We should like to see records of strength of the poles and details as to their weather-resisting powers.

Society of Arts.—The opening address of the society's session will be delivered on Wednesday, 16th inst., by Sir John Wolfe Barry, K.C.B., LL.D., F.R.S., the chairman of the society's council. The topic which the chairman proposes to deal with in his address is the internal traffic of London. In the list of papers also announced we note several of great interest. The one by Prof. George Forbes, F.R.S., on "Long-Distance Transmission of Electric Power," on 23rd inst., should command a large audience. A lecture by Mr. Philip Dawson, on "Electric Traction and its Application to Railway Works," is announced for after Christmas, as is also one by Mr. W. H. Preece, C.B., F.R.S., on "Wireless Telegraphy."

Electric Lighting at Darjeeling.—From notes appearing in *Indian Engineering* we gather that the town of Darjeeling is not happy in several of its public supplies. Thus microbes have started breeding in the new filter-beds, and the filtered water has, in consequence, been found to be more impure than the unfiltered water. Their electric lighting scheme seems also to be unfortunate, and some of the faults are specified in the present issue of our contemporary. Low voltage and high prices used to be the trouble. Now a Government expert has been called in, and reports that the distributing lines will require considerable alteration before they can be passed. The wires will have to be put further apart, so as to prevent contacts, the bamboo separators being discarded. A matter requiring improvement is the manner of taking off lamp connections from the distributing lines.

Liverpool Electric Tram Accident.—Mr. Sampson, Liverpool city coroner, held an inquest on Saturday last respecting the death of the boy, Alfred Edward Strong, who was run over by one of the Corporation electric tramcars on the previous day. The car was on a trial trip, and had a trailer car attached. The boy jumped on the platform in front of the trailer car, and in endeavouring to get off again fell between the front car and the trailer car. The evidence having been given, the Coroner said it was an unfortunate occurrence, but he did not think the jury could find that anyone was to blame. It might be advisable, in order to prevent loss of life, to have some sort of protection besides the wicket gates, because boys would be boys. The jury found that death was accidental, and expressed the opinion that some guard should be put in front of the trailer wheels.

The Derby Medal.—At a meeting of the Liverpool Engineering Society last week the city engineer was elected president for the ensuing year, and delivered his inaugural address. The outgoing president, Mr. George Farren, occupied the chair at the beginning of the meeting. He read a communication from the Earl of Derby, in which his Lordship wrote: "I am going to ask you the favour of formulating for me such conditions as may be necessary for the medal which the Liverpool Engineering Society are good enough to accept from me as one of their honorary members. You will know better than I do how they should be framed. Your original idea was, I think, that it should be annually awarded for the best paper read. But this I leave entirely in your hands. The chief accountant at Knowsley will have directions to pay over the annual sum of £10 during my lifetime."

Electrical Matters in Trinidad.—The *Liverpool Chronicle* announces that Mr. J. Stanley Richmond, of that city, who was appointed by the Government to make a

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thorough investigation of the electrical resources of Trinidad, West Indies, has just returned to this country. Mr. Richmond, who has been away seven months, had to investigate and report on the electric lighting, power, and telephone system of the island. It was believed that these resources had not been efficient and safe, and Mr. Richmond was appointed to ascertain what was required to place them on a satisfactory footing. From the records at times in the Trinidad papers it is evident he has had trouble in correcting the ideas of some officials interested in existing methods. However, he accomplished his mission, and has brought home with him a very complimentary letter from the governor of the island, Sir Herbert Jerningham.

Temperature—Entropy or θ ϕ Chart.—We have received from Messrs. Frost and Sons, of Rugby, a copy of Captain Sankey's temperature entropy chart, which they are publishing. The basis of this chart is the water line and saturated steam line described by Mr. J. Macfarlane Gray in his paper on "The Rationalisation of Regnault's Experiments on Steam (*Proceedings*, I.Mech.E., July, 1889), and the space between these lines is closely divided by "constant-pressure" and "constant-volume" lines, which are extended into the superheated steam field; lines of constant dryness fraction are also given. There are scales giving total heat, water heat, and internal energy, from which these quantities can be read off without interpolation. This chart embodies in a graphic form all the physical properties of steam used in thermodynamics from 100deg. F. to 400deg. F., and by its help thermodynamic problems can be graphically solved and the θ ϕ diagram of a steam-engine cylinder readily plotted from the indicator diagram. The price of single copies is 3s., post free.

The Central London Railway.—The work on this railway is being rapidly pushed forward, and we are glad to see that the erection and running of the electrical plant is to be placed in thoroughly competent hands. The contractors for this work are the British Thomson-Houston Company, and have appointed Mr. A. H. Walton their chief engineer for the erection and maintenance of all the plant in the power-house and sub-stations. He will also have full charge of the electrical work on the line and of the equipment of the electric locomotives. Mr. A. H. Walton has been connected with the Metropolitan Electric Supply Company almost since the inception of the company, and for the last four years has been acting as chief engineer. His position, with the rapid growth of the demand and the limited space available in the station, has been no sinecure, and in every way fits him for the new work he is now taking up. We wish Mr. Walton every success, and are proud to see that an Englishman has been selected by the British Thomson-Houston Company, and not an American.

More Marconi.—The untechnical Press find in the word "Marconi" an ample word to conjure with, and from the quantity of copy produced we cannot but conclude that the Marconi syndicate helps to keep up the supply. The latest is the rumour of wireless messages to France, and the *Daily Mail* understands that "the French authorities have given permission for signalling stations to be erected anywhere along the French coast, so the experiments will doubtless be put in hand without much delay." In spite of this, and the hope which scientists hold out that signals will be sent without wires from London to Cape Town, the shares of the Submarine Cable Company hold up in a wonderful way. We fancy that the hopes of a large and successful company flotation are the main cause of much of the vague and rosy information disseminated about Marconi. To quote Mr. W. H. Preece's recent address before the Institution of Civil Engineers: "Sensational experiments for booming a new financial enterprise are not processes that commend themselves to the institution. We want practical work and engineering progress."

Licensed Wiring Contractors.—It is a matter of surprise to us to see how much amateur work is appreciated by certain classes of society. Certain gentlemen we know of have voluntarily placed the wiring of their houses in amateur hands without making any stipulation either as to price or character of the work. The amateur may have distinguished himself in past years by carrying out some electric bell work in a novel way, and this only too often gives him his sole right to try his 'prentice hand on electric lighting cables. The other class of amateur which displays no lack of enterprise is the unqualified handy plumber. The best way to guard both the pockets of the would-be consumer and the insulation of the public mains is to allow only registered persons or firms to do electrical work. This course is becoming more and more common, although in some cases the introduction of the slight restriction to competition is declaimed against. This was so at Bootle recently, but we are glad to see that the policy of the Electrical Committee was upheld. A complaint against the usual charge of half a guinea in case an installation has to be inspected twice by the electrical engineer was also heard, but this was not pressed.

Italy.—Electric undertakings are growing apace in this country. In Naples work is being vigorously pushed on with the laying of the electric tramways which will connect the museum and the Toretto, and so open an easy way to the Posilipo. This, says *L'Elettricità*, is the first step towards the transformation of the whole Neapolitan tramway system—a matter which will shortly be considered by the Municipal Council. The municipal authorities of Savona have petitioned the Postmaster-General to connect their town by telephone with Genoa. A company has been formed in Turin for the purpose of building an electric tramway from Varallo to Aragna. Another powerful company has been formed in Bologna for the purpose of manufacturing and distributing current for lighting and motor purposes. The Mediterranean Railway Company is going to try electricity on its lines. The first trials will be made on the line from Milan to Gallarato and the three branch lines to Arona, Varese, and Laveno. In all 34 applications have been made for water power for the generation of electrical current; 29 of these have been granted, as being able to supply that demand without damaging other interests. From all the above it will be seen that electrical undertakings are flourishing in sunny Italy.

Refuse Destructors.—At the recent monthly meeting of the Leeds Association of Engineers a paper was given by Mr. F. Leslie Watson on "The Designing and Construction of Refuse Destructors." Mr. Watson observed that in the design of a successful refuse destructor its primary object was a practically absolute chemical separation of the combustible from the non-combustible portions of the refuse, which included the complete oxidation of the former and the fusion into hard clinker of the latter. For this purpose a temperature of 1,600deg. to 1,800deg. F. was desirable. It was necessary that the products of combustion passing up the chimney should be as free as possible from solid matter, as the mechanical effect of the dust upon the leaves of plants, the lungs of animals, clothing, and furniture, might be intolerable, and had been proved to be actionable at law. Machinery working where there are large quantities of dusty material deteriorates rapidly, and the machinery about a destructor must be boxed in. To ensure a continuous process the furnaces

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should be fed at one end and clinkered at the other. In the majority of towns destructors were being constructed in combination with electric lighting plants, and provided with boilers for taking up the whole of the heat. He regretted that in the case of Leeds the heat produced was absolutely wasted, although when the tramways were taken over by the Corporation a combined electric lighting and tramway scheme was suggested. A short discussion followed.

Speed of Electric Cars.—Sir Francis Marindin, on behalf of the Local Government Board, opened an enquiry last week into the proposed increase in speed of the cars on the Dublin and Clontarf and Dublin and Dalkey lines of the Dublin United Tramways Company and Southern Tramways Company. After discussion it was decided that proper notice had not been given in the case of the Southern District lines, and hence the inspector only heard evidence on behalf of the increased speed on the Clontarf line. Mr. Gordon, Q.C., opening the case for the company, said that Major Cardew, in his report on the line before it was open for traffic, expressed the opinion that a speed of 10 miles per hour might safely be allowed, especially if the cars were equipped with electric brakes. Evidence was given to the effect that the Clontarf Council only opposed the increase to 12 miles per hour by the casting vote of their chairman. The President of the Hackney Car and Cab Proprietors of the City of Dublin complained that while the tramway company were allowed to run their trams at 10 miles an hour on the Clontarf line, members of his association, were they found driving their vehicles seven or eight miles an hour, would be prosecuted. Another gentleman, who represented the Irish Roads Improvement Association, tried to introduce a question as to whether the tramway company kept their roads in proper repair. Sir F. Marindin said that he himself should not recommend the increase of speed if he thought they were not being kept in good order. The enquiry then adjourned, and the inspector's decision has not yet been given.

The City Police and Telephones.—The *City Press* has been investigating the almost incredible fact that the numerous police stations in the City are absolutely unconnected by the public telephone. It is explained that Old Jewry is in telegraphic communication with all the stations, and also with Scotland-yard, while a private telephone is used when communicating with the Mansion House, Guildhall, and the headquarters of the fire brigade at Southwark. Under these circumstances it is not thought by the police authorities that much advantage would be derived from a dual system of communication. In any case, as was explained by the Chief Clerk, the telephone would have to be a private one, and the additional facilities offered would hardly repay the trouble and expense involved in such an undertaking. The Metropolitan force, it should be noted, however, are far in advance of the City police in the matter of telegraphic communication, each station having been fitted with the necessary instruments for printing the numerous messages as they are received. This arrangement proves a great boon to the force, and would undoubtedly be welcomed in the City; but as regards the later method of transmitting messages, there seems to be no desire on the part of the authorities to have a new system established. The question of fixing the telephone in the City stations is, of course, one for the consideration of the Common Council, but, as no representations have yet been, or, indeed, are likely to be made, it is probable that some time will elapse before any alteration is effected in the present system. We very much doubt the correctness of the Chief Clerk's views, that the telephones must necessarily be private ones. The telegraph communication would serve for the very private messages. The connection of all their stations to the public exchanges would be a convenience to the public as well as to the police.

Blackpool Winter Gardens.—From the report of the electrical engineer to the Blackpool Winter Gardens Company, we gather that the electricity works are a great success. He says that, in order to prevent any mistake as to the results, he has gone through all invoices, etc., himself, and he has no hesitation in saying that the second year's working should be more successful even than the first. In order to show the economical conditions under which the electricity department has been conducted, he points out that at no other electricity supply works in England has current been generated at a less cost per unit than at the Winter Gardens, although at some of these works the annual output has been 10 times greater than at Blackpool. He then gives the output and cost per unit generated at the various Lancashire electricity works. With all these the Winter Gardens compares favourably. The cost per unit at the gardens is 1·3d., and the number of units generated is 203,095 per annum. In Manchester, with 2,508,568 units generated, the cost per unit is 1·62d., and at Liverpool, with a slightly less number generated, the cost is 1·38d. Burnley has the lowest cost other than the gardens, it being 1·8d., and the number of units generated 173,182. The engineer particularly commends the resident engineer, Mr. A. R. Sillar. In conclusion, he points out that the results obtained are a complete answer to the adverse criticisms which were made after the results of the first four months' working were published, for in spite of the difficulties of working economically with the light loads of the winter season and the exceptional costs of test runs, they had succeeded in keeping the total cost much lower than those of the Blackpool municipal electricity supply works.

Covent Garden.—The scenery for the masked balls at Covent Garden, the first of which took place last Friday, this year represents Khartoum. The cloth shows the confluence of the White and Blue Niles, the set-pieces the castle of Khartoum, streets, bazaars, etc., somewhat brighter and cleaner than the original, but in all a pleasing imitation. Easy-chairs and tables are distributed, wherever possible, in cosy nooks and corners. The adaptability of the electric light for scenic effects has been made use of to its fullest extent. The stage is well decorated with garlands of multicoloured incandescent lamps, some 400 in all. High up in the centre a brilliant star and crescent strikes the eye. The latter decoration is formed of about 100 small incandescent lamps, with special reflectors fixed upon a nickel-plated frame. The result is an extremely white silvery light. Transparencies filled with electric lamps inside abound, and pretty contrasts are achieved in the streets and bazaars by juxtaposition of outside and inside light effects. The moonlight shining on the cloth gives it a soft appearance and large perspective. We learn that the electric lighting of the whole body of this theatre is to be commenced almost at once, and that the proprietor, after protracted enquiries and visits to the best-lit theatres on the Continent, has decided to spare no outlay to make Covent Garden excel any of the latter. Everything is to be of the newest and best. A gamut of four colour-changes, red, white, blue, and amber, requiring over 2,000 incandescent lamps, will be provided for the stage, 500 for the rest of the house, while 14 to 20 arc lamps are contemplated to adorn the outside of the theatre. No arc lamps will be used on the stage, Mr. Romford, the electrician of the theatre, who will probably superintend the installation, not being in favour of the same. The London County

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Council have made their usual inspection, and have not found any fault with the arrangements made.

Boston Street-Lighting.—The contracts with the electric light companies supplying the arc lights at Boston have nearly expired, and the Municipality are seriously considering the question of their renewal. The lead in the discussion is to be given by a lengthy report by a Mr. Matthews, ex-mayor of the city, in which he contrasts the relative costs of supply from a company and from a municipal station. An interesting fact appears in the report with respect to overhead wires. It seems that the total number of lights in operation nightly in Boston is 2,365, of which 1,506 are operated by means of the overhead system and 538 supplied by underground mains. Besides these there are 321 lamps for park-lighting. The London County Council will be horrified to note that overhead wires for electric lighting purposes are used to such a large extent in Boston. We are surprised to find no word in the abstract we have seen of the report that the Council wish these wires removed in favour of underground mains. As regards price, we learn that the average price per arc lamp per annum paid at present is about £25. 10s. After comparisons with the cost at other towns, Mr. Matthews concludes his report by recommending that a new contract be entered into with the lighting company, with the understanding, however, that the latter shall agree to furnish all the latest improvements and cheapening devices, and, furthermore, that for every increase of 250 in the number of lights the price be reduced by ¼d. per night until 1s. 3d. per night is reached. It is also suggested that the price of lighting be regulated—and thus the city's interests guarded—at comparatively short intervals by means of an arbitration committee composed of three members, one appointed by the city, the second by the lighting company, and the third by the persons thus selected.

Regulating Apparatus for Reservoirs.—At a meeting of the Bristol Association of Engineers, held at Bristol on Oct. 29, a paper was read by Mr. J. A. McPherson, A.M.I.C.E., on "Notes upon Regulating and Recording Apparatus for Reservoirs, Gauge Weirs, and the Flow of Water," of which the following is an extract: The method of electrically recording the level of water in reservoirs or tidal basins was first dealt with, and the means of transmitting and recording the fluctuations of water described—the mode of alternating the direction of current to indicate either a rise or fall in water being a special feature. Diagrams were shown illustrating the mechanical and electrical action of the apparatus, consisting first of a transmitter at the reservoir, where a float rising and falling with the water communicates motion by means of gearing to an insulated cam wheel, which in turning engages a tumbler, causing it to revolve until the long arm strikes a commutator, throwing it to one side or the other into metallic contact with one pole of local battery, the direction of the current being thereby alternated for a rise or fall of water, according to the motion communicated by gearing. The cam in revolving sets up a rubbing contact between platinum springs making connection to the line wires, while the tumbler in falling over into equilibrium makes a contact and completes circuit. The descent of the tumbler is regulated by a dashpot. The current passes from the transmitter through the line wires to a recording instrument at the pumping station or engineer's central office, and there actuates a relay and completes circuit of local battery in either direction through electromagnets for a rise or fall. Soft-iron cores are attracted by whichever magnet is excited, and cause the engagement of pawls, and toothed wheel, moving a rack and pencil carrier to obtain a diagram record on a clockwork drum, while a second wheel carries a hand that gives a constant reading at sight upon a dial face of the fluctuations of the reservoir. Descriptions were also given of instruments for recording the flow of water over gauge weirs and for measuring large volumes of water passing through pipes under pressure.

The Michigan College of Mines.—The so-called catalogue of this college has been sent to us, and from a glance through the pages of the volume we formed a very good opinion of the organisation of the college. The elasticity of the courses arranged is a good feature. The introduction to the section on chemistry is so well expressed, and we may add, so foreign to all ordinary ideas of instructors in chemistry, that we feel obliged to quote the following verbatim extract: "The instruction in chemistry is designed to excite in the student a love for experimentation and to train him to inductive thinking. If this aim can be reached, or if it can only be approximated, it is believed that the gain to the student will be great, much greater than the accumulation of any number of facts might be to him. For all the modern advancement in the subjugation of Nature's forces is owing to experiment, and we know from the autobiographical statements of many inventors of genius, that they lost the labours of years through the lack of training in properly correlating the results of their experiments. In carrying out the plan of this course it has been found necessary and useful to abandon the use of text-books altogether. For no matter how such a text-book be written and arranged it will present to the beginner the science of chemistry as a finished edifice, very wonderful and very intricate in its details. The study of it thus becomes of necessity mechanical; the memory is loaded with facts and figures, and the thinking faculties become numbed rather than quickened. Experience of years has shown that even a set of notes will have a similar effect on the student. The best results are obtained when the teacher builds up the science from experiment, by making suggestions leading the student to experiment on similar bodies in his own way. In this course there are no definitions of atoms, molecules, and structural formulæ to start with. By means of a proper selection of common bodies, the student not only discovers the qualitative and quantitative relations of matter, the simple and compound bodies, but he produces his very reagents as he goes along; he comes to compare and correlate the phenomena; he finally classifies the phenomena and works up to the evolution of their laws. It is not claimed that any and all brain organisations will become thinking instruments under this system. But it is claimed that it will greatly stimulate and improve existing faculties."

A Peculiar Lightning Stroke.—During a thunderstorm in the Catskill Mountains last summer, a pine tree near an hotel was struck by lightning. The stroke had entered several of the top branches, and had then passed down the trunk as far as an insulator pin which supported the telephone wire of the hotel. So far the lightning had completely shattered the upper portion of the tree. The tie wire which held the telephone wire to the glass insulator was on the inside—that is, toward the tree from the insulator. The lightning jumped to this tie wire, burned it in two, and then, following the telephone wire, entered the hotel, and, reaching the telephone room, it there encountered the ordinary bell wire, the size of which was No. 18 B. & S. gauge. Apparently this was not able to carry the discharge without becoming heated sufficiently to ignite the insulation, which, being soaked with paraffin,

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caused a considerable blaze and set fire to the room; fortunately this was extinguished before much damage had been done. At the point where the fire had originated, about a foot of wire had been burned away and much of the insulation on the remainder of the wire was charred. The discharge finally passed to earth by leaping across a 3in. air-space to an exposed gas-pipe inside of the telephone room. Mr. A. J. Wurts, in the New York *Electrical Engineer*, endeavours from these facts to gauge the current strength of the stroke. He says the fact that the telephone wire leading to the hotel, which was the ordinary galvanised iron wire used for such purposes, was not melted, is interesting in showing that the current strength of this particular stroke was not sufficient to melt this wire, which was wet, uninsulated, and exposed to the air. The charring of the insulation of the bell wire in the telephone booth, and the ignition of the paraffin, would indicate a current strength sufficient to raise a No. 18 copper wire to about a white heat, and although the exact time taken by the current to pass through the wire cannot be determined, nevertheless the data is sufficient to suggest that the current strength of this particular stroke was at least hundreds, if not thousands, of amperes. A remarkable feature about the stroke is that, having chosen the tree in preference to the lightning rods on the hotel, it should leave the tree about one-third the distance from the top, and jump 2in. of air-space and follow several hundred feet of horizontal wire, and jump 3in. of air-space to a gas-pipe and pass to earth at a spot which would have been reached much more easily by means of the lightning conductors.

Conduits under Rivers.—The *Electrical World* of New York gives in a recent issue some most interesting facts about two different conduits laid down in Boston this autumn for carrying telegraph and telephone cables or electric light mains under rivers. The first was laid under the Charles River by the Union Telegraph and Telephone Company. This conduit consists fundamentally of seven wrought-iron pipes 4in. in internal diameter and ¼in. thick, with tight screw couplings, each pipe being covered to prevent corrosion with alternate layers of Bermuda asphalte and cheesecloth to a depth of $\frac{3}{16}$in. The seven pipes are maintained in a proper relative position by wooden diaphragms from 2ft. to 3ft. apart, 16in. in external diameter, and about 4in. thick. The whole is enclosed in a wooden shell 4in. thick, thus giving an external diameter of 24in. The sections of this shell are made in half cylinders, and vary in length from 1½ft. on the curves to 6ft. on the straight runs. All the wood was carefully creosoted before use. The half sections are bound together and around the diaphragms by bands of ⅜in. by 2in. strap iron. The whole conduit is in the form of a large U or inverted siphon, with about 48ft. between risers and a length of about 126ft. over all. It was built up on the draw pier, with a heavy beam across the upper end of the U, and then lowered into the stream from a lighter. A trench about 5½ft. deep had previously been dredged in the clay and rock bottom, the rocks being removed by divers. Into this trench the U was sunk until the upper surface of the horizontal section was 4ft. below the level of the bottom of the channel and the trench was then filled flush. The other conduit described was laid down by the Boston Electric Light Company. This conduit differs from all previously built in that no iron pipes are used, and the lead-covered cables will be drawn into ducts solely of wood. It is made of green pine, the six layers of ducts consisting of semicircular grooves planed in the opposite sides of seven layers of timbers, each layer being 6in. thick. The timber is untreated green pine, except for the sections passing through the mud line at the two terminals of the conduit, which for a distance of 12ft. (6ft. each side of the mud line) are of oak. This is for the purpose of avoiding the attacks of insects, which experience has shown are only made at these points. This conduit is also sunk in the mud to get protection from anchors, etc. Personally we prefer the first type of conduit, as the iron pipes are both more durable and less likely to give trouble in drawing-in.

Electrolytic Cleaning of Metal.—Mr. C. B. Burgess contributes to the *Electrical World* some excellent notes on the use of electrolysis in cleansing metallic surfaces. The notes have special reference to the preparation of the surfaces for electroplating. The author points out that, if the article to be cleaned is suspended in a sodium chloride solution and used as an anode, the metal will be attached and hence cleaned to a certain degree. The anode reaction will, however, have little or no effect on substances of an oily or greasy nature, but the chemical reactions at the cathode afford all that may be desired in this direction. With the above-named electrolyte, sodium is liberated at the cathode, immediately uniting with the water, forming sodium hydroxide and hydrogen, which rises to the surface. The reducing properties of the so-called nascent hydrogen thus formed are well known, and whether by the hydrogen alone, or by aid of the sodium, any oxide, sulphide, chloride, or similar compound on the metallic surface serving as the cathode will be quickly reduced to the metallic state. The sodium hydroxide formed will attack the grease or oil, producing saponification exactly as is done in the electroplater's lye vat. In most cases, the chemical action at the cathode will in no way affect the metal itself, but will act only on the foreign substances present, thus allowing polished surfaces to be cleaned without destroying the finish. The electrical energy necessary to effect the cleaning of articles of iron or copper as they come from the polishing room may be taken as approximately equal to that used for the electrodeposition. Although the current density must be considerably greater for cleaning than for plating, the time is much shorter. Current density has a marked effect upon the rapidity of cleaning, and the disappearance of foreign substances in no wise follows Faraday's laws. The following figures, taken from some observations made by Mr. H. A. Smith, illustrate this very clearly. The measurements were made to determine the effect of current density upon the rapidity of removal of a film of grease from an iron surface, such as it acquires from a grease polishing wheel. The electrolyte was a nearly saturated solution of sodium chloride:

Current per square foot.	Time necessary for cleaning.
20 amperes.....	15 minutes.
40 „	3·5 „
140 „	0·75 „ about.

With a solution of potassium hydroxide a current density of 80 amperes per square foot cleaned the iron almost instantly. Some of the advantages of the electrolytic method of cleaning over that commonly used in an electroplating plant are the following: There is less complication from the fact that the cleaning vat may be of similar construction to the plating vats, and connected to the 'bus bars in the same way. There is a considerable saving in labour and material in dispensing with the hand brushing. After once wiring an article there is no need of touching it with the hands, for it may be transferred directly from one tank to another. The oxides and other metallic compounds may be removed simultaneously with removal of grease and dirt, thus avoiding the use of a cyanide or an acid dip. A metal which has a brightly-polished surface may be cleaned without destroying the polish.

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FOLKESTONE ELECTRICITY WORKS.

Hesketh, T., was born in Lytham (Lancs.). He was a student at the Durham College under Profs. Garnett and Stroud, was apprenticed with Messrs. J. H. Holmes, of Newcastle, and subsequently was engaged with Messrs. Scott and Mountain, of the same city. From Newcastle Mr. Hesketh went to Blackpool to take charge of the electric trams, subsequently becoming chief assistant at the Blackpool electricity works. Still desirous of gathering experience, he went as chief assistant—succeeding Mr. Jacobs—to the Electricity Supply Company of Spain, in Madrid.

Last year he was appointed by Messrs. Edmundsons to act as resident engineer for the central station at Folkestone, and on the completion of the work was entrusted with the responsible position of engineer and manager to the Folkestone Company.

We gave a brief notice in our last issue of the opening of these works, and are now able through the courtesy of Messrs. Edmundsons', Limited, to give a more detailed account of the machinery now at work. The works in question are owned by the Folkestone Electricity Supply Company. This company is working under the powers of a provisional order which has been transferred from the Corporation. A want of unanimity amongst the members of the Corporation prevented a municipal station being erected. The transfer was only executed last November, and the first sod at the works cut in the first week in February, but by March 27 a supply from some temporary plant was given to an important consumer, and a general supply was commenced on July 1. Since that date the demand has grown very rapidly, the equivalent of nearly 10,000 8-c.p. lamps being now connected and applied for. The present consumers include most of the chief hotels and many private residences, while the shopkeepers are also applying in many cases. The prospectus of the company was issued in March last, and the share capital was considerably over-subscribed. The capital expenditure on the first contract amounts to about £83 per kilowatt, which is very reasonable considering that it is a low-tension station situated over a mile and a half from the centre of its area, and that the total capacity of the plant is not large. The whole contract for the erection and equipment of the works was placed with Messrs. Edmundsons' Electricity Corporation, who designed the arrangements of the buildings, works, and mains, and carried out the entire work. Messrs. Lacey, Clirehugh, and Sillar were called in as consulting engineers to the local company, and reported upon the contract. They have since supervised the execution of the work. On behalf of Messrs. Edmundsons, Mr. J. C. Wigham acted as superintending engineer. Mr. Thomas Hesketh

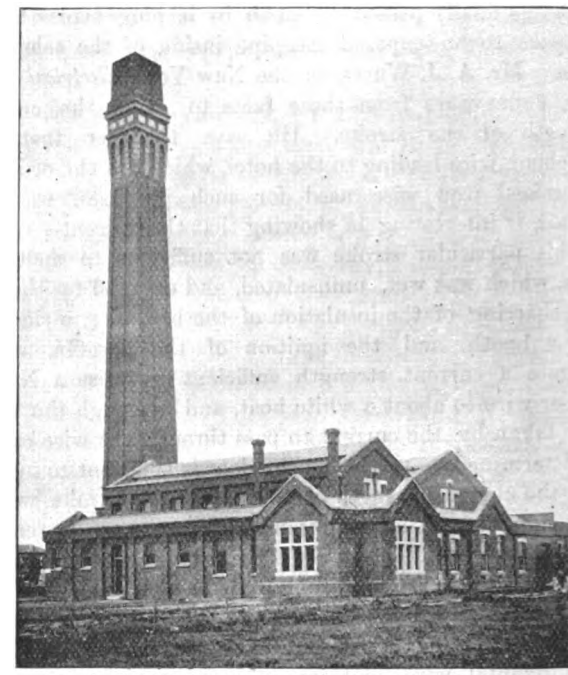

FIG. 2.—Outside View of the Folkestone Electricity Works.

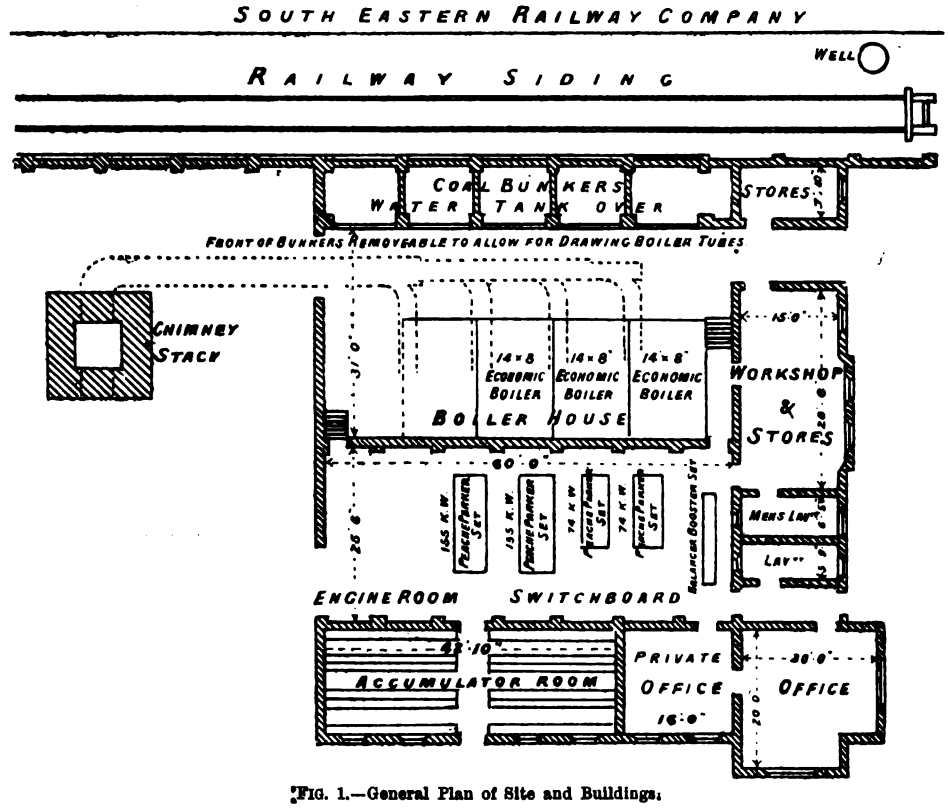

FIG. 1.—General Plan of Site and Buildings.

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has been the resident engineer from the commencement, and his services have now been secured by the Folkestone Company as their engineer and manager.

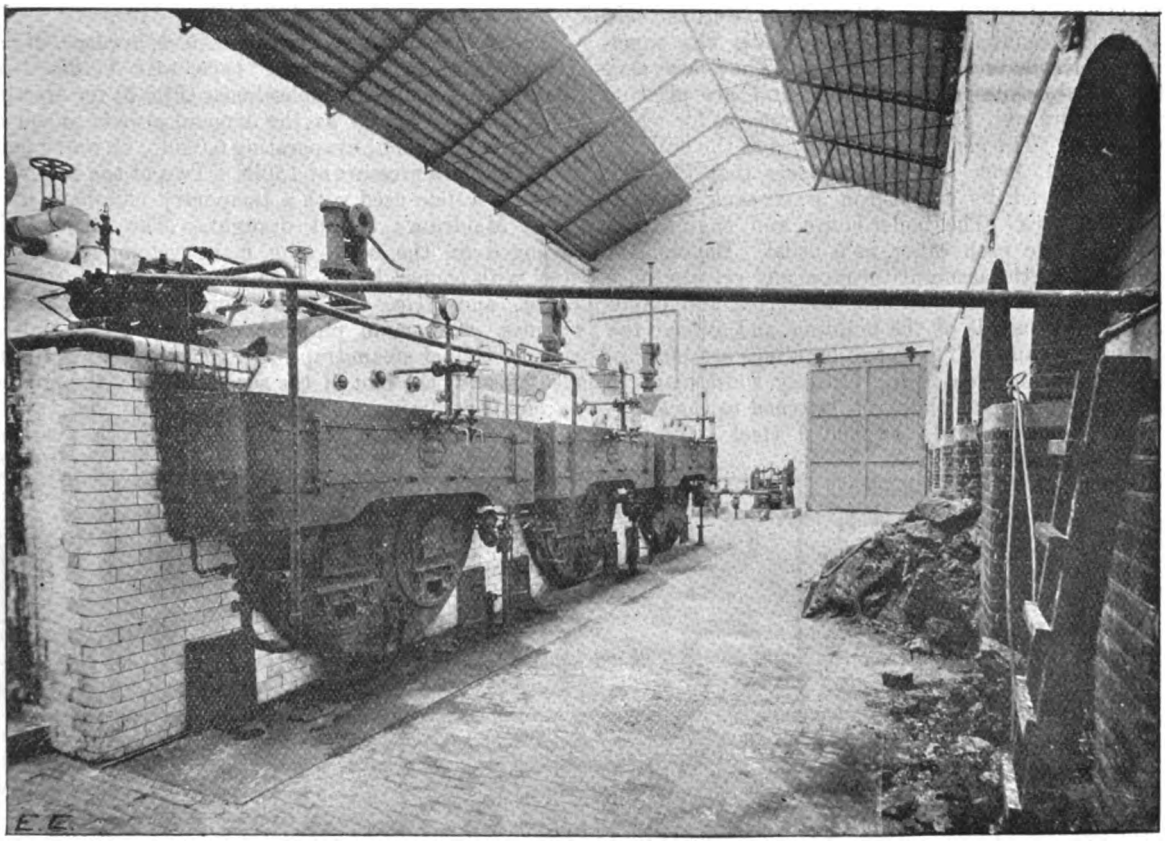

FIG. 3.—View of the Paxman Economic Boilers at Folkestone.

SITE.

As usual in a residential town, considerable difficulty was experienced in securing a site, most of the land being only available for building private dwellings. Eventually Lord Radnor, who is the owner of the greater portion of the newer part of Folkestone, kindly agreed to sell the company the present site, which, except for its distance from the centre of the town, is eminently suitable in all respects. The works (Fig. 1) are situated alongside of the South-Eastern Railway, close to Shorncliffe Station, and have a private siding from which the coal is delivered straight into the coal bunkers, which have a capacity of about 150 tons, and are placed close enough to the boilers to allow of the coal falling out conveniently for feeding into the furnaces. These bunkers are fitted with a movable front to allow of

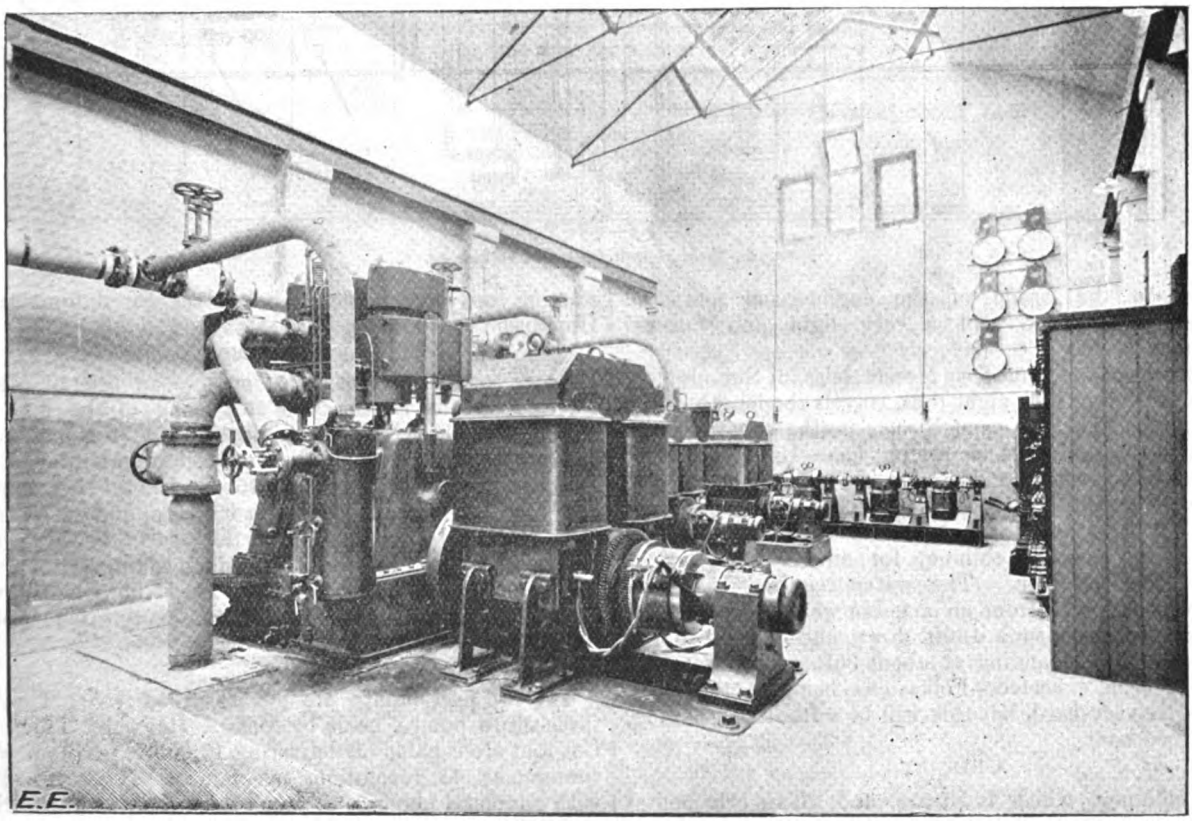

FIG. 4.—The Engine-room at Folkestone, showing the Parker-Peache Sets.

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the boiler tubes being drawn in case of repairs. About 1½ acres of ground have been secured, which will leave ample room for extensions of the buildings.

Buildings.

The buildings, of which Fig. 2 is a view, were erected by Mr. D. Baker, builder, of Folkestone, under the supervision of Mr. Reginald Pope, architect. They are very commodious, and, while not too ornamental, are pleasing in appearance and well suited for the purpose for which they are required. The general arrangement of the building is seen in Fig. 1, from which it appears that the coal bunkers are covered by a cast-iron water-tank, holding about 17,500 gallons. The boiler-house and engine-room are placed alongside each other, as is usual. Beyond the engine-room, again, the accumulator-room and private office are placed. The stores, workshops, lavatories, and public offices come at the outside of the building, and extend the full length of the same. The entire buildings are built of fireproof material, the roof being entirely constructed of steel, slate, and glass. The slates are fastened to the angle-iron purlins by lead clips; expanded steel lathing is attached to the inside of the engine-room roof and plastered, giving the roof a very light and finished appearance.

An overhead hand-crane, by Messrs. Isles, of Stanningley, capable of dealing with eight tons, travels the length of the engine-room. There is enough room in the present buildings for plant capable of supplying some 15,000 lamps at the same time, and every provision has been made for convenience in extending the buildings later. No economiser has been fitted at present, but space has been left between the building and the chimney for one if it is desired to erect one later on. The water required has been obtained on the site from an artesian well. This consists of a 7½in. steel tube sunk 180ft. down, and a good supply has been obtained standing at about 86ft. This water, as may have been expected—Folkestone being in the chalk district—is very hard, but this will be softened by boiling, as described later.

Chimney.

The chimney, which is square, and of an ornamental type, somewhat after the style of Messrs. Doulton's chimney in Lambeth, is 150ft. high, and with a 49 square feet cross-section at the narrowest part; it is lined with firebrick about one-third of the height. The chimney was built from the inside, and an electric motor, geared to a winch by belting, was used to lift all the material used, and also the workmen to and from their work. This proved a very useful and exceedingly economical arrangement.

Boilers.

There are at present three boilers in place, of Messrs. Davey-Paxman's "Economic" type, 14ft. by 8ft. diameter, space being left in the boiler-house (Fig. 3) for erecting two others when required, as the demand grows. Each of the boilers is capable of evaporating 6,000lb. of water per hour, and work at a pressure of 150lb. Two of the boilers, which were for a time used with a temporary chimney, are fitted with Meldrum's forced draught. The steam-piping is arranged on the usual ring main system, and are of 7in. steel with copper bends, with 5in. steel connections to the boiler, and 2½in. and 3½in. copper connections to the engines. The main piping is drained at the ends of the ring by Geipel steam-traps, and connections for drains are also fitted at the foot of the separators on the engine-beds to similar drains. The steam being at all times in these separators, dry steam is always available for starting up any engine. The valves throughout are of Hopkinson's own make.

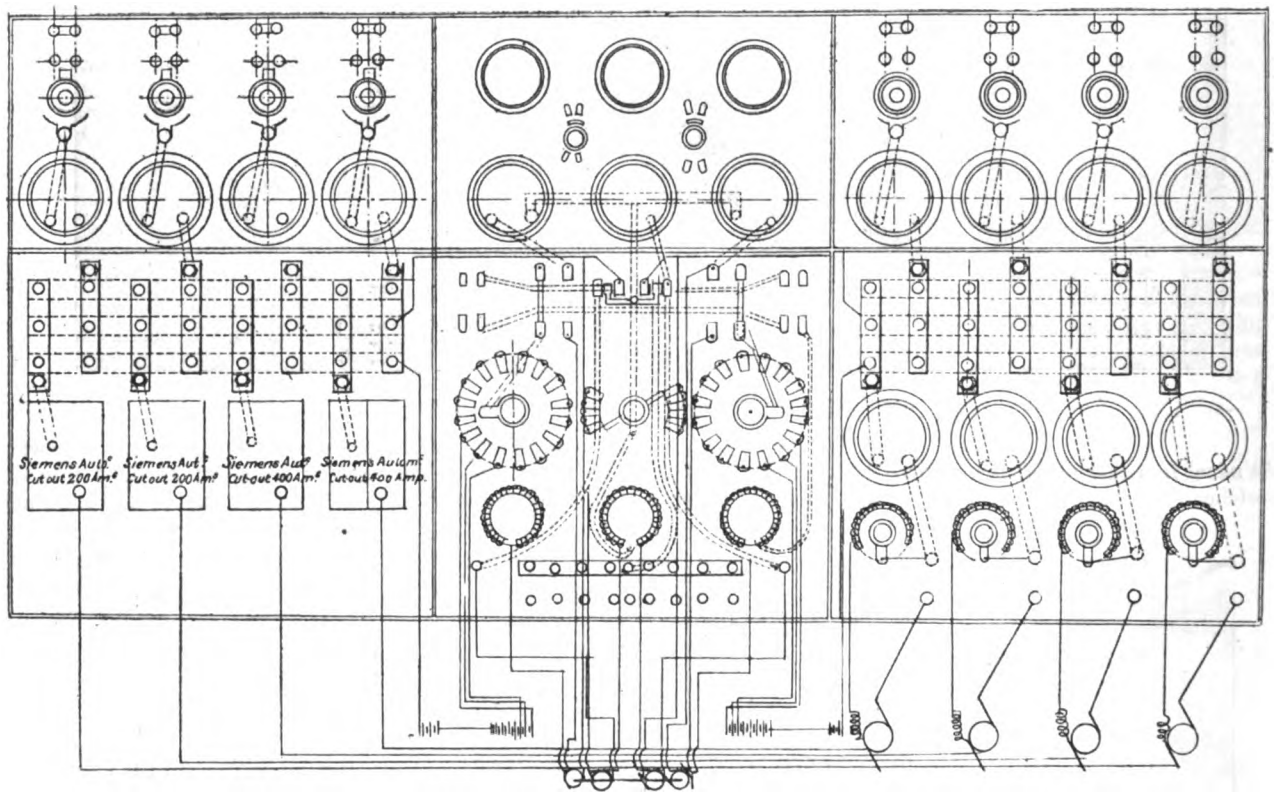

Fig. 5.—Front of Switchboard at Folkestone.

Engines.

There are at present three engines in use, of Messrs. Davey-Paxman's Peache type, two being of the F.C. size, giving 120 i.h.p. with steam at 140lb. at the stop-valve, and running at 450 revolutions per minute, and one of the J.C. size, giving 245 i.h.p. at 375 revolutions per minute. A second large engine is already in hand, and is expected to be in place before the end of the year. These engines, which can be seen in Fig. 4, are single-acting, three-crank, compounds, with six cylinders. They run silently, with very little vibration, and have given every satisfaction at Folkestone.

Pumps.

The two feed pumps are electrically driven. They are three-throw pumps, made by Messrs. Hayward Tyler and Co., and are capable of delivering 12,000lb. per hour when running at 43 revolutions per minute. They are fitted with gunmetal plungers to pump hot water, and are driven by two Parker motors by double-reduction spur gearing, having raw-hide teeth in the pinions to ensure silent running. Resistances and switches are fitted to allow of the armatures being supplied at 210 volts or 420 volts, giving two speeds at which the motor will work economically. Further

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regulation is obtained by inserting resistance in the field circuits, and, finally, by inserting resistance in the armature circuit. The feed piping is arranged in duplicate, with two connections to each boiler, with the requisite number of Hopkinson's valves to isolate any pump or any portion of the piping in case of failure. The pumps can either be supplied with cold water from the supply tank, or with hot water from the feed heater.

Feed Heater.

A "Chevalet" heater-detartariser deals with the heating and softening of the feed water. In this apparatus the water enters at the top and flows downwards till it reaches the suction pipe of the feed pumps, which it enters at a boiling temperature. The apparatus (which was fully described and illustrated on p. 362 of vol. xix.) consists of a number of circular trays set one upon another so as to form a column. Each tray is always nearly full of water, and the exhaust steam from the engines, entering near the bottom of the apparatus, blows into and through the water, raising it to boiling temperature, while the amount of back pressure caused in the exhaust pipe is so small as to be almost inappreciable, amounting to a few inches only on the water-gauge. The heating of the water causes the carbonates of lime to be deposited, and the sulphates are dealt with by means of a small amount of soda solution which is automatically injected at the top of the detartariser, in exact proportion to the amount of water passing through the machine. No attempt is made to remove the sediment by blowing out, but when cleaning is required the trays are lifted down and cleaned—a by no means lengthy operation, as the deposit, though compact, is soft. As there is practically no pressure in any part of the apparatus when at work, the joints are made by the weight of the parts without bolting, by simply employing ordinary glazier's putty. The apparatus is stated to reduce the hardness of the water to not exceeding three grains per gallon, and it possesses the advantage that its efficiency as a heater does not diminish as load is added to the plant, nor is it affected by the amount of deposit existing at any time in the trays. The trouble arising from the grease in the steam passing into the feed water is overcome by the fact that the lime, when being precipitated by boiling, carries with it all the particles of oil held in the water, leaving it perfectly pure.

Dynamos.

The three dynamos were supplied by Messrs. Thomas Parker, of Wolverhampton, the two smaller ones having an output of 160 amperes at 420 to 460 volts. The larger machine can give 380 amperes at the same voltage. These dynamos are of the firm's standard well-known two-pole type, with steel magnets and the Eickemeyer winding of the armature. The pole-pieces are jointed across the horizontal diameter of the armature, so that the armature is readily accessible.

Switchboard.

The switchboard (Fig. 5) is, in its main characteristics, of the type now so frequently seen in a low-tension station, and is made of enamelled slate supported on steel frame, a moulding round the edge being the only wood-work near the board. It is fitted with ammeters and duplex cut-outs on the feeders, and with ammeters and Siemens automatic cut-outs on the dynamos. The dynamos and feeders are connected together by a plug board having three 'bus bars at the back of the board. The centre panel of the board is that connected with the middle wire of the feeders and the centre cells of the accumulators, and is of Messrs. Edmundsons' standard type. It contains a

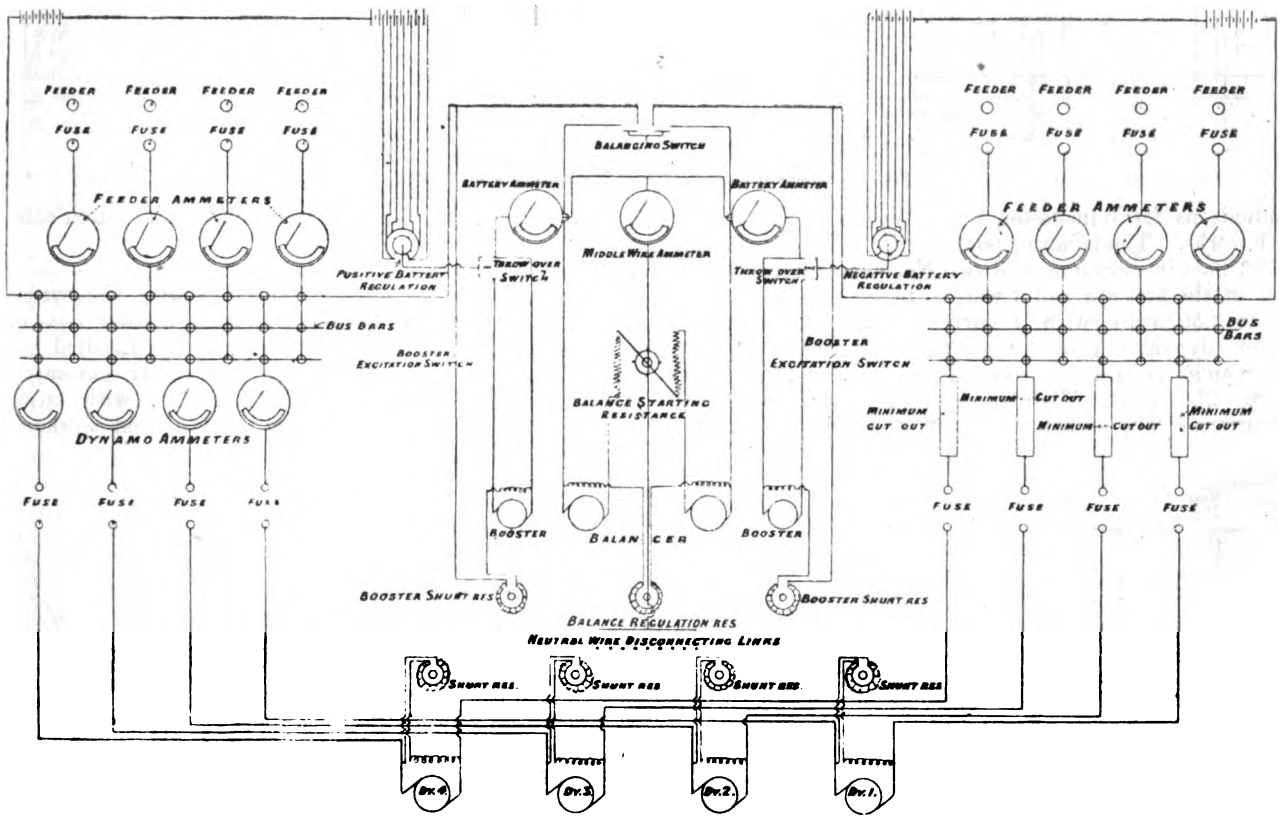

Fig. 6.—The Switchboard Connections.

14-way regulating switch for each side of the battery, and a throw-over switch by means of which the cells are connected to the 'bus bars direct or through the armature of the booster. Two other throw-over switches are for the purpose of exciting the field circuit of the boosters and short-circuiting the same immediately the circuit is broken, thereby preventing an abnormal rise of pressure in the winding. The remaining switch is a double-pole for starting the balancer, and is interlocked with a resistance switch. On the upper panel are the battery ammeters, the middle-wire ammeters, and three zero indicators, which are the only means provided for putting the dynamo or boosters in parallel. As we believe the use of these instruments is novel, it may be interesting to state that they are simply low-reading voltmeters, but made to withstand a high pressure, and having the zero in the centre of the scale; they are connected to the poles of the switch it is desired to close when the potential of both machines is the same. The attendant closes the switch when the needle comes to the centre point, the potentials being then equal. A simpler arrangement for paralleling could hardly be. The switch-board was made by Mr. Edmund Charrington, of 63, Queen Victoria-street, E.C. The only voltmeters employed are those on the pilots from the feeding points, which are Kelvin's engine-room type, as are the electrostatic standard

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voltmeters, and all the ammeters and zero indicators on the board. The voltmeters are placed on the end wall of the engine-room, so as to be visible from all points. The full diagram of the connections on this switchboard is shown in Fig. 6.

Balancer Booster Set.

This set is fixed at the end of the room, is of Messrs. Parker's make, and similar to that supplied to Messrs. Edmundsons for Winchester, High Wycombe, and several other works. The balancer booster (Fig. 7) consists of two No. 12 Parker machines and two No. 4 separately excited. Each of the first are shunt-wound to give an E.M.F. of 210 to 230 volts with a current of 50 amperes. The smaller dynamos give 80 volts 70 amperes, the magnets being separately excited with an E.M.F. of 210 to 230 volts. The speed of the set is about 950 revolutions. The dynamos are of the Parker standard type with patent hinged pole-pieces, which makes a combination of this length possible, as the armatures can be lifted out of the magnets by a direct vertical lift. The booster machines will be chiefly used for battery charging, and this can be proceeded with while the balancing machines are equalising the pressure on the two sides of the three-wire network. Thomson-Houston meters are fitted on the outgoing mains of the dynamos, and Aron meters, fitted with Millar's arrangement of single dial, are used for the accumulators. These latter consist of 230 cells of the D.P. type in glass boxes. The cells have a capacity of 715 ampere-hours, and are erected on wooden stands in two tiers. They are capable of discharging at 80 amperes for nine hours, or 119 amperes for four hours.

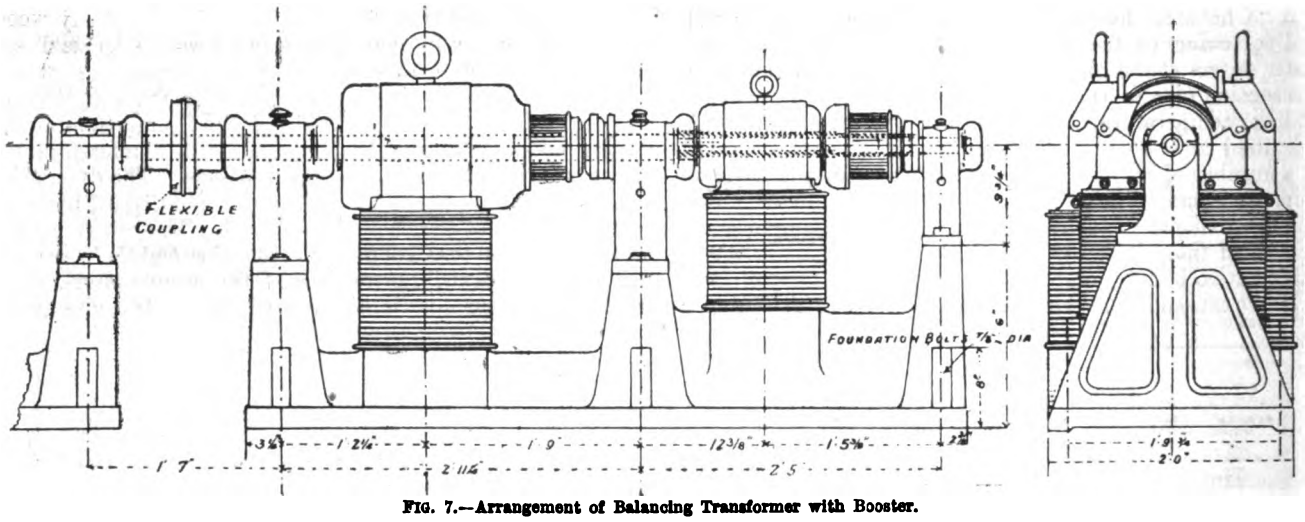

Fig. 7.—Arrangement of Balancing Transformer with Booster.

Method of Working.

The supply is at 210 volts at the consumers' lamps, and as the dynamos are wound for 420 volts the current returning to the station by the middle wire is either taken up by the balancer or by the battery. The charging of the cells is done through the boosters, which add the required extra voltage.

Mains.

The whole of the work in connection with the system of mains outside the station has been carried out by Callender's Cable and Construction Company, Limited. All the mains are laid direct in the ground under pavements and roadways, where found most suitable, with tarred boards laid over them to give protection from workmen who may be working near the mains at any future time. The feeders are triple concentric, heavily lead sheathed and steel taped. They run direct from the generating station to various feeding points on the circuit to large feeder boxes, which supply current to the distributors. This can be seen in the map (Fig. 8).

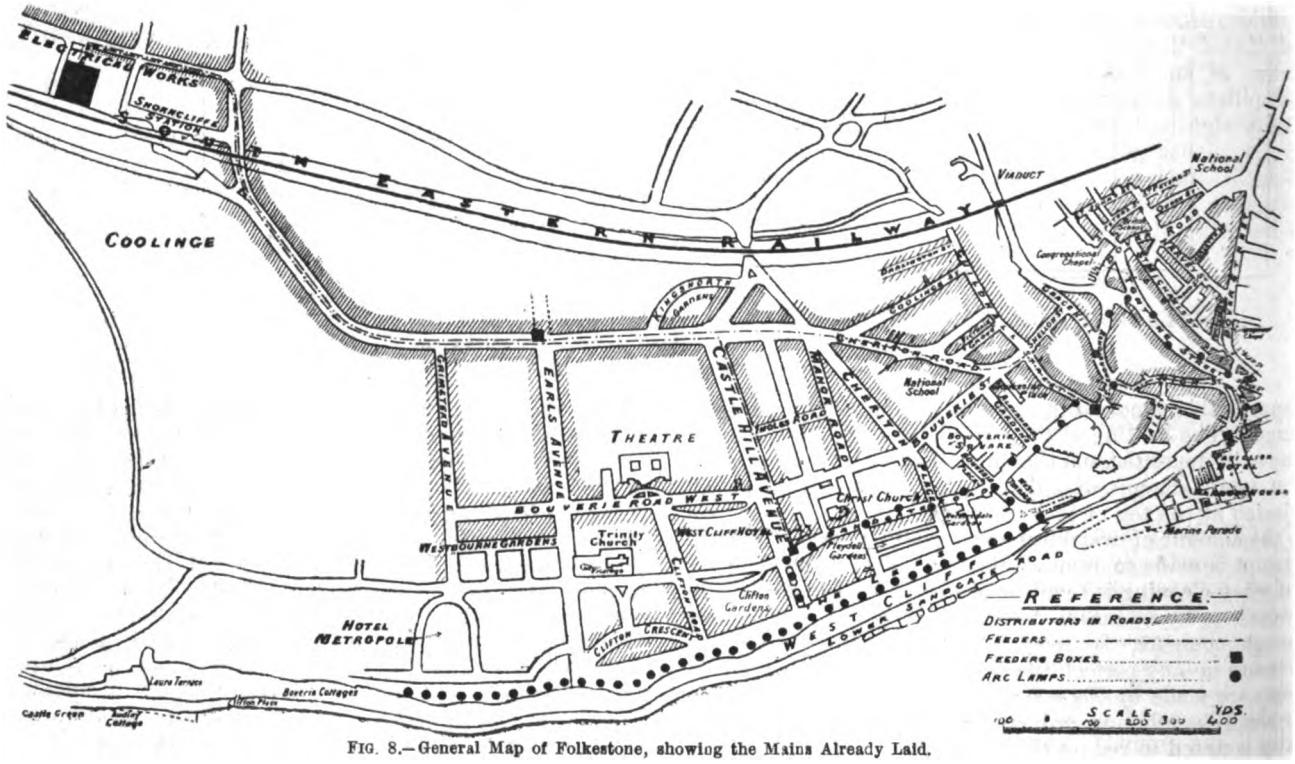

Fig. 8.—General Map of Folkestone, showing the Mains Already Laid.

Pilot cables, which are three-core, lead sheathed, and steel taped, are laid in the same trench as the feeders for recording the fall in potential at the feeding points. All the distributors are three-core, lead sheathed, and steel taped. The three-core makes it very simple for the con-

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necting of house services. There are a number of Callender's standard type of network boxes fixed at the junction of the mains. These are so constructed that it is an easy matter to disconnect the mains into sections for testing or otherwise.

The street arc lamps are run in series of eight in number on each circuit, which is tapped from the network boxes on the mains. The lamps are connected to the arc main by four-core non-hygroscopic cable, which is lead sheathed and steel armoured. Two cores are for the arcs, and the other two for incandescent lights. The house services are laid with two-core cable, which is lead sheathed and steel taped. These are connected with the mains, and end in Reid's patent fuse boxes.

The following is approximately the present amount of mains laid :

6,000 yds.	·4 sq. in.	·4 sq. in.	·2 sq. in.	triple concentric
2,000 „	·2 „	·2 „	·1 „	„ „
1,000 „	·1 „	·1 „	·06 „	three-core.
11,000 „	·075 „	·075 „	·05 „	„ „
2,000 „	·05 „	·05 „	·03 „	„ „
8,000 „	·008 „	·008 „	·008 „	three-core pilot.
4,000 „	·0126 „	·0126 „	·0126 „	three-core arc main.

Perhaps the most noteworthy point in the Folkestone supply undertaking is the extraordinary length of the feeders. Thus, No. 1 is 1,592 yards long, and consists of triple-concentric cable of the second size listed above. The second feeder is 2,563 yards long, and the third 3,434 yards; both these are of the largest size listed.

Street-Lighting.

There are at present being erected in the town 68 arc lamps of Johnson and Phillips's make. These lamps take 10 amperes, and burn for 14 hours with single carbons. There are also two incandescent lamps of 25 c.p. placed on each post for use after 11.30 p.m. As the designs of post selected by the Corporation have very small chambers in the base, only the isolating switches and substitutional resistances for each individual lamp are placed therein. The line switches and resistances are contained in pillar boxes similar in appearance to the boxes used for the line switches of an electric tram system. Each of the five switch pillars are arranged for three circuits, although there are only eight circuits in use at present. In these pillars there is plenty of room for the switches, etc., and no trouble is likely to arise from the awkward crowded arrangement which would have been entailed if the switches were placed in the base of the lamp columns.

INSTITUTION OF CIVIL ENGINEERS.

Presidential Address.

BY WILLIAM HENRY PREECE, C.B., F.R.S., PRESIDENT.

(*Continued from page 587.*)

Telegraphy.

In 1837 Cooke and Wheatstone showed how electricity could be practically used to facilitate intercommunication of ideas between town and town and between country and country. The first line was constructed in July of that year upon the incline connecting Camden Town and Euston-grove Station, the resident engineer being Sir Charles Fox, father of the senior vice-president. Five copper wires were embedded in wood of a truncated pyramidal section and buried in the ground. The instrument used possessed five needles or indicators to form the alphabet. A portion of this original line was recently recovered *in situ*. I call it the "fossil telegraph," and used it to complete a special circuit between Buckingham Palace and the General Post Office to enable the Queen on her Diamond Jubilee day, as she started on her procession through London, to telegraph her simple message, "From my heart I thank my beloved people. May God bless them!" to all our princes, governors, captains, and rulers scattered over the whole globe. To north, south, east, and west, over every quarter and every continent, under every ocean and every sea, these words flew with the speed of thought. When her Majesty returned to Buckingham Palace acknowledgments and replies had arrived from every colony, the first to come being from Ottawa, Canada, 16 minutes after the message was dispatched.

The pioneer line of 1837, $1\frac{1}{3}$ miles long, has during this period of 60 years grown into a gigantic world-embracing system. Every man at his breakfast-table can read an account of every stirring event that has transpired on the previous day in every quarter of the world. Distance is annihilated and time overcome.

The extent of the present system of British telegraphs is shown by the following table :

	Miles of wire.
General Post Office and its licensees	435,000
Railway companies	105,000
India and Colonies	387,966
Submarine cables	183,400
Total	1,111,366

The mechanical construction of the telegraphs of this country was designed by our late distinguished member Edwin Clark, and his brother, Latimer Clark, also a member. Their affairs were originally directed by our past-presidents, Robert Stephenson, Bidder, and Locke. We in this country have always been in advance of other countries in telegraphic progress, and this was greatly due to the inventive genius of Cromwell Varley, a member of the institution. These are men under whom I served and learnt, and whose engineering traditions I have done my best to maintain and to better. Progress has never been checked. The speed of signalling and the capacity of working have been increased sixfold, and wires can now be worked faster than messages can be handled by the clerical staff.

The form of submarine cable and the nature of the materials used in its construction have varied but very little since the first cable was laid in 1851. The recent invasion of our channels and seas by the *Limnoria terebrans*, a mischievous little crustacean which bores through the guttapercha insulating covering, and exposes the copper conductor to the sea-water, leading to its certain destruction, has led to the use of a serving of brass tape as a defence. It has proved most effective.

No one has done more than Lord Kelvin (honorary member) to improve the working of submarine cables. His recording apparatus is almost universally employed on long cables. By the duplex method of transmission the capacity of cables has been practically doubled, and this has been still further improved by applying to the cables the system of automatic working, which is such a distinguishing feature of our Post Office system. The number of electrical impulses which can be sent through any cable per minute is dependent upon its form, and is subject to simple and exact laws, but it varies with the quality and purity of the materials used. There is no difficulty in maintaining the purity of copper. Indeed, copper is frequently supplied purer than the standard of purity adopted in this country known as Matthiessen's standard. The purity of guttapercha is, however, questionable. The supply of this dielectric has dwindled; it has failed to meet the demand; its cultivation has been neglected. The result is a dearth of the commodity, a great increase in price, and its adulteration by spurious gums. Indiarubber, its sole competitor for cables, is being absorbed for waterproof garments and pneumatic tyres, but for underground purposes paper is being used to an enormous paper. Paper has the merit, when kept dry, not only of being an admirable insulator, but of being very durable. There is paper in existence in our libraries over 1,000 years old. The difficulty is to keep it dry. This is one of the problems the engineer delights to consider. He has been most successful in obtaining a solution. The lead-covered paper cables, which are being laid in the streets of all our great cities, are admirable. I am laying one of 76 wires for the Post Office telegraphs between London and Birmingham, and the cable companies are contemplating leading their long cables from Cornwall up to London, so as to be free from the weather troubles of this wet and stormy island.

It is impossible to forecast the future of telegraphy. New instruments and new processes are constantly being

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patented, but few of them secure adoption, for they rarely meet a pressing need, or improve our existing practice. The writing telegraph, originating with our late member of council, E. A. Cowper, which reproduced actual handwriting, much improved by Elisha Gray, and called the "telautograph," is steadily working its way into practical form, and electrical type-writing machines of simple and economical form are gradually replacing the A B C visual indicator. The introduction of the telephone is revolutionising the mode of transacting business. There seems to be a distinct want of some instrument to record the fleeting words and figures of bargains and orders transmitted by telephone. Hence a supplement to that marvellous machine is needed. The telautograph and electrical typewriter will fill this want. Visions of dispensing with wires altogether have been fostered by the popularity of Marconi's "wireless telegraphy"; but wireless telegraphy is as old as telegraphy itself, and a practical system of my own is now in actual use by the Post Office and the War Department. Sensational experiments for booming a new financial enterprise are not processes that commend themselves to the institution. We want practical work and engineering progress.

Telephony.

I was sent, in 1877, together with Sir Henry Fischer, to investigate the telegraph system of the American Continent, and especially to enquire into the accuracy of the incredible report that a young Scotchman named Bell had succeeded in transmitting the human voice along wires to great distances by electricity. I returned from the States with the first pair of practical instruments that reached this country. They differed but little from the instrument that is used to-day to receive the sounds. The receiver, the part of the telephone that converts the energy of electric currents into sounds that reproduce speech, sprang nearly perfect in all its beauty and startling effect, from the hands of Graham Bell. But the transmitting portion, that part which transforms the energy of the human voice into electric currents, has constantly been improved since Edison and Hughes showed us how to use the varying resistance of carbon in a loose condition, subject to change of pressure and of motion under the influence of sonorous vibrations. The third portion, the circuit, is that to the improvement of which I have devoted my special attention. Speech is now practically possible between any two post offices in the United Kingdom. We can also speak between many important towns in England and in France. It is theoretically possible to talk with every capital in Europe, and we are now considering the submersion of special telephone cables to Belgium, Holland, and Germany. The progress of the use of the telephone in Great Britain has been checked by financial complications. It fell into the hands of the company promoter. It has remained the shuttlecock of the Stock Exchange. It is the function of the Postmaster-General to work for the public every system of intercommunication of thought which affects the interests of the whole nation. Telephony is an Imperial business, like the post and the telegraph. It ought to be in the hands of the State. The public and the Press have frequently kicked violently against the present *régime*. Committees of Parliament have sat and deliberated upon the question. The report of the last committee is now under consideration.

"*Quidquid delirant reges, plectuntur Achivi.*" Two causes exist to impede this desirable absorption, the fear of being "done" by watered and inflated capital, and the assumed bad bargain made in absorbing the telegraphs in 1869. The former is a mere bugbear. The public does not want to purchase stock. It wants to acquire a plant and business which can be easily and fairly valued. The latter is a gross fallacy. The business of the telegraph companies—practically an unlimited monopoly—was purchased on absolutely fair terms—viz., 20 years' purchase of the net profits. The sum paid was £4,989,048. The number of messages then sent in one year was about 5,000,000, and the gross income about £500,000. The income has now grown to £3,071,723, the number of messages has reached 83,029,999, and the capital account, which was closed in 1891—viz, £10,131,129, including the cost of the Post Office extensions—remained the same. If a syndicate desired now to repurchase the business and acquire the plant, they would have to find a capital of over £30,000,000. In what respect, then, was the transfer of the telegraphs to the State a failure? Our magnificent system has been built virtually out of revenue, our tariff is very cheap, scarcely a village of any consequence is without its telegraph, our Press is virtually subsidised by having its news supplied at much less than cost price; we can rely upon safe and accurate delivery, and upon speedy dispatch of messages. We lead the world. There has been no failure, and there was no bad bargain. The present condition of the telephone business in this country is shown by the following return:

Telephones in Use, June 30, 1898.

National Telephone Company	133,498
General Post Office	9,588
Railway companies	8,933
Total	152,019

Railways.

The regulation of the traffic on a railway, and the general business of the line, could not possibly be conducted without the telegraph. The safety of the passenger and the freedom from collision are due to the introduction of the block system, which is worked entirely by electric signals, and which has been made compulsory by Parliament on all British railways. It was my good fortune to have taken a very active part in the introduction of the block system, especially in the assimilation of the working of the indoor (electric) and the outdoor (mechanical) systems of signalling and in their interlocking. More recently, the control of the traffic and the secure working of single lines by the tablet and electrical train staff has been carried to a very high state of perfection. Distant signals can now be fixed anywhere out of sight of the signalman who works them, for the position of the semaphore by day, or the character of the light by night, are repeated back by electricity upon miniature signals fixed in the signal-box. The state of the signals can even be indicated on the engine to the driver in foggy weather or by night, and the state of distant points shown to the signalman in all seasons.

The regulations of the Board of Trade, regarded often as unnecessary interference by railway men, together with the careful engineering inspection before the opening of a line, and a judicial enquiry in case of accident, have tended more than anything else to add to the security of railway travelling.

In 1897, 24 persons, including six railway servants, when travelling were killed from accidents beyond their own control. This was above the average. It has been said that a first-class compartment on one of our great railways is the safest place in the world. It is safer than bed, for, in 1896, 1,809 persons were suffocated in bed. It is safer than a dining-room, for, in the same year, 148 people were choked by food. Nine hundred and twenty-five were killed by falling down stairs. Bicycles are far more destructive to life. Accidents in the streets of London are so frequent, and therefore so uneventful, that they are not even recorded in the Press. Accidents on railways are so rare and eventful that columns of large type are devoted to a description of their minutest details.

The safety of railway travelling as effected by modern improvements in working is shown by the following facts: In 1874 one person in 5,556,284 journeys was killed; in 1884 the ratio was 1 in 22,419,092; in 1894, 1 in 56,963,307; and in 1896, 1 in 196,067,887. The train accidents in 1878 were 108; in 1888, 61; and in 1897, 48. More than 50 per cent. of the causes of these accidents were due to the negligence, want of care, or mistake, of those conducting the traffic, which emphasises my previous statement that carelessness is the direst disease we suffer from.

The employment of electricity in the working of railways has not only been highly beneficent in the security of human life, but it has vastly increased the capacity of a road to carry trains. The underground traffic of the Metropolis is conducted with marvellous regularity and security, though the trains are burrowing about in darkness and following each other with such short intervals of time that the limit of the line for the number of trains has been

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TABLE I.

—	Line open for passenger traffic.		Worked on absolute-block system.				Worked on other telegraph systems.		Single lines worked under—		
				Single line.							
	Double.	Single.	Double line.	Combined with train-staff system.	Without train-staff system.	By electrically-controlled train staff or tablet.	Double line.	Single line.	Single-engine system.	Train-porter system.	Train-staff system.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
England and Wales.	9,325	4,472	9,310	2,200	20	1,847	15	29	228	1	147
Scotland	1,314	1,768	1,312	210	32	1,066	1	—	427	1	31
Ireland	613	2,534	613	494	1	1,824	—	—	118	—	98
United Kingdom	11,252	8,774	11,235	2,904	53	4,737	16	29	773	2	276

reached. Electric traction is going to extend this limit by increasing the acceleration at starting and improving the speed of running. It will also reduce the cost of working per train mile, so that the advent of electricity as a moving agency is certain to prove highly economical. What it will do as a remover of bad smells and foul air, and for personal comfort, cannot be estimated. Time alone will enable us to assess the intrinsic value of public satisfaction acquired by the change.

The extent to which electrical appliances are used on the railways of this country is shown by the following tables: Table I. gives the length of double and single line in the United Kingdom open for passenger traffic on Dec. 31, 1895, the latest period for which returns have been published, and the length of such lines worked upon the various systems. Table II. gives the number and description of the various classes of electrical apparatus in use on railways in the United Kingdom in the year 1898:

TABLE II.

Single-needle instruments	13,494
Morse sounders	431
,, recorders	105
Telephones	12,043
Duplex apparatus (complete)	26
Bell instruments (for message work, complete, with keys, relay, and galvanometers, etc.)	425
Phonopores (complete)	110
Block instruments	27,146
Train staff instruments	673
Tyer's tablet instruments	1,137
Interlocking ,,	4,275
Repeater ,,	18,450
Treadles	1,658
Fouling bars	452
,, bar indicators	224
Replacers	31
Slot selectors	368
Single-stroke and relay bells	18,447
Galvanometers	390
Large trembler bells (platform, etc.)	2,063
Small ,, ,,	5,913
Night and day switches	4,527
Fire-alarm commutators	96
Train describers	1,122
Light indicators	1,100
Signal repeater discs	924
Test boxes	27
Water-tank apparatus	13
Telephone switchboards	17
Bell indicators	86
Point detector	1
Signal lever lock	230
Extra contact-makers and switches	539
Magneto-electric bells	4
Total	115,247

Domestic Appliances.

The introduction of electricity into our houses has added materially to the comfort and luxury of home. If we were living in the days of ancient Greece, the presiding domestic deity would have been Electra. The old bellhanger has been rung out by the new goddess. Electra has entered our hall-door, and attracts the attention of our domestics, not by a gamut of ill-toned and irregularly excited bells, but by neat indicators and one uniform sound. The timid visitor fears no more that he has expressed rage or impatience by his inexperience of the mechanical pull required at the front door. The domestic telephone is coming in as an adjunct to the bell. Its use saves two journeys. The bell attracts attention, the telephone transmits the order. Hot water is obtained in half the time and with half the labour. Fire and burglar alarms are fixed to our doors and windows; clocks are propelled, regulated, and controlled. Even lifts are hoisted for the infirm and aged. Ventilation, and in warmer countries coolness, are assisted by fans. Heating appliances are becoming very general where powerful currents are available. Radiators assist the coal fire by maintaining the temperature of a room uniform throughout its length and breadth. Ovens are heated, water is boiled, flat-irons become and are maintained at a useful temperature, breakfast dishes and tea-cakes are kept hot, even curling-tongs have imparted to them the requisite temperature to perform their peculiar function.

Electric Light.

But it is in supplying us with light, without defiling the air we breathe in our dwellings with noxious vapour, that electricity has proved to be a true benefactor to the human race. The Legislature has facilitated the acquisition by municipalities of those local industries that affect the welfare of the whole community, such as roadmaking, sewerage, the supply of water, tramways, and, above all, electric light. No one doubts that new industries of a speculative character are best pioneered by private enterprise. The company promoter has, however, so abused the power placed in his hands by the Limited Liability Act that not only has the development of electric lighting been retarded in this country, but the prospects of private enterprise in furthering other industries has been checked. Fortunately, the success, the comfort, the intrinsic value, the economy, and the sanitary properties of electric light have commended it to our municipal magnates, and its introduction has become the fashion. The following table shows the position of the industry in this country and in the United States at the present time:

Electric Light Undertakings.

—	United Kingdom.		United States.	
	Municipalities.	Companies.	Municipalities.	Companies
Number of central stations	72	63	338	2,251
Capital stock £	4,599,154	3,258,343	3,419,019	48,207,527
Number of arcs	5,753	1,259	26,087	265,064
Number of incandescents	1,393,514	1,936,893	693,984	14 278,358
Kilowatt capacity	44,219	24,344	41,193	578,051

In spite of our financial troubles, of the inertia of municipal bodies, of the active competition of vested interests, our progress compares not unfavourably with other European countries, but the progress of the industry in the United States has been phenomenal. The return for the United Kingdom is, however, by no means complete. It omits all private installations. We in the Post Office alone have 50,000 lamps which are not enumerated; and if we consider all our great railway companies, banks, warehouses, manufactories, and shops which have their own installations, the statistics will be very considerably extended. Lamps are being improved and cheapened,

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wiring is being reduced in cost, and the economic distribution of energy is being furthered. But the most promising field for economy is the combination of all classes of electrical industry in one centre, especially that of light and tramway working where fuel is cheap, water abundant for condensing, and nuisances of no account. The cost of the production of electrical energy depends principally upon the continuity of its output. If it can be generated continuously during the 24 hours of the day its cost is only a fraction of a penny per unit. If it is used solely for light, a unit may cost 3d. Hence local authorities who are undertakers of electric energy, neglect their duty to those who have elected them as the custodians of their interests if they fail to secure the tramways in their district, either as their own property or as customers for their current. For the tramways, by taking energy during the day, reduce the cost of working during the night by removing the incubus of running continuously imposed on undertakers by Act of Parliament. This may enable the ratepayers to be supplied at a price for electric light certainly 1d. per unit less than if there were no tramways. The cheaper the supply of energy per unit the more certain and speedy the advent of the electric light as the poor man's lamp, and the more beneficial its introduction into the confined, ill-ventilated, and overcrowded homes of the working classes. By improving the locomotion to the suburbs and enabling them to live in pure air, and by clearing the air they breathe of the impurities due to the combustion of tallow, oil, and gas, the more readily should the public fall down and worship the golden image which Parliament and science have set up.

It is on board ship that electric light has been pre-eminently successful, and where it filled such a crying want that its introduction met with no check. It was almost immediately and universally adopted. Searchlights, prompted by the great development of the torpedo, were introduced into our navy as early as 1875 by Mr. Henry Wilde. The first ship to be fitted with internal electric lighting was the "Inflexible" in 1882. In 1884 the Admiralty ordered it to be applied to all H.M. warships. The first application of electrical power was in the case of H.M.S. "Barfleur," where motors were used for working guns and for the supply of ammunition. It has subsequently been partially extended to the working of gun turrets, ventilating fans, capstans, and boat-hoisting gear; but hydraulics, the child of our venerable past-president, Lord Armstrong, is the form still more generally preferred and used for power in our navy, though other nations make a much more extended use of electricity. The technical reports received by the United States Navy Department indicate that the electrical appliances on their warships worked very successfully during the recent war. Electrical conductors are readily stowed away in safe quarters, and easily repaired when severed by shot. The electrical energy used in a first-class battleship is expended thus:

	E.H.P.
Internal lighting	60
Searchlights	65
Ventilation	30
Capstans, hoists, etc	60
Reserve	45
Total	260
Number of incandescent lamps	1,000
,, ,, search-lamps	6
,, ,, ventilating fans	16
,, ,, motors	2 to 8

Year.	Ships fitted with electricity.		Total number fitted.		Electric machinery.	
	Search-lights.	Internal lighting.	Search-lights.	Internal lighting.	Number of sets fitted.	Total E.H.P.
1876	Nil	Nil	Nil	Nil	Nil	Nil
1876 to 1880	19	Nil	38	Nil	19	33
1880 to 1884	30	1	50	—	30	120
1884 to 1888	150	30	220	8,000*	180	3,700
1888 to 1894	265	126	750	50,000*	450	15,000
1894 to 1898	500	240	1,100	95,000*	800	25,000

*Number of lamps.

The preceding table illustrates the progress of electric work done by that branch of the service which is so eminently presided over by our vice-president, Sir W. H. White.

(To be continued.)

THE REGULATION OF THE MECHANICVILLE PLANT.*

The system of automatically regulating the voltage of power delivered to the works of the General Electric Company by the transmission line from Mechanicville is unusually elaborate, and an interesting application of various principles of alternating-current working. This plant, which was described in the *Electrical World* of Sept. 3, 1898, delivers power in two divisions to the General Electric Company—one for the testing department and the other for the running of the various motors driving the machinery of the shops. The former is supplied by a motor-generator set, consisting of a synchronous alternating-current motor wound for high-tension supply, coupled to a 500-volt multipolar railway-type generator. The speed of this unit is obviously dependent only upon and equal to the speed in alternations per minute of the generators at Mechanicville, and the voltage of the direct-current end is thus obviously not affected by any changes of the voltage of the power delivered by the transmission line. The shop motors, however, are supplied through step-down stationary and rotary transformers, and as the voltage of the direct-current end of this sort of a transforming system is dependent on the alternating-current voltage delivered, special means are necessary for properly adjusting the latter to obtain proper pressure on the distribution lines. The means adopted in this case are the use of leading and lagging currents by which the ohmic line drop can be inductively diminished or increased—a means previously used, notably in the St. Anthony Falls line—combined with an ingenious modification of a plan claimed in a patent issued to E. W. Rice, jun., Dec. 14, 1897.

The system is practically compounded for constant potential at the direct-current terminals of the rotaries, or it may be over-compounded at that point. The compounding is effected, not internally in any machine, but strangely enough in the transmission line itself. The latter consists of three No. 000 wires, all mounted on one cross-arm. This naturally gives double the self-induction between the two outside wires as between either of them and the wire in the middle, but this effect is neutralised by the transpositions of the lines, another purpose of which is the reduction of inductive disturbances in neighbouring telephone circuits. The rotaries at the receiving end of the system are compound wound with quite a heavy series winding, the ampere-turns of the two field windings being so proportioned that on no load the excitation of the shunt winding is insufficient to generate at synchronous speed a back E.M.F. sufficient to choke back the impressed alternating-current waves.

The result is that wattless currents lagging behind the impressed E.M.F. enter the rotary armature and automatically increase the field excitation to a proper value. These lagging currents react upon the self-induction of the line, causing a drop considerably greater than that due to its resistance alone, and—the direct-current voltage being practically proportional to the impressed alternating voltage at the rotary rings—the reduction of the latter by means of the increased line drop prevents too great a pressure being delivered from the direct-current end on no load.

As the load rises, however, the action of the series fields of the rotaries begins to assert itself. As the direct-current excitation of the fields increases, the wattless currents in the armature necessary to maintain the field excitation fall off until at a point about three-quarter load the power factor of the increasing current approaches unity, and the voltage drop on the line is equal only to the amperes multiplied by the line resistance. On further increasing the load the exciting action of the field windings of the rotaries becomes sufficient to generate a back E.M.F.

* From the *Electrical World* (New York).

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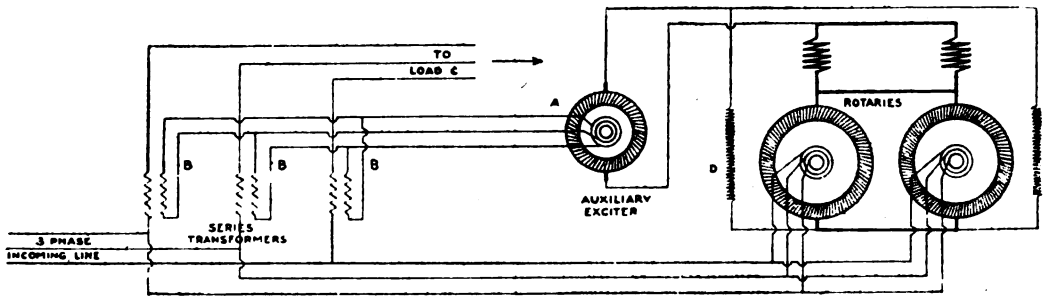
at synchronous speed greater than that delivered, and as the rotaries cannot change their speed, but must remain in synchronism with the generators at the other end of the line, the alternating currents, so to speak, automatically cut down the field excitation by a flow of wattless currents leading the impressed E.M.F. The action of this on the line inductance is the reverse of that of the lagging currents described above. In other words, the line drop is diminished, and in case the leading current and line inductance are of sufficient magnitude, the voltage-boosting effect in the line may even be greater than the ohmic or resistance drop, in which case the voltage at the receiving end is greater than that at the generating end. The direct-current pressure being proportional to the alternating-current pressure delivered, it is in turn compounded or even over-compounded if necessary. The direct-current pressure delivered by the rotaries is thus increased just as though they were engine-driven generators, by the use of a compound winding, but the effect is not immediately due to action of an increased field flux on the armature conductors, but is due to a boosting or depressing action of the inductances of the transmission circuit on the alternating currents therein.

In the case of the Mechanicville-Schenectady system, there is, of course, in addition to the self-induction of the line, the self-induction of the rotaries and stationary transformers and the generator armatures, at least for the present. If at any later time other transmission lines are run from Mechanicville to other cities, it will become necessary to excite the generators for constant potential at the switchboard in order to prevent the various lines interfering with each other. In this case the self-induction of the generators cannot be depended upon, but at present the generator fields can be left at constant excitation and the voltage at Schenectady controlled entirely automatically by the compound fields of the rotaries, the self-induction of the generators materially aiding the inductive compounding.

This arrangement alone would be sufficient to obtain proper voltage regulation but for the interference of the load taken by the synchronous motors driving the generators of the testing department. Any increase of the load in this department increases the current in the line, consequently increases the ohmic or resistance drop without the proper compensating effect in the wattless currents taken by the rotary. Any variation also of the phase relations of the synchronous motor load will still further disturb the proper combination of the ohmic and inductive drop on the line, the sum of which two quantities should be, by the action of the rotaries described above, rendered a constant independent of the load. To make the rotaries take leading or lagging currents which shall balance out the disturbing effects of the synchronous machines, the following system has been devised, this being, as mentioned above, a modification of Mr. Rice's recent patent. The rotary shunt fields, as shown at D D in the accompanying diagrammatic illustration, are excited from a separate direct-current 'bus bar, which is fed with current from the main 'bus through an auxiliary exciter, A. The auxiliary exciter serves to raise the voltage across the rotary fields, and is driven by an alternating-current synchronous motor of the same number of poles, thus keeping its armature in step with the alternating system. It has no field-exciting winding, but its armature is fitted with three collecting rings, into which alternating current may be introduced from the secondaries of three small series transformers shown at B, the primaries of which are inserted in the lines feeding the synchronous motor, C, and any other loads supplied over the same transmission line, with the exception of the rotaries. The armature of the auxiliary exciter is coupled to the synchronous motor at such an angle that the currents introduced from these series transformers, when the load passing through their primaries is of unity power factor, tend to set up a field of force in the magnetic circuit of the auxiliary exciter and build up a direct-current voltage across the brushes thereof; thus the greater the load on the system, C, the greater is the boosting action of the machine, A, and the greater in consequence the voltage across the field windings, D, of the rotaries. Further, if the load on the system, C, becomes lagging, tending thereby to still further increase the drop on the transmission line, the currents entering the armature of machine, A, lag also and excite to a correspondingly greater extent the field magnetic circuit of that machine, causing a greater current in the winding, D, of the rotaries, which in turn causes the armatures of the rotaries to take a leading current to cut down their excitation, this leading current balancing the lagging current of the load, C, and preventing any deleterious effect on the line drop. *Vice versâ*, leading currents of the load, C, build down the voltage across the shunt fields of the rotaries, D, causing lagging currents to enter the armatures thereof which balance the leading currents and equalise their effect on the transmission system. In this way the load on the system, C, can vary in magnitude or phase relation by any amount within limits without affecting the voltage relation at the direct-current terminals of the rotaries.



FORTHCOMING EVENTS.

FRIDAY, NOV. 11.

Physical Society.—At Burlington House, at 5 p.m. (1) Discussion on Mr. A. Campbell's paper on "The Magnetic Fluxes in Meters and other Electrical Instruments," to be opened by Prof. W. E. Ayrton, F.R.S.; (2) "On the Propagation of Damped Electrical Oscillations along Parallel Wires," by Prof. W. B. Morton, M.A.; (3) "On the Properties of Liquid Mixtures," by R. A. Lehfeldt.

Chemical Society.—At the Hôtel Métropole, dinner in honour of past-presidents.

SATURDAY, NOV. 12.

Institution of Junior Engineers.—At the King William-street Station of the City and South London Railway, at 3 p.m., inspection of the extension works of the Company.

TUESDAY, NOV. 15.

Institution of Civil Engineers.—At 8 p.m., "Electrical Transmission of Power in Mining," by William Beedie Esson, M.Inst.C.E.

WEDNESDAY, NOV. 16.

Institution of Electrical Engineers.—In the Library at 28, Victoria-street, at 7.30 p.m., annual general meeting of students.

Society of Arts.—At 8 p.m., opening address by Sir John Wolfe Barry, K.C.B., LL.D., F.R.S.

Liverpool Engineering Society.—At Royal Institution, Liverpool, at 8 p.m., discussion on Mr. Andrew Hamilton's paper on "Diagrams as Illustrating Ship and Engine Performances."

Royal Meteorological Society.—At Institution of Civil Engineers, at 7.30 p.m., "Report on Experiments upon the Exposure of Anemometers at Different Elevations," by the Wind Force Committee. "Comparison of Estimated Wind Force with that given by Anemometers," by Captain D. Wilson-Barker, F.R.S.E., F.R.Met.Soc. "The Tornado at Camberwell, Oct. 29, 1898," by William Marriott, F.R.Met.Soc.

THURSDAY, NOV. 17.

Chemical Society.—At Burlington House, at 8 p.m., ordinary meeting.

FRIDAY, NOV. 18.

Institution of Civil Engineers.—Students' meeting, at 8 p.m. "The Production of Liquid Air, and its Application to Chemical and Other Industries," by Cecil Lightfoot, Stud.Inst.C.E.

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

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TELEPHONIC SECRECY.

It is exceedingly difficult and, perhaps, dangerous ground to tread in the present state of the telephone question to open up any discussion upon telephonic secrecy. The misfortune, too, is while we know as a matter of absolute fact that the existing system admits the surreptitious gaining of valuable information, that such information is obtained and used to the great advantage of persons for whom it is not intended, and to the disadvantage of persons for whom it is intended, we are not in a position to prove our case in a court of law. The various authorities are possibly in such a position, but that would not help us. It is a notorious fact that the existing telephone systems are not secret, and one person speaking confidentially to another may not give the information only or even to the person for whom it is intended. It may be remembered that Dr. Lodge more than once, we believe, when referring to wireless systems of telegraphy, pointed out their non-secrecy. Most people who use a telephone accept it as an article of faith that the passing communications are secret and sacred to the various senders and receivers. We say this is not so, and any system which is to come into general use under the ægis of the postal authorities must provide for absolute secrecy of transmission. No doubt many of our contemporaries will directly traverse our statement as to secrecy, or, if they do not, will contend that absolute secrecy is impossible. With all due deference to their knowledge it must be said, and emphatically said, that secrecy is possible, and so far as we know it cannot be obtained anywhere at present by any subscriber to an exchange. Our indictment against the present system is it is not secret, that information is systematically and illegally obtained and used, that business plans and transactions are constantly upset, and all because the fundamental principles which should govern a telephone system are wilfully ignored. It is not that these matters are unknown—they are well known. Is the commercial public going to remain satisfied with this condition of things, or will secrecy be insisted upon? The time for useful agitation is now, when things are in a transitive state, with everything unsettled. It will be too late to complain when thousands or millions of pounds have been spent in installing apparatus of the usual kind. The suggestions we made in a recent issue that the Government should make up its mind at once to agree with those who hold licenses, and insist upon every future piece of work being carried out under supervision and in accordance with the plans of the Post Office after further consideration and discussion, seem the only possible solution.

AMERICANISMS.

It seems that Edison and Emmens are played out, that the *Daily News* and *Chronicle* are out of the running, and that the *Daily Mail's* " own correspondent " has put up Tesla to have a star turn. True, " fools rush in where angels fear to tread ";

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thus we are indebted to the *Mail* of Nov. 9 for such a tit-bit as the following :

"It consists of a combination of devices for producing and projecting into the air currents of electricity of enormous voltages, which will extend many miles, and also of means of using the waves thus produced for controlling the driving, steering, and other machinery of moving bodies on land and sea. If desirable, a vessel carrying great quantities of explosives can be blown up by operators at a far-distant point. Tesla exhibits a working model of a vessel whose every movement is controlled by turning a crank in another part of the room with no connection with the vessel other than atmospheric air. The working of the model proves that there is no operation aboard a great warship in which automatic machines could replace human hands that could not be controlled by the master hand at the tiny crank miles away, with as much certainty and precision as if the hand were aboard the ship. Tesla declares that a single fast unarmoured vessel, without guns, but supplied with a fleet of little vessels, whose movements would be controlled by the operator on board the big vessel, could destroy an enemy's fleet without ever coming within range of any warlike engines used in present warfare. It could also send vast quantities of explosives into a hostile harbour, where the explosion would be almost as destructive as an earthquake. The invention is so wonderful as to be almost beyond the power of belief, but Tesla's reputation as a scientist and inventor guarantees that it will do all that he claims. In his application for a patent Tesla says : 'The greatest value of my invention will result from its effects upon warfare and armaments, for by reason of its certain and unlimited destructiveness it will tend to bring about and maintain permanent peace among the nations.'"

The man who telegraphed the above rubbish is a fit colleague for the editor who inserts it as true, or approximately true. Tesla has long been working with enormous voltages, and the directions in which he has been working are well known, but any attempt to connect the rubbish as given in the *Daily Mail* with Teslaic developments will end in failure. The *Mail* of Oct. 28 also contained what purported to be the gist of an article from our contemporary, the *Electrical Review* (New York). We have carefully read the *Review's* article which appeared on Oct. 26, and find it has little connection with the rhodomontade of the *Mail*. Mr. Tesla's claims are as follows :

1. The method of transmitting electrical energy herein described, which consists in producing at a given point a very high electrical pressure, conducting the current caused thereby to earth, and to a terminal at an elevation at which the atmosphere serves as a conductor therefor, and collecting the current by a second elevated terminal at a distance from the first, as set forth.

. 2. A system for the transmission of electrical energy, comprising in combination a source of current of very high pressure, connected respectively with the earth and with a terminal at an elevation where the atmosphere forms a conducting path for the current produced, a second elevated terminal at a distance from the first for receiving the current transmitted therefrom and means for utilising the said current, as set forth.

It will be seen these few words give a very different complexion to the new departure to those of the correspondent of the *Mail*. It is a great pity that newspapers ignorant of technical subjects should without hesitation sow broadcast utterly untrustworthy information.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THOMPSON-WALKER TRACTION SYSTEM.

SIR,—May I correct some misconceptions which may arise in the minds of your readers from the criticism of the Thompson-Walker surface-contact system in your last issue ?

The height of the stud above the level of the rail is from 1¼in. to 1½in. This may at first sight seem excessive, but when it is remembered that the usual crowning of the stones in the middle of a tram track is 1⅛in., and that the curvature so produced is only just noticeable, it will be seen that the addition of from ⅛in. to ⅜in. to this is not at all objectionable.

Between the boxes the crowning is gradually reduced to ¾in., thus giving from ½in. to ¾in. for the skate to clear the level of the roadway.

Any loose obstacle, such as a stone or a piece of wood, laid haphazard on a stud is usually knocked away by the skate. Your representative succeeded in carefully plastering down a folded newspaper soaked in water so as to prevent contact between stud and skate. But the effect was not to stop the car, which ran on by its own impetus to the next stud, where contact was renewed by means of the auxiliary accumulator which you describe.

With regard to the earthing device, your representative is evidently under a misapprehension. I distinctly explained that in the earliest form of switch, with which the short line is principally equipped, this particular earthing device is not used. In the later types of switch (one of which was shown in Fig. 11, p. 558 of your last issue), in case the stud has not been disconnected from the branch from the feeder main when the skate has passed, the plunger in falling earths this branch and blows the switch fuse ; this earth connection is *not* made through the switch coil. In the switch referred to above it is made through a steel strip ⅜in. wide, about $\frac{1}{10}$in. thick, and 3in. long.

In a still later design it is made through a copper rod about 4in. long and ¼in. in diameter.—Yours, etc.,

CHARLES E. HOLLAND.

[The above is the letter which we could not publish last week owing to erratic postal delivery.—ED. *E. E.*]

WIRELESS TELEGRAPHY.

SIR,—In your note on Mr. Preece's presidential address at the Institution of Civil Engineers (*Electrical Engineer*, Nov. 4, p. 578) you question the accuracy of his statement that wireless telegraphy is as old as telegraphy itself.

Presuming that he and you mean practical electric telegraphy, which dates, let us say, from 1837, the date of Cooke and Wheatstone's first patent, Mr. Preece's statement is quite correct. In 1838 experiments were made to prove that signalling without connecting wires was practicable up to 50 yards. Even 40 years before this (1795) the scientific imagination saw the possibility of signalling across the seas "without any other connecting medium than the water, which is an excellent conductor of electricity" !

As regards Marconi's special form of wireless telegraph, I do not think that we can question his right to be

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considered the first and original inventor. Two or three people before him *suggested* the thing, but he *did* it, and, curiously enough, did it in the very way that one of these far-seers suggested—"The practical man will seize upon Hertzian waves ere long, patent their application to the use and convenience of man, start syndicates, float companies, and so on."

I have just completed a history of wireless telegraphy which deals fully with the subject from the earliest suggestions and attempts up to date. The record is a surprising one.—Yours, etc., J. J. FAHIE.

THE NORTHERN SOCIETY ADDRESS.

SIR,—I observe with regret that you have received an uncorrected copy of my address to the Northern Society of Electrical Engineers. Many of the sentences are unintelligible, and in some cases the meaning is distorted; probably the blame rests with me for not having spoken more distinctly. I trust, however, that your readers will not debit me with everything that I am reported to have said.—Yours, etc., JOHN S. RAWORTH.

2, Queen Anne's-gate, Westminster, S.W.,
Nov. 8, 1898.

[We received our copy direct from the secretary of the Northern Society of Electrical Engineers, and regret that we had not time to send a proof to Mr. Raworth before going to press.—ED. *E. E.*]

THE LIGHTING OF THE CITY.

At a recent meeting of the Court of Common Council of the City of London an application from the Metropolitan Electric Supply Company asking for the formal consent of the Corporation to their intended application to the Board of Trade for a provisional order for the supply of electricity within the City was read. It was reported in the *City Press* that this application had been granted, but this, the secretary of the company informs us, is incorrect. The letter was referred to a special committee, which have to consider the application of the Charing Cross and Strand Company also. The question of the Corporation purchasing the present City of London Electric Lighting Company is also under discussion, and hence it is hardly likely that it will decide to allow another company to come in to be bought out afterwards.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 10.

Rotatory Converters.

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S., VICE-PRESIDENT.

So much interest is concentrated at the present time upon the transmission and distribution of electric energy for motive and locomotive power, as well as for lighting, that attention may profitably be directed to a class of machines which hitherto have been little discussed—namely, rotatory converters.

In general a rotatory converter may be described as a machine having something in common both with a dynamo and with a motor so far as its structure goes, and of which the function performed by its rotation is to transform the electric energy which is imparted to it in one form into an output of electric energy of some other form. Of such converters there are many varieties, subserving many different uses. For example, one sort of rotatory converter will change continuous currents at one voltage into continuous currents at a different voltage. Another will change two-phase alternating current into three-phase alternating current. Another will change three-phase alternating current into continuous current. Yet another will change an alternating current of a certain frequency into an alternating current of a different frequency.

In the following table of the principal conversions which may thus be accomplished, C stands for continuous current, A_1 for alternate current of single-phase, A_2 for two-phase, A_3 for three-phase:

1. C to C at higher or lower voltage.
2. A_1 to A_1 „ „ „
3. A_2 to A_2 „ „ „
4. A_3 to A_3 „ „ „
5. C to A_1, or A_1 to C.
6. C to A_2, or A_2 to C.
7. C to A_3, or A_3 to C.
8. A_1 to A_2, or A_2 to A_1.
9. A_1 to A_3, or A_3 to A_1.
10. A_2 to A_3, or A_3 to A_2.
11. A_1 to A_1 of different phase.
12. A_1 to A_1 of different frequency.

Any one of these conversions might be accomplished by selecting an appropriate motor to receive and be driven by the primary current, and coupling it to a generator to give out a secondary current of the species desired. It will be noted that of these conversions No. 2 is the ordinary alternate-current transformation, and is better accomplished by ordinary stationary transformers; as also are Nos. 3 and 4. By a suitable combination of stationary transformers No. 10 can also be effected, whilst Nos. 8 and 9 may be more or less satisfactorily effected by the use of auxiliary choking coils and condensers. But all of them may, and all the others must, be effected by means of rotatory apparatus. From the above list there have been omitted several possible cases of conversion, as, for example, that of a current supplied at fixed voltage but of varying amperage, to a current of fixed amperage but delivered at varying voltage.

It is not proposed here to deal, save purely incidentally, with the continuous-current transformer (No. 1 of the above table), which was brought before this Institution seven years ago by Major-General Webber (vol. xx., p. 63, 1891); nor with phase transformers (Nos. 8, 9, 10, and 11); nor with frequency transformers (No. 12); nor with any stationary kind of transformer. This paper will be directed to the machines devoted to the purpose of converting continuous currents into alternating currents of one, two, or three phases, or *vice versâ*. The importance which such machines have now assumed in the electrical industry arises from several causes. Long-distance transmission, with its corollary of the employment of high voltages, has demanded for this service alternating currents. The development of the electric tramway with continuous-current motors has called for methods of feeding at distant points. For this service rotatory converters are required. Also for charging accumulators in cases where the public supply is an alternating one, and for factory driving with three-phase motors in cases where the public supply is one with continuous currents, rotatory converters are wanted. All these cases might, of course, be met by the use of coupled machines, motor and generator. An early example of this method was afforded by the lighting station at Cassel, where the high-voltage alternating transmission was effected by the use of synchronous single-phase alternators, and the town distribution by continuous-current dynamos coupled to the shaft of the synchronous motors. Even now, in the case of a three-phase transmission and a continuous-current distribution, some engineers recommend the use of a group converter, consisting of a non-synchronous three-phase motor coupled to a continuous-current dynamo. But in all such cases the efficiency of the group is necessarily lower than that of either of its component parts. If a motor having, say, a 90 per cent. efficiency is coupled to a dynamo, also of 90 per cent. efficiency, the efficiency of the group cannot possibly exceed 81 per cent.

Two other solutions to the general problem are possible. One is to wind the revolving armature with two sets of windings—one to receive the primary current and revolve as a motor, the other to generate the secondary current. As only one field magnet and one pair of bearings are required, there is an obvious economy of material, though no great saving in efficiency. Another solution—not, it is true, of universal application, but having the advantage of effecting a considerable increase of efficiency as well as an

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economy in material—is to wind the armature with but one set of windings, furnished at one end with a commutator, and at the other with appropriate contact rings, the same winding serving both to receive the incoming primary current and to generate the secondary current. It is this specialised type of machine which is the main subject of the present discussion, and which is called *par excellence* a rotatory converter.

At this point it may be convenient to drop the adjective "rotatory," and speak simply of converters, leaving the term "transformer" to denote the stationary apparatus.

Converters of a simple kind have been known for many years. Ever since 1885 there has been one at the Technical College, Finsbury, consisting of a bipolar Gramme machine with the ordinary commutator, with the addition of two insulated contact rings at the other end of the armature, these rings being connected to two points on the winding at opposite ends of a diameter. It, therefore, belongs to the species C A_1 (or No. 5 of Table I.) The addition of three contact rings connected to three symmetrical points on the winding would constitute a machine of the species C A_3 (or No. 7 of Table I.).

It may be convenient here to point out the relation between the number of contact rings (called for brevity slip rings) that are applied in any alternate-current generator, and the uses to which such generator may be put with respect to the phasal relations of the currents that may be drawn from it. For brevity these are enumerated in the following table. The figures in the second column relate to the angles between the points on the winding at which the slip rings are connected for the simple case of a bipolar machine.

TABLE II.

No. of slip rings.	Angle.	Possible service.
2	180°	Single-phase.
3	120°	3 single-phase in ternature = "three-phase."
4	90°	2 single-phase in quadrature = "two-phase," or 4 single-phase in successive quadrature = "four-phase."
5	72°	5 single-phase in quinature = "five-phase."
6	60°	3 single-phase in ternature = three-phase with separate leads, or 6 single-phase in successive sexature = "six-phase," or 2 three-phase in sexature.
7	$51\frac{3}{7}°$	7 single-phase in septature = "seven-phase."
8	45°	4 single-phase in successive octature = "four-phase" with separate leads, or 8 single-phase in successive octature = "eight-phase," or 2 two-phase in octature.
9	40°	3 three-phase in nonature, or 9 single-phase in successive nonature = "nine-phase."

The general principles of conversion from polyphase to continuous currents, or *vice versâ*, are well known. The relation between the respective voltages on the alternating-current side and the continuous-current side have long ago been investigated, and expressions for their values in the several instances that may arise have been given for those cases in which it is assumed (*a*) that the alternating currents are simple sine functions of the time, and (*b*) that the magnetic flux is distributed as a sine function in space with respect to the periphery of the armature. Calculations for the voltages of two-phase and three-phase converters were given by Prof. Ayrton in the *Journal* of the Institution of Electrical Engineers, vol. xxii., p. 340, in a discussion on April 27, 1893. For the purpose of studying such machines they may be considered either as used to convert continuous currents into alternating, or as converting alternating into continuous. The latter function is of more frequent occurrence in practice; the former is rather more easy to follow out in thought. Taking, then, the instance of the converters as used to change continuous currents into alternating, and applying Prof. Ayrton's results to the several cases, we obtain the following numerical values. If we take the continuous currents as being supplied at a constant pressure of 100 volts, the voltmeter readings at the alternate-current side will be as follows.

Number of slip rings.	Angle between connections to rings.	Nature of service generated.	Voltage ratio.	Voltage (virtual volts).
2	180°	Single-phase	$\frac{1}{\sqrt{2}}$	70·71
3	120°	Three-phase	$\frac{1}{2}\frac{\sqrt{3}}{\sqrt{2}}$	61·23
4	90°	As two-phase	$\frac{1}{\sqrt{2}}$	70·71
4	90°	As four-phase	$\frac{1}{2}$	50·00
6	60°	As three-phase	$\frac{1}{2}\frac{\sqrt{3}}{\sqrt{2}}$	61·23
6	60°	As six-phase	$\frac{1}{2\sqrt{2}}$	35·35

A very complete discussion of the voltage relations, with formulæ applicable to the cases of open-coil windings as well as of closed-coil windings, was given by Herr R. M. Friese in the *Elektrotechnische Zeitschrift* of Feb. 15, 1894. Throughout the series of articles he assumes the sine values of the distribution of the magnetic flux around the periphery of the armature. More recently Mr. Steinmetz has reconsidered the same problem in the same journal in articles which appeared on March 3 and 10, 1898. From these theoretical considerations it is easy to write down not only the voltages in the several cases, but also to calculate the corresponding relative values of the working currents in the armature and in the line wires. Similar calculations, down to a certain point, have to be made by every designer of polyphase motors. If we assume the above values for the voltages, and proceed to calculate the corresponding currents for an output of 10 kw., we find the values of the currents generated to be as follows, the circuits being supposed non-inductive. Maximum as well as virtual values are given. Columns 4 and 5 refer to currents in the armatures, and columns 6 and 7 to currents in the lines. Star groupings are out of the question here, as they cannot be applied in armatures of converters. The only two-phase case that is possible is really a four-phase.

WORKING CURRENTS IN ALTERNATING ARMATURES.

Number of slip rings	Angle between connections to rings.	Nature of service.	Armature current.		Line current.	
			Virtual.	Maximum.	Virtual.	Maximum.
2	180°	Single-phase	70·7	100·0	141·4	200·0
3	120°	Three-phase	54·5	77·0	94·3	133·3
4	90°	Two-phase (four wires)	50·0	70·7	70·7	100·0
6	60°	Six-phase	47·2	66·7	47·2	66·7

If the circuits are inductive, there will be a lag of phase in the currents, and wattless currents as well as working currents. For an equal output of power the numbers in columns 4 to 7 of the above table will need to be increased by dividing them by the cosine of the angle of lag.

Let us return to the problems presented by a converter, in which an armature, furnished with slip rings at one end and a commutator at the other, is wound with but one set of windings, receiving current as a motor and delivering it as a generator. The question for consideration is how the current in the act of being transformed from alternating to continuous, or *vice versâ*, flows through the windings of the armature. This is a matter that has not hitherto been considered in detail in any publication. Consider the general case of a revolving armature which is at the same time being traversed by continuous currents to drive it as motor, and by alternating currents which it is putting forth as generator. It is self-evident that the currents which it receives as motor must be flowing in general against the E.M.F.'s induced internally by its rotation, while the currents which it gives out as generator must be flowing with those E.M.F.'s. Further, since at every instant (under steady conditions of operation) the value of the continuous current is (by hypothesis) unvarying, whilst the instantaneous value of the alternating current is continually changing, it is clear that at some instants the motor current must be in excess of the generating current, whilst at

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other instants the reverse must be the case. Whilst the average speed of rotation remains uniform it is certain that during each period or revolution there will at times be a positive acceleration, and at other times a negative acceleration. Further, it is clear that if there are any irreversible sources of loss of energy, such as friction, hysteresis, or eddy currents, the motor current must on the whole be greater than would otherwise be requisite, the power supplied at the motor side being greater than the output of power at the generator side, the difference being equal to the sum of the various items of power wasted in the machine.

To make this clear, as well as to exhibit the way in which the circulation of current in the windings is effected, it is well to take some concrete case. All cannot follow an analytical argument; and, therefore, though the analytical treatment has many advantages, I have deliberately preferred, for the purposes of the present paper, to avoid formulæ (though they have been used in its preparation), and instead to exhibit the arguments numerically by taking specific cases that are readily followed.

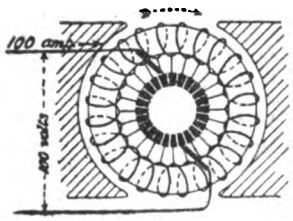

FIG. 1.

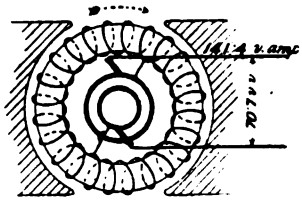

FIG. 2.

Let us consider a 10-kw. bipolar ring armature, having at its periphery 96 conductors, connected symmetrically down to a 48-part commutator, running at 1,200 revolutions per minute, or 20 revolutions per second. There will be two turns of the winding between each commutator bar and the bar next adjacent. (Or the armature might be wound as a lap-wound drum, with two conductors to constitute each element of the winding.) That it may run as a 100-volt continuous-current machine the magnetic flux through the armature core must be 5,208,333 lines, or a little over five megalines. Fig. 1 will serve to represent diagrammatically this armature when receiving 100 amperes at 100 volts, and running as a motor. The flow of current in the armature winding will, of course, be 50 amperes in each half of the ring.

Now, suppose a precisely similar armature to be revolving in a precisely similar field, but let its windings be connected at two diametrically opposite points to two slip rings on the axis. If driven by power it will generate an alternating current. As the maximum voltage between the points that are connected to the slip rings will be 100 volts, and the virtual volts (as measured by a voltmeter) between the rings will be 70·7 ($=100 \div \sqrt{2}$), if the power applied in turning this armature (Fig. 2) be 10 kw., and if the circuit

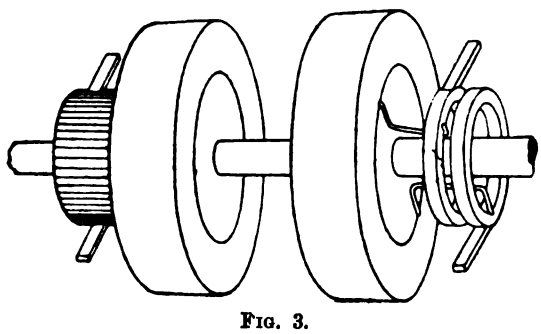

FIG. 3.

is non-inductive, the output in virtual amperes will be $10{,}000 \div 70{\cdot}7 = 141{\cdot}4$. If the resistances of each of the armatures is negligibly small, and if there are no frictional or other losses, the power given out by the armature which serves as motor will just suffice to drive the armature which serves as generator. Accordingly, let us suppose them both mounted upon the same shaft, as in Fig. 3, and placed so that each lies in a similar and equal bipolar magnetic field. We have here the well-known combination of a motor-dynamo.* In every actual case there are, of course, losses (*a*) by friction, hysteresis, and eddy currents, (*b*) by heating of the resistances in the armatures. The former have to be paid for by an increase in the motor current. Suppose them in the present case to amount to 4 per cent. for each armature, then 108 amperes instead of 100 must flow in from the supply circuit. The heat losses manifest themselves electrically by a fall of potential at the terminals of the generator, and by a fall of speed in the motor if the primary voltage is not raised. Let the primary voltage be supposed to be raised the requisite small percentage to keep up the speed and to maintain the secondary voltage at 70·7 on the generator side: the output of the generator will then be 10 kw., the input at the motor 10 kw. plus the number of watts required to make up all the various items of lost power. Though the armatures are of equal resistance, and are respectively receiving and giving out (approximately) equal amounts of electric energy, the armature of the alternate-current side (whether used as generator or motor) will heat more than that of the continuous-current side; for it carries $\sqrt{2}$ times as large a current, and the ohmic heat will be proportional to the square of this, or twice that produced in the continuous-current armature by the 100 amperes of working current. In each armature the heat will be developed equally in all the separate coils around the ring. As the armatures are alike, and as the similarly placed windings in each are passing through identical magnetic fields, there is no reason why one winding should not answer for both purposes. Fig. 4 shows the case in which this change has been made. One armature only is used; it is connected at one end of the commutator, and the other to the two slip rings, and the machine now becomes a simple rotatory converter. The total hysteresis and eddy-current losses will obviously be now one-half of their former amount. The total heating due to resistance will be also reduced, because now the single winding has

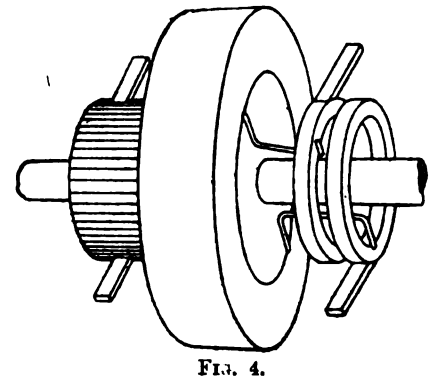

FIG. 4.

to carry only the differences of the two currents—a point presently to be considered—and the ohmic losses will be less. The waste of power, in fact, is approximately halved. How far this economy of losses can be carried depends on the number of phases of the alternating current. But there is another consideration involved—the question of armature reactions and sparkless collection of current. In the combined pair of machines called a motor-dynamo the brushes on the continuous-current side must be set, exactly as in any continuous-current machine, with a lead, negative or positive, according as whether it is operating as motor or dynamo. In the rotatory converter no lead in either sense need be given to the brushes; for the armature reactions of the motor part being, in general, opposed by those in the dynamo part, they cancel one another to a large extent. This property, which is common to all those motor-generators in which there is used, whether with one winding or two, a common core in a common field, was pointed out by the author in 1888, when giving the theory of continuous-current transformers.

The relations between speed and field are peculiar. In the case of those grouped machines or motor-dynamos (Fig. 3), in which each armature revolves in its own field,

* The term dynamotor is not only philologically bad, but is a misdescription. When two machines, of whatever kind, are thus coupled together, it is always the motor which drives the dynamo, not the dynamo which drives the motor.

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the conditions differ from those of the converter (Fig. 4), where there is only one field. If in either case the continuous-current side is the primary—*i.e.*, motor—side, the speed of revolution will depend on the field magnet, the weakening of which will increase the speed. The frequency of the secondary or alternating current will in that case also vary. But the ratio of the primary and secondary voltages will be independent of speed if the fields are alike, or if only one common field is used. The secondary voltage cannot be varied, while the primary voltage is kept constant unless separate fields and separate windings are employed, as in Fig. 3.

If, on the other hand, the alternating-current side is used as primary, then the machine, whether motor-dynamo or converter, runs as a synchronous motor with a fixed speed. In that case the voltage ratio remains also nearly a constant, even though the excitation of the field is increased or diminished, owing to the peculiar phase relations which take place, as is known, in the currents of synchronous motors when under-excited or over-excited. This question, and the expediency of exciting in series or in shunt from the continuous-current side, or of running without excitation, has been discussed by Mr. E. J. Berg in the *American Electrician* of February, 1897.

Returning to the question how the current in the armature of the converter gets through the windings, it will be found that a simple means of answering it is afforded by the principle of superposition of instantaneous values of currents. Still taking as a concrete case the 10-kw. converter of Fig. 3, we may calculate out the instantaneous values of the currents in its windings at different epochs in its period of rotation. If we do this for the motor currents and for the generator currents separately, and then superpose them, we shall obtain a number of instantaneous values for the combined armature as converter. This has been done in the series of drawings in Fig. 5. If the continuous current acts as motor taking 100 amperes, there will be 50 amperes flowing in each half of the winding at every instant—*qua motor*—in a direction opposing the E.M.F. in the winding. This is shown in the first diagram in the upper row of Fig. 5. As single-phase generator the armature is working, as already described, with a virtual voltage of 70·7 volts, and an output (supposing the power factor = 1) of 141·4 virtual amperes. The maximum current will be $141{\cdot}4 \times \sqrt{2} = 200$ amperes; and this will be attained at the instant when the two conductors which lead down from the winding to the slip rings are turned to the position of 90deg. to the axis joining the middles of the pole-faces. The eight diagrams which follow in the top row of Fig. 5 exhibit the successive values of the currents flowing in the armature—*qua generator*—in positions differing successively by 15deg. By supposing these eight diagrams successively superposed upon the motor diagram which precedes them, we obtain the eight diagrams of the lower row, which exhibit the currents actually flowing in the different parts at the particular times when the armature has the position shown.

(To be continued.)

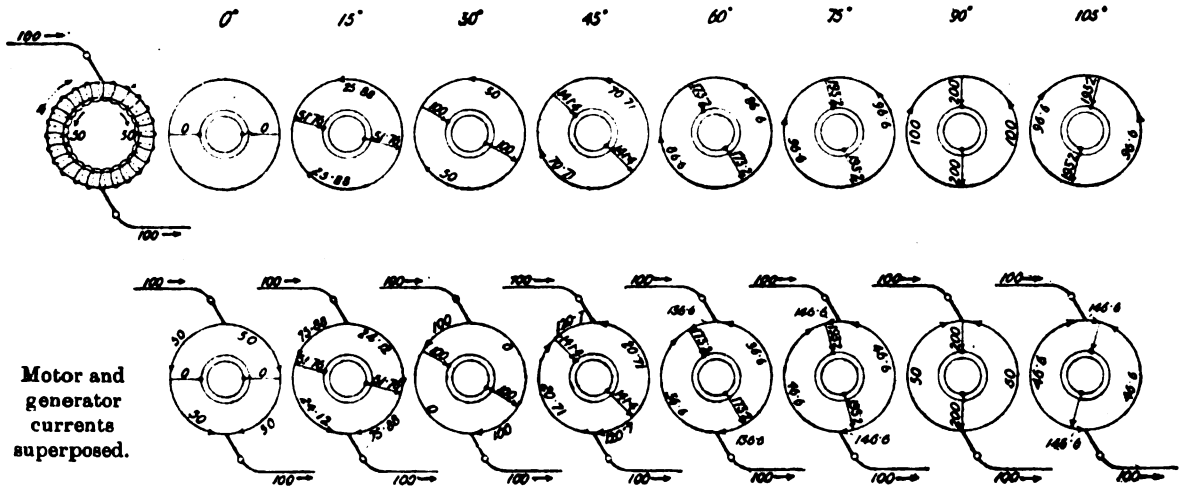

FIG. 5.—Flow of Currents in Single-Phase Converter. Continuous current: 100 amperes, at 100 volts. Single-phase current: 141·4 virtual amperes at 70·7 virtual volts.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE III.

(Concluded from page 597.)

I shall now show you some diagrams which will give you a good idea of the action of a car during the process of getting up speed and the way in which that action is modified by different methods of handling the controller.

The curves in Figs. 20 and 21 are the results of experiments made by my friend, Mr. H. P. Curtiss, on the Buffalo and Niagara Falls Electric Railway. The cars used in the experiments weighed 13·6 tons, and were 36ft. in length. There are four driving wheels, each equipped with one G.E. 800 motor. I have already given you the induction and other curves of this motor. The wheels are 33in. in diameter, and the velocity ratio 4·78. The tension of the line in the experiments was 550 volts. In both figures the vertical ordinates give speed in feet per second for the acceleration curves, and the total current from the line in amperes for the current curves. Fig. 20 is the record of a test in which the controller was manipulated so as to effect a continuous start. The acceleration curve is very even, and the point at which the motors are thrown over to parallel can only be detected from the current curve. The initial acceleration was about 2ft. per second, the motors then taking 60 amperes each. On throwing over to parallel, the current from the line was increased from 120 to 200 amperes. The starting rheostat is all out in eight seconds, and the final speed is 24 miles per hour. In the experiment, of which Fig. 21 is a record, the motors were allowed to speed up for some time in series. The form of the current curve during this process is very well shown, and the sudden rise in the acceleration curve after uniform speed has been attained indicates the jerk to which the whole car was subjected when the motors were thrown over to parallel connection. An inspection of the curves will show you that this method involves a longer time for starting up, though the energy required to attain a given speed is rather less than in the first case. In all these experiments the track was quite straight and level. In looking at the curves which I have been showing you, no doubt you will have noticed that most of them indicate a very marked peak in the current curve at the moment when the motors are thrown over to parallel. The question may have presented itself to you whether it is not possible to get rid of this peak. For you are all, of course, aware that it is the peak in the current curves for the individual cars which are mainly responsible for the very irregular demand on the power-house. It will, therefore, be worth while to consider any means of getting rid of these objectionable peaks. Let us then for a few minutes examine this matter.

Let us take the case of a single car weighing 10 tons, and find out how the motion is affected by taking currents of different amounts when the controller is on the parallel step. I have worked out the results on the assumption that the car is equipped with two G.E. 800 motors, and that on the series step the current per motor is 50 amperes, while on the parallel step the current is respectively 50, 35, and 25 amperes. The results are given in the form of curves in Fig. 22. The acceleration curves have been worked out graphically from the known induction curves of the motors. You will notice that in each of the three cases the current per motor on the series step is the same, and that the difference is only on the parallel step. Of course the car makes the quickest start when the current is 50 amperes per motor. But you see that the time required to travel 300ft. is only three seconds shorter than that required

* Cantor lectures, delivered before the Society of Arts.

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when the current per motor is 35 amperes, and is six seconds shorter than when the current is 25 amperes per motor. The practical effect of the different currents is well shown by the curve of distances. When the distance is greater than 300ft., the difference in time between the 50 and 25 ampere arrangement becomes constant and equal to seven seconds—that is to say, if the distance travelled is great, the gain due to taking 50 amperes per motor instead of 25 is only seven seconds. If you look at the current curves you will see how much more even

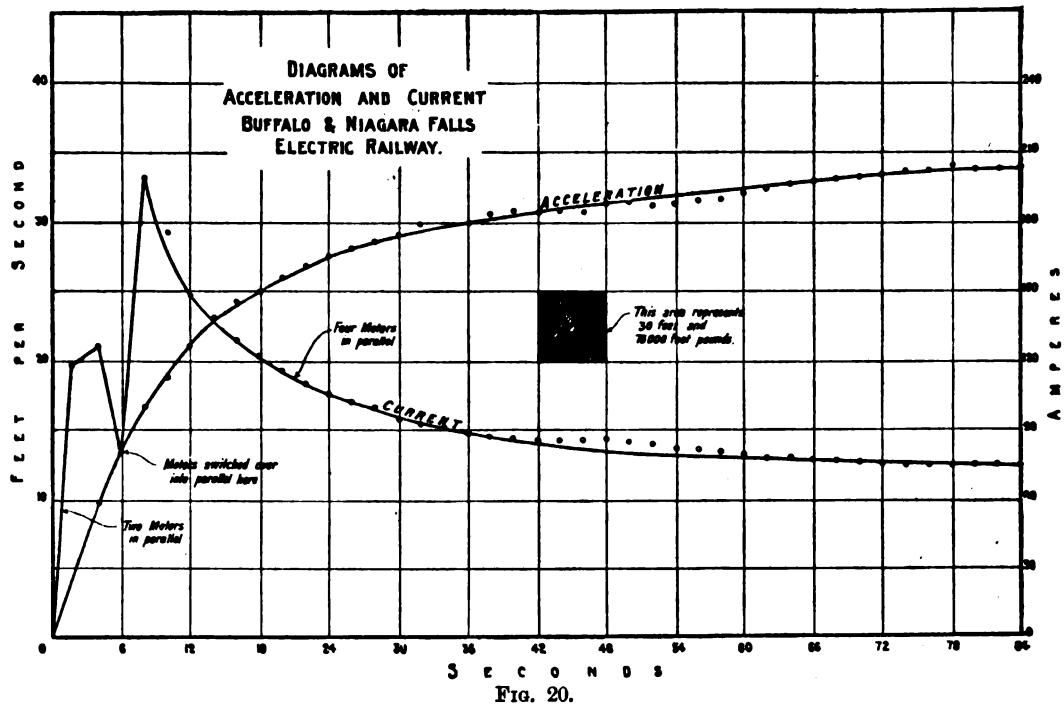

FIG. 20.

is the 25-ampere curve than the 50. If the distance travelled is 400ft. or less, it may be worth while to gain the seven seconds at the expense of the peak in the curve; but if the distance is 800ft. or over, it would probably not be worth while. As a general rule, you will find that the current drawn from the line on the parallel step is out of all proportion to the gain in time. I need hardly remind you that the amount of current to be taken is determined simply by the resistance in series with the motors when the controller is thrown on to the parallel step.

tant example of the application of electricity to traction, and one that has received much attention on account of the magnitude of the undertaking. The freight service through the Belt Line tunnel on the Baltimore and Ohio Railroad, in Baltimore, is now carried on by means of electricity. The conditions of working are very severe. Much of the line is on a grade, and the trains to be hauled weigh between 700 and 800 tons. An account of the electrical equipment may be found in a paper by L. H. Parker in the *Street Railway Journal* for March, 1896.

The trains are hauled by locomotives, one of which is illustrated in Fig. 23. Each locomotive is made up of two trucks, a detailed view of which is given in Fig. 24. Each truck is driven by two motors, one on each axle. The armatures are built directly on the driving axles, without the use of gearing.

I do not propose to take up your time with an account of the way in which all the difficult problems connected with the design of these locomotives have been successfully met. Those of you who are anxious to know more can find all information in

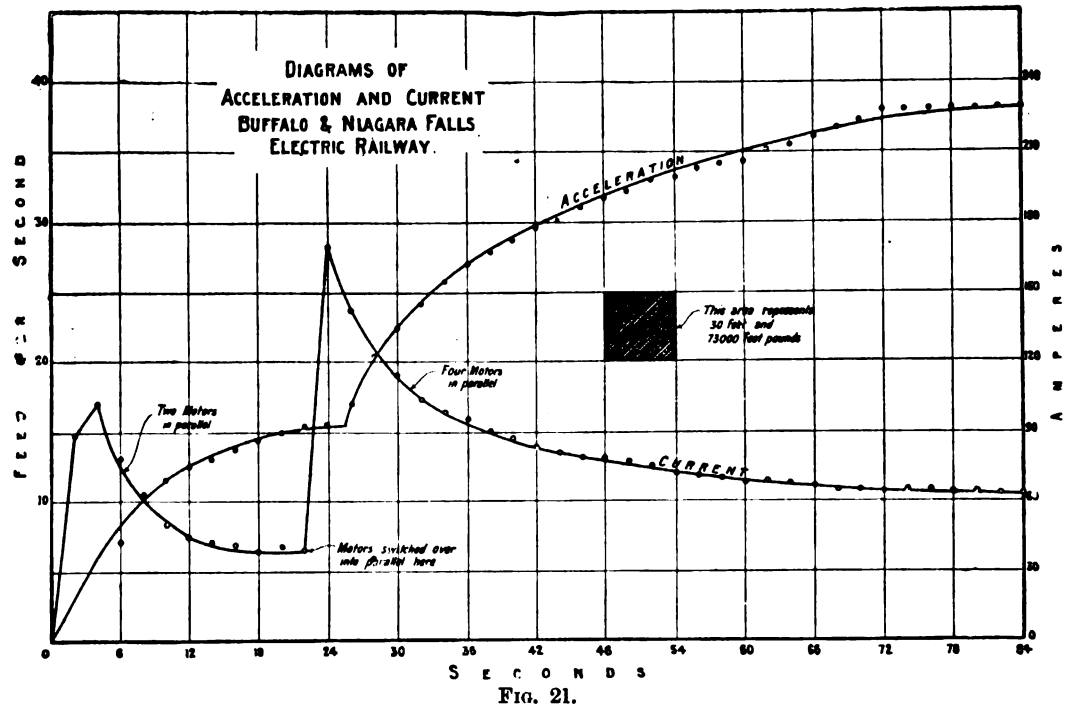

FIG. 21.

We can effect a saving in the current required to start by reducing the frictional and other resistances opposing the motion. Thus, by using roller bearings, we may start up with the same acceleration but with a greatly reduced current, or we may start up a heavier train with the same current. On the Liverpool Overhead Railway the introduction of roller bearings enabled the engineers to add a third car without reducing the acceleration or increasing the current taken from the line.

I want, in conclusion, to bring to your notice a very important example of the application of electricity to traction, and one that has received much attention on account of the magnitude of the undertaking. The freight service through the Belt Line tunnel on the Baltimore and Ohio Railroad, in Baltimore, is now carried on by means of electricity. The conditions of working are very severe. Much of the line is on a grade, and the trains to be hauled weigh between 700 and 800 tons. An account of the electrical equipment may be found in a paper by L. H. Parker in the *Street Railway Journal* for March, 1896.

the paper to which I have alluded. I will, however, briefly indicate the application of the principles that we have been discussing to this very interesting case. I will take the actual figures met with in practice, and assume that we have a freight train weighing, with the locomotive, 780 tons. This has to be started on a grade of 0·8 per cent., and hauled up the incline at 10·7 miles per hour. The frictional resistance to motion may be taken at 9lb. horizontal pull per ton of load. The tension of the line is 625 volts. The internal resistance of

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each of the four motors is 0·0209 ohm, and they are connected permanently in series. The draw-bar pull per motor for the grade is 3,490lb., and for friction 1,755lb., making altogether 5,245lb. If we allow a mechanical efficiency of 95 per cent., you see that each motor must be able to exert a total horizontal pull of 5,500lb. I have already told you that the speed when ascending the grade is to be 10·7 miles per hour, and that the velocity ratio is unity, since the motors are gearless. With these data we can at once find the ratio of the induction factor to the diameter of the driving wheel and obtain the equation $\frac{M}{d} = 2{\cdot}33$ — that is to say, if the diameter of the driving wheel is fixed, then the induction factor is given by this equation, or *vice versâ*.

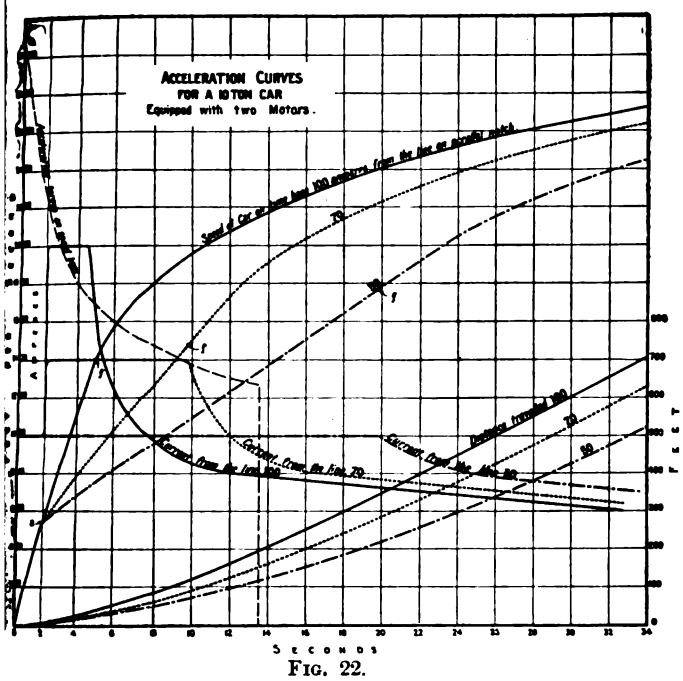

FIG. 22.

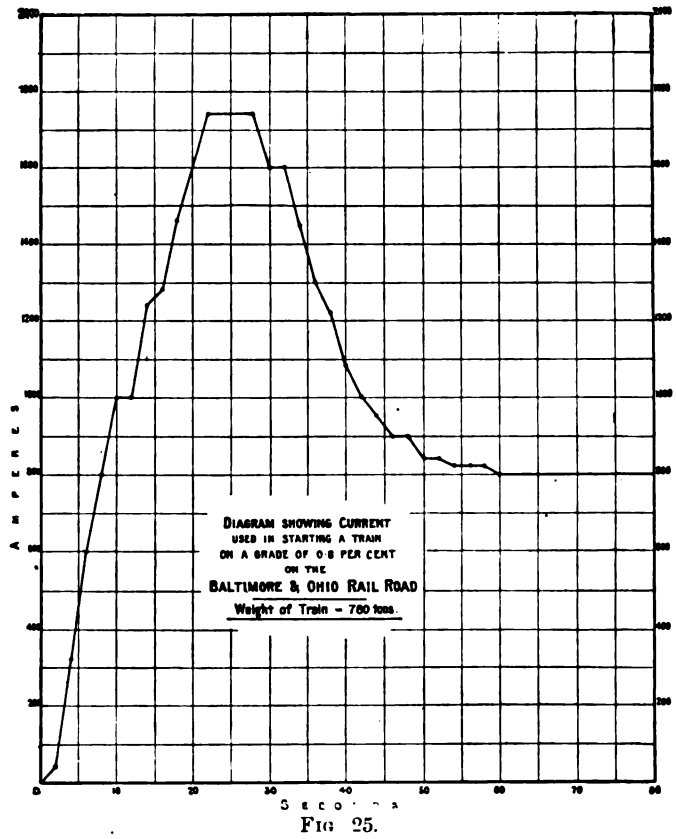

FIG. 25.

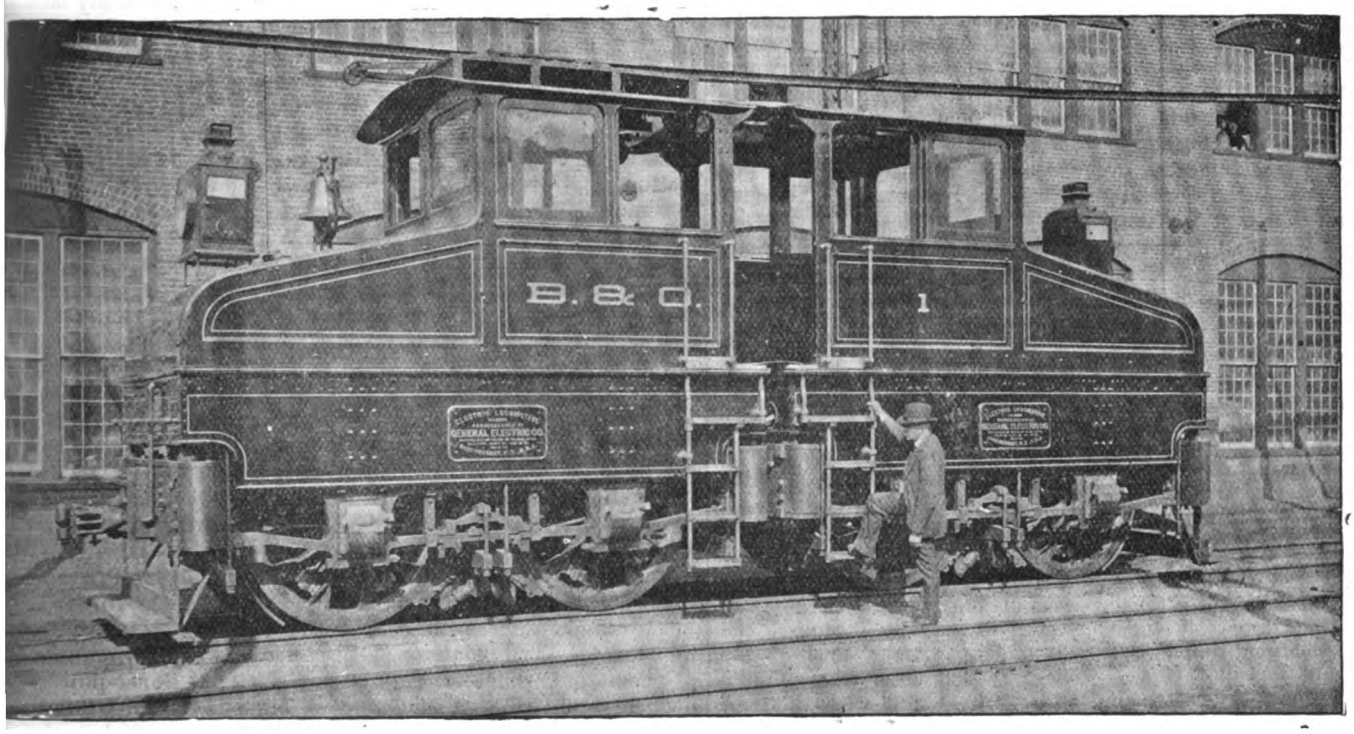

FIG. 23.

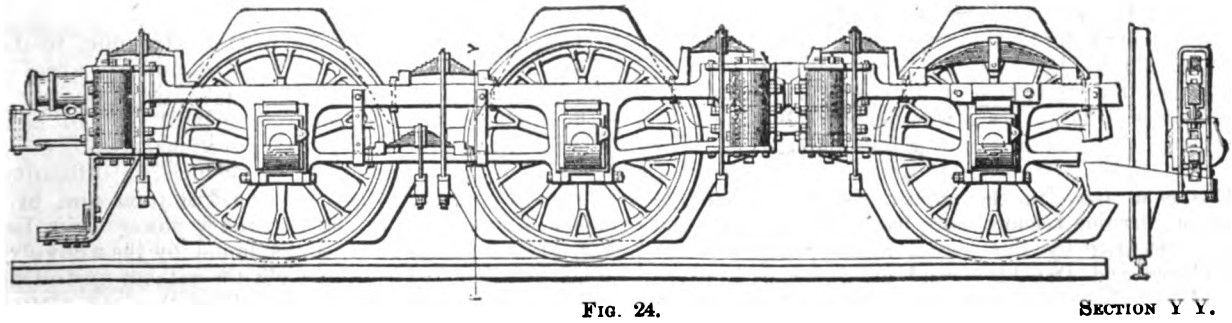

FIG. 24. SECTION Y Y.

But whatever values of M and d we employ, their ratio must be that given by this equation in order that the train may be hauled up the grade at the required speed. Thus, if

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we adopted 64in. as the diameter of the driving wheel, we should have to make M equal to 150. The values actually used are M = 144, and d = 62in. Now, if you were to make a very simple calculation, with which I shall not now trouble you, you would find that the current required to move the train against the opposing forces of friction and of the grade is almost exactly 800 amperes; but this will only enable the motors to move the train when once started; we shall have to take very much more current in order to start the train. If we knew the acceleration at which the train has to start, we can find the corresponding accelerating current by a very simple equation, given on p. 156 of the book to which I have already referred you. The acceleration actually attained in practice is about 0·5ft. per second per second. To obtain this we require an accelerating current of 1,000 amperes, supposing the induction factor to remain the same at the start as at full speed. Now, the induction factor actually increases slightly with the current, owing to the use of series winding for the magnets. I must, however, defer consideration of the influence of this change in the induction factor on the conditions of starting, and assume that it remains constant. Under these circumstances we should require a total current of 1,800 amperes at the moment of starting. I can now show you, in Fig. 25, the current curve actually obtained in starting a train weighing 780 tons on the grade. You see that the total current rises gradually to very nearly 1,800 amperes; this gradual rise is necessary on account of the need of avoiding sudden shocks to the equipment. You see also that when full speed has been attained, which is in about 60 seconds from the moment of first connecting to the line, the current has fallen to 800 amperes, and the speed is 10·7 miles per hour. In examining this diagram you must bear in mind that the current must rise to 800 amperes before the train can begin to move, so that the moment at which motion commences is not where the current is nothing, but where it has this value—*i.e.*, about eight seconds from first connecting to the line.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

114. In low-pressure three-wire networks, where copper strip supported on porcelain insulators and run in culverts is employed, the "earth leakage" is invariably in excess on the negative side of the system. How is this?—R. E. E.

115. How do you find the loss of steam pressure in a steam-pipe when you know the velocity of the steam in the pipe? J. C. R.

ANSWERS.

Question No. 108.—Should accumulators for traction purposes be tested at constant current or by keeping the charging E.M.F. constant? Does this make any difference in the results?

Best Answer to No. 108 (*awarded* 10*s.*).—The best method to adopt in charging an accumulator for testing purposes is that method by which it is destined to be charged in actual use on the track—that is to say, if the type of cell to be tested is required for a line in which constant current is to be employed for charging, then constant current should be used for the testing of that cell. The reason for this is obvious, as in all tests, whether of cells, dynamos, transformers, or anything else, it is essential that they be carried out as far as is possible under *working conditions*. That this is of the greatest importance in the method adopted for charging accumulators has been very fully and ably demonstrated by the results recently obtained by Messrs. Cahen and Donaldson, and published in a paper read by them before Section A of the British Association.* Roughly speaking, these experiments showed that a gain of 30 per cent. in the ampere-hour capacity of a cell and a loss of 10 per cent. in the watt-hour or energy efficiency when the constant P.D. at terminals of cell method of charging was adopted as compared with the more usual constant-current method. The time required for charging was also shortened by 50 per cent. when the former method was adopted. It is therefore evident that were the published tests of a cell obtained by employing constant P.D. for charging the ampere-hour capacity per pound of cell would appear to excellent advantage from the manufacturer's point, but might, on the other hand, lead to heartrending disappointment to the buyer. And if the latter individual was afterwards told that he should of course charge his battery by employing constant P.D. if he desired maximum capacity, it is just likely that he will be still more greatly disappointed by finding his cells quite useless after a few months' work. It must be remembered that the cell used in the experiments before mentioned was of a small Tudor L.A. type, and although *this* appeared to stand the very high initial strain naturally imposed upon it with constant P.D., it yet remains to be proved that the various very light types of cell now on the market for portable traction purposes would put up with many charges under a like condition. If it is decided to adopt the constant P.D. method, however, then undoubtedly a long series of tests should be undertaken on the type of cell chosen in which it is charged exclusively by keeping the E.M.F. at the terminals constant.—F. J.

Question No. 109.—In a transmission of power scheme what considerations should determine the permissible loss in the line wires?

Best Answer to No. 109 (*awarded* 10*s.*).—The local considerations of power transmission schemes vary to such an extent that it is impossible to give a hard-and-fast rule to determine the amount of energy that can economically be lost in the line. For instance, in one case we may have a cheap and unlimited supply of power, and can, therefore, afford to lose a large amount in transmission at a low cost for copper. In another case the power may be expensive or limited, and there will have to be a correspondingly greater expense in copper, so that the energy lost may not be too great.

Transmission of power schemes can be classed under three heads: (1) Where there is a plentiful and cheap supply of power at the generating station; in this case, the power being unlimited, the generator may be as large as desired, and the area of conductor will depend upon the pressure of the line and the power required at the motor. (2) Where the source of power is limited or expensive; here the power being limited, the loss in the line will also be limited, consistent with a reasonable outlay in copper. (3) When the generated power is fixed, and it is required to get as much of it at the motor as possible; in this case as much of the capital as can be spared for the purpose must be spent in copper, so that the loss in the line may be a minimum.

In finding the permissible loss, then the following points must be considered in detail, and a general rule for the most economical area of conductor as nearly as possible adhered to. The points to be observed are: (1) pressure at generator terminals; (2) cost per electrical horse-power at generator; (3) annual value of brake horse-power at generator; (4) horse-power required at motor; (5) length of line; (6) capital outlay per ton of copper erected; (7) interest and depreciation of plant.

The general law to be followed is that due to Lord Kelvin, expressed thus: the most economical area of a conductor is that for which the annual value of energy lost in the line is equal to the interest on that part of capital outlay which is proportional to the sectional area of copper. But this law has frequently to be modified, as difficulty in its practical working is found sometimes from one of the following reasons: (1) the generated power may be so cheap that the energy wasted, as found by the above rule, cannot be dissipated by the conductor without undue heating, thus causing deterioration of insulation, etc.; (2) the area of conductor may be fixed by the permissible drop in voltage; (3) the size of conductor may be fixed by mechanical reasons, as is sometimes the case in aerial lines.

* A Comparison between Charging a Secondary Cell at Constant Potential and at Constant Current, more especially as regards Efficiency." (British Association, Section A, 1898.)

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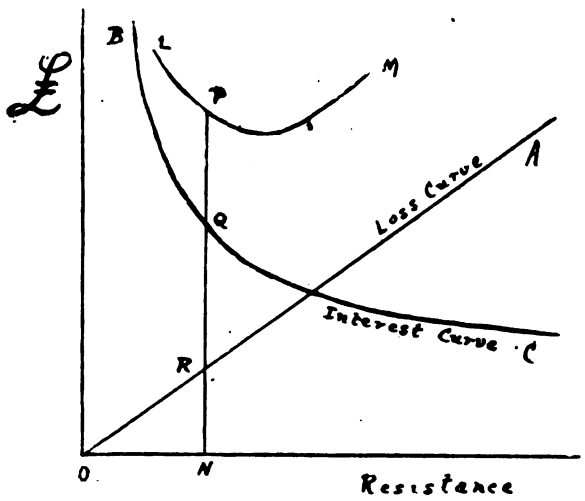
An example will serve to illustrate the above rule: Average current = 100 amperes. Total length of cable = 1,000 yards. Number of hours used per annum = 1,000. Cost of Board of Trade unit = 6d. Interest and depreciation = 10 per cent per annum. Cost of cable laid per ton = £360.

Cable.	Board of Trade units lost per annum.	Cost of energy lost per annum.	Cost of cable and laying per ton.	Interest and depreciation at 10 per cent. per annum.	Total cost of energy lost and depreciation per annum.
$^{19}/_{15}$	3,200	£80 0 0	£150	£15 0 0	£95 0 0
$^{19}/_{12}$	1,500	37 10 0	310	31 0 0	68 10 0
$^{37}/_{14}$	1,300	32 10 0	358	35 16 0	68 0 0
$^{37}/_{12}$	700	17 10 0	586	58 12 0	76 2 0

Thus it will be seen that out of the four cables the one selected as being the most economical is the $^{37}/_{14}$.—F. A.

Answer to No. 109 (*awarded* 5*s.*).—If the voltage at the generating station is fixed, and also the power that is to be transmitted, then the permissible loss in the line wires is determined by the modified statement of Kelvin's law given below. If this solution gives too great a current density, then the most economical cable is that which gives the highest permissible current density.

Kelvin's law is that the annual cost of the energy wasted in the line must equal the interest and depreciation on the initial cost of the line. This is worked out in practice as follows: We plot out the interest plus depreciation on cables of various sections, and therefore varying resistances, in the form of a curve (B C in the figure). Lines measured



horizontally give the resistances of the various cables, and lines drawn vertically give the interest and depreciation on their costs, the data being got from makers' catalogues. Knowing the number of hours per annum that the current is used, and the cost of the generation of a unit at the power station, we can plot out the annual cost of the power wasted in the various cables. This will be the straight line, O A, in the figure. Now construct a new curve, L M, in the figure, whose ordinate, P N, will equal the sum of the ordinates of the other two curves, Q N and R N, so that

$$PN = QN + RN.$$

If P be the lowest point of this curve, then O N will be the resistance of the required cable, seeing that for a cable of this resistance the sum of the annual cost of the energy wasted, plus the interest and depreciation on its prime cost, is a minimum. If this solution gives too great a current density, then the most economical cable is that which gives the highest permissible current density.

Hitherto we have supposed that the voltage was fixed. Theoretically the higher the voltage, the more efficient the transmission. For example, if we double the voltage we can transmit twice as much power for the same percentage loss. We must therefore use the highest permissible voltage, provided that the high-voltage machines which we can buy are not very much more expensive than lower-voltage machines of equal power, and can be guaranteed to run without constant risk of breaking down. When, however, the voltage is fixed, the permissible loss in the line is fixed as above.

Numerical Example.—In a transmission power scheme the voltage is 500; the total length of each main (0·25 square inch section) is 1½ miles, and their total resistance is 0·53 ohm. Power is required for 5,000 hours per annum, and the cost of generating a unit at the power station is 0·5d. The total cost of the mains was £1,650 (£550 per mile); what is the loss in the mains when it is working at its highest efficiency? Taking interest and depreciation at 10 per cent., the annual cost of the energy wasted must equal £16. 10s. Hence 330 × 24 Board of Trade units are wasted in the 5,000 hours. If C be current in mains,

$$C^2 \times 0{\cdot}53 = \frac{330 \times 24}{5{,}000} \times 1{,}000.$$

$$\therefore C = 54{\cdot}7 \text{ amperes.}$$

This only gives a current density of 218 amperes per square inch. The power transmitted is 27 kw. Hence the above cable is the most economical one to transmit 27 kw. for 5,000 hours per annum under the given conditions.—J. C. R.

Answer to No. 109 (*awarded* 5*s.*).—The most economical section for a transmission of power line depends upon the special circumstances of the case. The most usual condition is that of having a certain amount of power to transmit through a line the section of which we may arrive at as follows:

Let P = power in watts to be transmitted;
V = pressure in volts at sending end.

V is generally known, having been fixed when designing the generators. It should always be as high as circumstances will permit. Twenty thousand volts is about the limit at present.

Let A = current in amperes to be transmitted;

then $$A = \frac{P}{V}.$$

Let n = total length of line (go and return);
r = resistance per mile of conductor;
N = number of hours working per annum;
k = cost, in pounds, of generating one watt-hour;
C = cost, in pounds, of one ton of copper;
i = interest rate per £1 per annum including depreciation (thus, 8 per cent. rate, $i = \frac{8}{100}$)

Take the resistance of one mile of copper one square inch cross-section as ·044 ω: its weight would be 8·989 tons.

Power, in watts, lost in line = $A^2 n r$.

Cost, in pounds, of yearly line loss = $k A^2 n r N$.

Interest on cost of conductor = $\frac{·044}{r} \times 8{\cdot}989 \times C i n$.

According to the principle first enunciated by Lord Kelvin, the maximum economy is obtained by making these two items equal.

Hence, $$k A^2 n r N = \frac{·044}{r} \times 8{\cdot}989\ C i n;$$

or, $$k A^2 N r^2 = ·395\ C i;$$

$$r = \frac{1}{A}\sqrt{\frac{·395\ C i}{k N}}.$$

This determines the best section of copper to use, and consequently the proper current density.

It is important to notice that this solution is entirely independent of the *distance* to which power is transmitted.

Example.—Required to transmit 1,000 h.p. 20 miles at a pressure of 2,000 volts:

$$A = \frac{P}{V} = \frac{1{,}000 \times 746}{2{,}000} = 373.$$

Let C = 50;

$$i = \frac{8}{100};$$

$$k = \frac{10^{-4}}{16} \text{ at } 1\tfrac{1}{2}\text{d. per B.T.U.};$$

N = 3,650 at 10 hours per day;

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then $$r = \frac{1}{373}\sqrt{\frac{\cdot395 \times 50}{3{,}650} \times \frac{8}{100} \times 10^4 \times 16}$$

$$= \cdot0224 \text{ ohm per mile,}$$

corresponding to a section of 1·89 square inches.

The volts lost in line would, therefore, be

$$40 \times \cdot0224 \times 373 = 334.$$

These could be made up, if necessary, by increasing the voltage of the generator.—E. M.

EALING ELECTRICITY WORKS.

The following is an abstract of the report to the Electric Lighting Committee for the third complete year of working ending March 31, 1898:

The sum of £9,554. 6s. 6d. has been expended on additional outlay for permanent works, the larger item being for mains—viz., £5,722. New cables have been laid along the Grove from the Green to the King's Arms, from the common transformer to Hanger-lane, and from Argyle-road to the Helena Home at Drayton Green. New cables have been laid along Madeley-road, Westbury-road, Webster-gardens, Montpelier-road, Helena-road, St. Mary's-road to Warwick-road and Kerrison-road, the Park and Kenilworth-road. The high-tension cable has been run from Rothschilds, Gunnersbury-lane, to the top of Hanger Hill. From Hanger Hill, "Greystoke" has been connected, and the line continued across the footpath to Montpelier-road. From Kasner's Corner mains have been continued along the main road nearly to Hanwell boundary, and new consumers have been connected. Mains are now laid along the Gordon-road, Windsor-road (part of), and Castlebar-road (part of). Along these lines of new mains 102 street lamps have been connected, making the Council their own customers to an additional £325 per annum. On these new lines of mains new customers are being connected as rapidly as possible, and during the year closed 125 were connected, making an addition of 4,922 8-c.p. lamps, a total of 14,281 8-c.p. lamps since the commencement, making a total of private consumers at March 31 last, 326. So that a fairly large increase in the revenue for the current year may be anticipated. The new buildings have been completed and accommodation provided for more than double the existing plant. For the present some £4,000 of the capital laid out on the new building is unremunerative, and on which principal and interest have to be paid and included in revenue account, but at the present rate of progress it will not be many weeks before the Council will have to consider the advisability of extending their plant at the central station. Six new transformers were put in to cope with the increased demand last year. It may be well at this point to compare the gradual reduction of the loss on the three years' working: 1895 96, loss, £1,595. 0s. 5d.; 1896-97, loss, £1,184. 17s. 2d.; 1897-98, loss, £498. 10s. 6½d. This does not include the £800 "saving on gas" included in the previous accounts. It may be well to assume that we have fairly turned the corner, and that at the present moment the undertaking is a profit-yielding concern, and this in the short space of three years—the period originally estimated by your executive as the possible period of loss—and it may be fairly assumed that the coming three years will fully recoup the account the loss necessarily incurred in starting so extensive a concern. It should be pointed out that the Local Government Board's sanction to the loans extends for only 25 years, so that to compare ours with other undertakings (the London vestries, for instance, where their loans are spread over 42 years) is unfair. If this Council could borrow on the same terms—viz, 42 years at 3 per cent.—the account for last year would show a profit of £289. The amount of repayment of loans takes the place of the amounts usually set aside for depreciation, and repayments being spread over 25 years, amounts to 4 per cent. for the year on the capital outlay. And, further, assuming that the undertaking was the property of a company, the amount of £1,536. 12s. 2d. charged for interest would swell the profits and go towards dividend, making a gross profit for the year of £1,825. Abstract of lamps applied for and connected since works were opened:

	8 c.p.		8 c.p.
Applied for, March 31, 1897	10,103.	Connected	9,359
,, ,, March 31, 1898	14,990.	,, ...	14,281
,, ,, March 31, 1898 to Oct. 3, 1898	19,022.	,, ...	18,276

General Balance-Sheet.

Liabilities.	£	s.	d.
Capital account—			
Value of land appropriated for electrical purposes...	1,000	0	0
Outstanding on loan account	55,027	6	11
Due to bank on temporary loans.....	664	19	7
	56,692	6	6
Sundry creditors on revenue account...	729	1	2
Contribution from district rate account	1,371	16	6
Due to consumers on deposits	70	13	4
Due to surveyor on wages account.....	1	2	9
	£58,865	0	3

Assets.	£	s.	d.
Capital account—amount expended	59,367	19	7
Less depreciation reserve, being amounts repaid, mortgages and charged revenue	2,675	13	1
	56,692	6	6
Deposit account	70	13	4
Stores on hand at March 31, 1898: coal, £180. 10s.; oil, waste, etc., £19. 10s. 9d.; cables, carbons, etc., £46. 12s. 3d.; miscellaneous, £35	281	13	0
Sundry debtors for current to March 31, 1898	1,321	16	11
Actual loss on working for year ending March 31, 1898.....	498	10	6
	£58,865	0	3

Revenue Account.

Dr. Generation of Electricity.			£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works.....	£2,208	18 11			
Oil, waste, water, and engine-room stores.....	209	7 7			
Wages at generating station	831	15 9			
Repairs and maintenance as follows:					
Buildings	2	6 10			
Engines, boilers, machinery, etc. ...	177	1 5			
			3,429	10	6
Distribution of Electricity.					
Wages	3	3 1			
Repairs, maintenance, and renewals of mains, including materials and laying the same	0	14 10			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, including cost of materials	21	7 6			
			25	5	5
Public Lamps.					
Attending and repairing lamps	161	4 0			
Renewal of lamps	112	11 4			
			273	15	4
Rents, Rates, and Taxes.					
Rates and taxes	219	10 0			
Rents..	2	10 0			
			222	0	0
Management Charges.					
Salaries of engineer's department.....	430	5 0			
Salaries of clerical and accountants' department	12	0 0			
Collector's commission	45	4 3			
Stationery and printing	16	11 9			
General establishment charges	29	13 4			
			533	14	4
			4,484	5	7
Balance carried to net revenue account			1,619	19	5
			6,104	5	0
Cr.			£	s.	d.
Cash received in respect of sale of current at 6d. per B.T.U.			2 342	5	10
Ditto at 5d.			979	1	10
Ditto at 4½d.			35	18	3
Ditto at 4d.			15	11	8
Sale under contracts			190	3	1
			3,563	0	8
Rental of meters on consumers' premises.....			111	3	0
Public lighting, £2,150. 15s.; attending, repairing, and renewing public lamps, £273. 15s. 4d.			2,424	10	4
Sales and repairs of apparatus			3	2	6
Fees for testing consumers' installations, etc..... ...			2	8	6
			£6 104	5	0

LEGAL INTELLIGENCE.

KAYE v. THE CROYDON TRAMWAYS COMPANY AND OTHERS.

This was an action brought before Mr. Justice Kekewich in the High Court of Justice (Chancery Division) by Major-General George Farquhar Kaye on behalf of himself and all other, the members of the Croydon Tramways Company, against the company, its directors, and the British Electric Traction Company, Limited, for a declaration that an agreement dated Nov. 25, 1897, between the tramways company and the traction company for the sale to the latter company of the tramways company's undertaking, and a resolution approving the same purporting to have been passed at a meeting of the shareholders of the tramways company held on Dec. 14, 1897, in pursuance of a notice dated Nov. 26, 1897, were *ultra vires* and ought to be set aside, and for an injunction to restrain the defendants from carrying out the agreement, and also claiming relief against the directors of the tramways company personally. The agreement contained a provision for liberal compensation to

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the directors of the tramways company for loss of office consequent on the proposed sale, and it was contended that this provision made the agreement *ultra vires*. On Feb. 23 last the Court of Appeal, varying an order made by Mr. Justice Kekewich on a motion for an interim injunction, held (L.R., 1898, 1 Ch., 358) that the provision in favour of the directors did not render the agreement *ultra vires*, but that the notice convening the meeting of shareholders, by reason of its omission to refer to this provision, did not fairly disclose the purpose for which the meeting was convened, and did not comply with Section 71 of the Companies' Clauses Act, 1845, which requires the purpose for which a meeting of a company is called to be specified, and the Court granted an injunction restraining the tramways company from carrying the agreement into effect until duly sanctioned by the shareholders at a meeting duly convened for the purpose. The plaintiffs amended their statement of claim by charging that the agreement and the resolution approving the terms of it were not only *ultra vires*, but "fraudulent." The action now came on for trial.

Mr. Bramwell Davis, Q.C., and Mr. Bradford appeared for the plaintiffs; Mr. Warrington, Q.C., and Mr. Rowden for the defendants the directors of the tramways company; and Mr. Buckley, Q.C., and Mr. Stewart-Smith for the defendants the traction company.

Mr. Justice Kekewich said that Mr. Warrington, on behalf of the directors, had admitted that so far as the action was one depending upon the notice of Nov. 26, 1897, and the meeting of Dec. 14, 1897, which the Court of Appeal had determined to be insufficient and invalid, he could not resist an order for payment to the plaintiff of costs, and his Lordship did not himself entertain the slightest doubt that in making that admission the learned counsel was in reality giving up nothing, and that after the decision of the Lords Justices he was right with regard to that. Then, having got rid of that matter, which might have been got rid of, his Lordship thought, without bringing the action to trial, there really was nothing in the case left except the charge of fraud. The whole case of the plaintiff depended on fraud. Of course, if in the circumstances of the case fraud had been made out, it would have been a very grievous charge, depending on a gross fraud. His Lordship then went into the circumstances attending the agreement, and continued: The plaintiff had not based his case on negligence, saying that the directors had too easily sanctioned this agreement and had not brought in expert evidence, but he had put it distinctly on the ground of fraud. If fraud was charged it ought to be proved; if it was not proved the usual consequences must follow. To his Lordship's mind it had not been proved. His Lordship then went further into the details of the case, and an examination of the allegations in the statement of claim, and eventually dismissed the action, so far as it alleged fraud, and made an order giving the defendants the traction company the costs of the action and the defendants the directors the costs of the action so far as they did not relate to the insufficiency of the notice and the invalidity of the resolution.—*The Times.*

IN RE APOSTOLOFF AUTOMATIC TELEPHONE PARENT SYNDICATE, LIMITED.

The voluntary winding up of this company under the supervision of the Court has been ordered by Mr. Justice Wright, sitting as an additional judge of the Chancery Division.

Mr. Jenkins, Q.C., Mr. Dobb, Mr. E. Clayton, and Mr. Eustace Smith were counsel for the parties.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Warsaw.—Tenders are invited for transforming and working by electricity the present horse trams. Particulars are to be obtained from, and tenders addressed to, the Municipal Authorities.

Middlesbrough.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Nov. 29.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Dec. 1.

Leatherhead.—The Urban District Council intend to sell the lease of their electric lighting order for a number of years. Details may be obtained at the office of the Clerk to the Council. The offer is open until Nov. 21.

Barrow-in-Furness.—The Corporation invite tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches, and fittings. For particulars see our advertisement columns. Tenders by Nov. 14.

Blackpool.—The Corporation are prepared to receive tenders for trolleys, wire, and other material in connection with the conversion of their present conduit system to the overhead system, particulars of which will be found in our advertisement columns. Tenders by 22nd inst.

Dublin.—Tenders are invited for the supply on hire of plant, etc., required for the electric lighting of the State apartments, Dublin Castle, during next Castle season. Tenders will be received up to 10 a.m. on 14th inst. Specification can be seen at the Office of Public Works, Dublin.

Cuenca (Spain).—Tenders are invited for the establishment and exploitation of a telephone system in the town. The deposit required is £20, to be raised to £40 within 30 days of acceptance of contract. Particulars, etc., are to be obtained from, and tenders addressed to, the Civil Government of the province of Cuenca.

Cork.—Tenders are invited by the Cork Electric Tramway and Lighting Company for proposed offices adjoining the power house, Albert-street, Cork. Specification, etc., may be inspected at the offices of Mr. Robert Walker, P.P.S.A., architect and C.E., 17, South-mall, Cork, with whom sealed tenders are to be lodged by Nov. 14.

Belfast.—Tenders are invited by the Electric Committee for the supply and erection of four 400-kw. steam dynamos. Specification, etc., may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer, on payment of £1. 1s., which sum will be refunded on the return of the specification with a *bonâ fide* tender. Tenders by noon on 17th inst.

Glasgow.—The Glasgow Corporation invite tenders for the supply of about 800 lineal feet of cast-iron pipes, 21in. diameter, and certain cast-iron pipes, 22in. and 29in. diameter, with special castings, for the new electricity works at Port Dundas. Specifications, etc., may be had on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street. Tenders by 22nd inst.

Hanley (Staffs).—Tenders are invited for the erection of a refuse destructor. The building in which the destructor is to be placed, or the brick chimney shaft, is not included in the contract. Further particulars, together with copies of the plan of two suggested sites, may be obtained on application to Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley, by Nov. 15

London.—Tenders are invited by the British Electric Traction Company, Limited, for about 400 tons of about 4in. cast-iron socket and spigot pipes for electric cables, with about 400 each of socket and spigot bellmouths, at the earliest possible date. Contractors able to supply these promptly are requested to communicate with Mr. C. H. Gadsby, contract engineer to the company, Donington House, Norfolk-street, London, W.C.

London, E.C.—The East Indian Railway Company being desirous of introducing electrically-controlled block instruments on their system, invite proposals from makers only for the supply of (for single line) 18 instruments for nine blocks; (for double line) 80 instruments for 41 stations and six spare instruments. Tenders will be received up to 1 p.m. on Nov. 23, and particulars can be obtained on reference to Mr. A. P. Dunstan, secretary, Nicholas-lane, London, E.C.

Dublin.—Tenders are invited by the Great Northern Railway Company (Ireland) for the following works in connection with their power station to be erected at Sutton, near Dublin: (Contract No. 1) boilers, Lancashire type, and with or without mechanical stokers; (2) engines, dynamos, pumps, steam and exhaust pipes, etc., crane, feed heater, and tools; (3) switchboard. In Contract No. 2 it is a condition that the dynamo makers must have already constructed dynamos of at least 100 units capacity. Specifications, etc., can be obtained from Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, on payment of £1. 1s. for each specification. Specifications may be seen (but not obtained) at the office of Prof. A. B. W. Kennedy, 17, Victoria-street, Westminster, S.W. Tenders by 19th inst.

Edinburgh.—Tenders are invited by the Magistrates and Council for the following works in connection with their electric light station in McDonald-road: (Contract No. 1) boilers (marine type) and mechanical stokers; (2) engines and dynamos. In contract No. 2 it is a condition that the firms tendering must have constructed machines of the very largest size for use in this country, and that the engines are made either by Messrs. Willans and Robinson, Rugby, or by Messrs. Bellis, Birmingham. Specifications, etc., can be obtained from the Resident Engineer, Dewar-place, Edinburgh, upon payment of £2. 2s. for each specification, to be returned on receipt by the Council of a bona fide tender. Specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by Nov. 14.

RESULTS OF TENDERS.

Ipswich.—The Guardians have accepted the tender of Messrs. Crompton and Co. to provide an electric motor at a cost of £159.

London, S.W.—The tender of Mr. C. J. Smith, King-street, Regent-street, for electric light fittings to 42 additional bedrooms at Hampden Residential Club, at £90, has been accepted.

Liverpool.—The tender of the Walsall Electrical Company, at £56, has been accepted for fixing at the Everton centre, St. Domingo-road, a 36in. electric fan, with galvanised shafting, for the City Council.

Wakefield.—The tender of the Wakefield Electrical Engineering Company, Manor House Yard, £120. 13s. 6d., has been accepted for the various works necessary for a complete installation of electric lighting at the Wakefield Mechanics' Institution.

St. Helens (Lancs.).—Tenders have been received for new boiler plant at the Corporation Electricity Works as follows: Yates and Thom, Blackburn (accepted); Tinkers, Limited, Hyde; R. Taylor and Co., Marsden; J. Baldwin, Keighley; Babcock and Wilcox, London; Musgrave and Sons, Bolton.

Aberdeen.—The following tenders have been accepted by the Corporation for the supply of materials for the year ending Aug. 31, 1899: house-service cable, Callender Cable Company, Limited, London; house fuse-boxes, Alexander Spark, Aberdeen; electricity supply meters, De Ferranti, Limited, London.

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BUSINESS NOTES.

Haggerston.—New mains are to be laid here at an expense of £2,200.

Spennymoor.—There is some talk about obtaining a provisional electric lighting order for the urban district.

Nelson.—Notices have been given applying for an order to construct a light railway by the Corporation.

Removal.—Le Carbone have removed from 7, Carteret-street, Queen Anne's-gate, S.W., to 36, Lime-street, E.C.

Bournemouth.—The Bournemouth and Poole Electricity Supply Company, Limited, are laying new underground wires through the main road.

Heywood.—The Town Council is now taking steps to obtain the permission of the Local Government Board for the adoption of the Electric Lighting Act.

Sleaford.—A committee of the Urban District Council is arranging with the Tradesmen's Association for the installation of the electric light at Sleaford.

Bury.—The Town Council have, not without some wrangling, adopted the modified scheme of electric lighting already referred to, which will cost £16,000.

Newcastle-under-Lyme.—The Corporation have sealed a memorial to the Board of Trade for a provisional order for powers to supply electricity within the borough.

Lambeth.—A committee has been appointed by the Vestry to enquire into the statements and charges made on the subject of the transfer of the electric lighting order.

Cheltenham.—The enquiry into an application of the Town Council to borrow an additional £17,200 for electric lighting was held last week. There was no opposition.

Blackpool.—Power is to be sought to supply current outside the borough with a view of ultimately providing for the working by electricity of the Blackpool-Lytham trams.

Tanfield.—The report of the Lighting Committee to illuminate the district with electric light has been adopted by the Urban District Council, and the agreement duly signed.

Mansfield.—The Town Council have resolved to apply forthwith to the Board of Trade for a provisional order to supply electricity for public and private purposes within the district.

Durham.—The Urban District Council have decided to apply to the Board of Trade for a provisional order to supply electricity for any public or private purpose within the district.

Bacup.—At the monthly meeting of the Town Council in December a resolution will be discussed against the handing over of the powers to supply electricity to a private syndicate.

Acton.—The District Council have received notices from various companies of intention to apply for a provisional order, and are replying that they intend to do the electric lighting themselves.

Teignmouth.—The District Council are considering a draft memorial to the Board of Trade for a provisional order to supply electric light. The cost of the installation is estimated at £4,000.

Blackburn.—At the first meeting of the newly-constituted Town Council on Tuesday the Mayor referred to the pressing need for extension of market accommodation and the electric lighting and traction undertakings now approaching completion.

Kirkcaldy.—The Town Council have decided to apply to the Board of Trade, under the Electric Lighting Act, 1882, for powers to authorise them to supply electricity for public and private purposes within the area of the municipal burgh of Kirkcaldy.

Northallerton Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £2,000 in £1 shares, with the object to carry on the general business of electricians, electrical and mechanical engineers, suppliers of electricity, etc

Accident.—Damages assessed at £300 have been awarded a plumber named Winfield, who sued a contractor employed by the St. Pancras Vestry for compensation for injuries sustained in consequence of an electric standard falling upon him while he was walking along Chalk Farm-road.

New Book.—We beg to acknowledge receipt of an illustrated pamphlet by Mr. I. Burnelli, inspector at the Department of Post and Telegraphs in Rome, and published for that department. It contains practical instructions for the working of the telephone between different municipalities.

Appointments Vacant.—The St. Pancras Vestry require several clerks in the electricity and public lighting department. An electrical engineer for electrical machinery insurance and general electrical engineering work is also wanted. Particulars of these and other vacancies appear in another column.

Hull.—At a special meeting of the Hull City Council, held on Friday last, the minutes of the Works Committee were adopted, and these asked the Council for power to take the work of constructing the new electric tramway system out of the hands of the present contractor, and to enable the works department to do the work.

West Bromwich.—The Electricity Committee of the Town Council are considering a notice from the Midland Electric Lighting Corporation stating their intention to apply to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within an area including the borough of West Bromwich.

Rathmines.—Mr. Charles P. Cotton, Local Government Board inspector, has held an enquiry into an application of the Town Commissioners of Rathmines and Rathgar, as the urban sanitary authority, for a loan of £50,000 for the purpose of lighting the district by electricity. The total length of distributing mains to be laid is 25,000 yards, or over 14 miles.

St. Helens.—The Corporation have resolved to content themselves with generating and supplying the electric power and the system of rails, and to lease the working to a company for 21 years. The company undertakes to provide an efficient service of cars to run at frequent intervals and cheap fares. We understand that the Simplex Electric Traction Company is interested in this venture.

Hampstead.—The Vestry have decided to form a reserve fund in connection with the Vestry's electric lighting undertaking. The Finance Committee is to consider and report upon the formation and investment of such a fund. The amount of the electric consumers' accounts for the quarter ended at Michaelmas was £3,620. 10s. 7d., as compared with £2,446. 11s. 8d. for the corresponding quarter of last year.

Worcester.—The Electricity Committee of the City Council at the meeting on Nov. 16 will recommend the appointment of Mr. F. H. Lewis, of Wolverhampton, as electrical engineer, at a salary of £350 a year. There were 29 applications. Mr. Lewis has held successively the appointment of electrical engineer under the Hull and Wolverhampton Corporations, and has laid down electrical works in these towns.

Llandudno.—The Electric Light Committee have been instructed to extend the cable to Craigydon. This extension will involve an expenditure of about £2,000. A permanent electrical engineer is to be appointed by the Council immediately. The electric light was switched on for the first time on Saturday, and proved a success. Mr. A. H. Preece was the electrical engineer, and the scheme has been carried out at an outlay of £25,000.

Bexley.—The contract for the electric lighting of the Bexley Lunatic Asylum (of the London County Council) has been given to Messrs. Edmundson's, according to a scheme and specification prepared by the architect, Mr. G. T. Hine, and Mr. A. A. Campbell Swinton, consulting engineer. There will be three sets of engines and dynamos, each of 100 kw. capacity, and some 3,200 200-volt incandescent lamps, arranged on the three-wire system.

Maidstone.—The Urban District Council have come to the conclusion that it is not advisable to advertise for designs and schemes for the combined electric light and dust destructor works as previously recommended, or to appoint an assessor to judge the same. Messrs. Kincaid, Waller, and Manville have been instructed to draw up a report and scheme for carrying out the work, and also to advise on the most suitable site for the buildings in question.

Enfield.—The Urban Council sub-committee appointed to report upon the subject of electric lighting stated at the last meeting that the only conclusion they had up to the present arrived at was that it would be very undesirable for the Council to consent to the application of any person or company for a provisional order. The committee expressed itself of the opinion that the order should be in the hands of the Council, and promised to give a more detailed report at a future date.

Colchester.—The opening ceremony in connection with the electric lighting works will possibly be held in the first week of December. The number of applications for the light already is eminently satisfactory. The number of lamps applied for at present is 1,363, excluding the lighting at the military hospital, where there will be about 500 lights bringing up the number to a total of some 2,000. The number of lights which the plant can supply is upwards of 4,000.

Weybridge.—A draft of the provisional order granted by the Board of Trade to the Electric Works Company, Limited, in respect to the urban districts of Walton and Weybridge has been received by the Urban Council. It provides, among other things, that the urban councils shall have power to acquire the undertakings at any time, that any overhead wires that may exist at present must be removed within one year, and that no others shall be erected unless by the express authority of the Board of Trade.

Waterloo.—The District Council have received favourably a letter from the Overhead Railway Company with reference to the proposal of the company to introduce electric tramways in the district, in which the latter refuse to come under any legal obligation to establish penny stages as asked for. They offer, in return, that if the District Council's withdrawal of the requirement that the company should bind itself to establish penny stages, to accept a lease for 26 years only, the rent after the first 20 years not to exceed 4 per cent. upon the cost of the works to be done by the District Council.

Hammersmith.—The Vestry have received notice of intention to apply during the ensuing session of Parliament for provisional orders authorising the supply of electric energy for public and private purposes in the parish from the House-to-House Electric Light Supply Company, Limited, and the Kensington and Knightsbridge Electric Lighting Company, Limited; also a notification from the Kensington Vestry of intention to produce, store, and supply electricity within the parish of Kensington at certain wharves and premises belonging to them in the parish of Hammersmith and in the parish of Chelsea.

New Issue.—An issue has been made this week by the Chelsea Electricity Supply Company, Limited, of £40,000 4½ per cent. debenture stock at the price of £108. 10s., ranking *pari passu* with

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£60,000 already issued, and being redeemable after 1910, at the company's option, at £110. The share capital authorised (issued and fully paid up) is £200,500 divided into 34 000 ordinary and 6,000 6 per cent. preference of £5 each and 500 £1 founders' shares. The expenditure on the undertaking up to Dec. 31 last amounted to £273,810, and the revenue for the year 1897, available for payment of interest on debenture stock, was £14,517.

Dudley and Wolverhampton Tramways Company.—An extraordinary general meeting of this Company will be held at the Westminster Palace Hotel, London, to-day for the purpose of considering, and, if deemed expedient, passing, the following resolution: "That it has been proved to the satisfaction of this meeting that the Company cannot, by reason of its liabilities, continue its business, and, accordingly, that the Company be wound up voluntarily, and that Walter James Kershaw, of Talbot House, 9, Arundel-street, London, chartered accountant, be, and is hereby, appointed liquidator for the purpose of such winding-up."

Manchester.—The committee of the Manchester Corporation which has in its charge the municipalisation of the tramway system in Manchester, is conducting negotiations with the various urban authorities into whose districts the lines extend, as already pointed out by us. Arrangements have been come to with the Heaton Norris, Levenshulme, Gorton, Denton, Audenshaw, Droylsden, and Failsworth Urban District Councils. The councils which govern the affairs of Withington, Moss Side, and Stretford are still in negotiation with the committee. The two former appear inclined to fall in with the general scheme, while Stretford is still holding out.

Moray Firth Cable.—During the recent gale and storm which caused so much damage at sea, the telegraph cable which is laid between Helmsdale and Burghead was broken about two miles from the shore end at Helmsdale. Owing to the very severe weather, the work of repairing was found very difficult, but by a staff of men from the cable steamer "Monarch" at Portsmouth, under the superintendence of the cable inspector, Mr. Hall, the work has just been finished, and the cable put in working order. Over two tons of new cable had to be spliced between the broken ends, a large piece of the old cable being much chafed and damaged.

Brierley Hill.—At the meeting of the District Council on the 7th inst. the Lighting Committee presented a report relative to the question of electric lighting and power supply by the Midland Electric Corporation, Limited, and the Dudley and Stourbridge Electric Traction Company, and they recommended the Council not to give their consent to the application for a provisional order by either company; but that the Council take the advice of an expert as to their applying for an order to supply electrcity. The clerk stated that the traction company had abandoned their application owing to the action of the committee. After a discussion the report was adopted.

Venezuela Telephone and Electrical Appliances Company, Limited.—The annual general meeting of the shareholders was held on the 7th inst. at 28, Victoria-street, S.W., Sir Douglas Fox, the chairman of the Company, presiding. The directors' report, balance-sheet, and profit and loss account were received and adopted. The 8 per cent. preference dividend paid on the preference shares to June 30 was approved, and a dividend of 4 per cent., payable forthwith, on the ordinary share capital of the Company was declared in respect of the profits for the year ended June 30. Mr. J. S. Austen, the retiring director, and Messrs. Price, Waterhouse, and Co., the retiring auditors, were re-elected.

Darwen.—Speaking at his installation on Wednesday, Dr. Ballantyne, the new mayor of Darwen, said that an important work which the Town Council had in hand was the refuse destructor, in combination with the supply of electricity, which, he believed, would eventually become a source of profit to the ratepayers. The new works at Robin Bank were already well advanced, and, given an open winter, they would have an electrical supply to some parts of the town before the next six months were over. Already about 1,000 lamps of 8 c.p. had been promised. The Corporation hoped at an early date to acquire the trams; these would take a large supply of current for their motive power.

Leeds.—The Council have approved of the proposed agreement with the Yorkshire House-to-House Electricity Company, Limited, for the purchase by the Corporation of the company's undertaking. The Corporation will take over the company's huge undertaking from Sept. 1 so far as the capital expenditure is concerned, and from Oct. 1 so far as the revenue account is concerned, and arrangements have been made to value such materials as require to be valued. The Corporation will take over the whole staff of the company, their agreements for service, all contracts, and fire and other insurance policies. The great courtesy and fairness of the directors of the company in the negotiations was favourably commented upon at the Council meeting.

Sedgley.—At the last meeting of the Council the Chairman said they had received an assurance from a deputation, consisting of Mr. Lycett (manager of the British Electric Traction Company), the present secretary of the Dudley and Wolverhampton Tramway Company, and Mr. Hatch (manager of that company), that the company had got two engines in fairly good condition, and could this week initiate an hourly service with certain regularity, and half-hourly service later until the line was reconstructed for electric traction. It was decided that consent should not be given for a month to the renewal of the license for the running of the trams. It was also decided not to entertain the offer of the Wolverhampton Corporation to include Sedgley in the Bill to Parliament to acquire the tramlines in their district.

Whitechapel.—The Vestry have received a letter from the County of London and Brush Provincial Electric Lighting Company, Limited, giving notice of the intention of that company to apply for a provisional order to light the district with electricity; but the Vestry evidently intend to proceed themselves, as the Electric Lighting Committee recommended on Monday last that the premises of Messrs. Ind, Coope, and Co., 27, Osborn-street, Whitechapel, containing an area of about 20,000 superficial feet, with the extensive range of offices and building thereon, adjoining the premises of the Board in Angel-alley, be purchased by the Board for the sum of £18 250, this sum to include the movable furniture and fixtures and plant and machinery upon such premises, and that it be referred to the solicitor of the Board to carry out such arrangement on behalf of the Board.

Yarmouth.—The Council resolved last Tuesday that, provided the requisite assents can be obtained, the necessary means of electrical communication with Gorleston and Southtown be by way of the overhead system. The Surveyor stated that the cable would be 162ft. above the harbour. A further report was received from the Land Committee on the subject of the proposed electric tramways. At the previous meeting the Council adopted a scheme to cost £42,000. The committee now advised the Council to ask for parliamentary powers to borrow £53.000, and include in their scheme large public improvements on St. Peter's-road (west end), Northgate-street, and Market-place. In the course of debate it was stated there was no intention of burdening the tramway undertakings with the cost of these three extra works. Ultimately the committee's recommendation was carried unanimously.

Valleyfield.—A successful trial has been made of the electric light installation which is being completed at the works of Messrs. Alexander Cowan and Sons, Limited, papermakers, Valleyfield, Penicuik. Messrs. Lowdon, Dundee and Edinburgh, were the contractors, and have carried it out successfully, and the installation, while surpassed by some jute mills, is understood to be the largest in any papermaking works in Scotland. An engine of 100 h.p. furnishes power through the medium of patent Brush clutches to three shunt-wound continuous-current dynamos, two of which are of 140 amperes each and the third of 80 amperes. The dynamos can be worked up to 250 volts. Upon the switchboard are placed 12 switches, directing the current to as many sections of the mills. The lighting is effected by means of 36 arc lamps of 2,000 c.p. each, and close upon 1,000 incandescent lamps of from 16 c.p. to 50 c.p.

Carlisle.—The report of the General Purposes Committee, adopted at the last meeting of the Town Council, stated they had appointed Mr. C. D. Burnet to the post of resident electrical engineer, to devote the whole of his time to the duties of the office, with the option of taking not more than two pupils at any one time, the engagement to be determinable by three months' notice in writing on either side. They had appointed sub-committees to consider the scale of rebates and the system of traction for the tramways. With regard to the latter question, they had had a letter before them from Prof. Kennedy in which he stated that the present alternative was between overhead electric traction and horse haulage, and of the two he should certainly advise them under the circumstances to give their permission for the overhead traction—of course, on suitable terms. The Cumberland County Council propose to instal the electric light in the Courts at Carlisle.

Enclosed Arc Lamps.—In the suit of the Marks Enclosed Arc Light Company, 687, Broadway, New York *v.* Washington Mills Company, 74, Worth-street, New York, a decision has just been rendered in favour of the complainant. The suit was begun in the United States Circuit Court, Sept. 10, 1897, and the decree granted to the Marks Company by Judge Coxe on Oct. 18, 1898. The patent infringed is No. 520,996, of Marks and Ransom, dated June 5, 1894. This patent is said to broadly cover the method of operation used in all modern enclosed arc lamps. The Washington Mills Company were users of the Kinsman lamp, sold by the Electric Construction and Supply Company, 27, Thames-street, New York. The decision peremptorily stops the sale of unlicensed enclosed arc lamps by the Kinsman Company, and also involves the payment of damages by the defendant. This decision is understood to be unfavourable to the General Electric Company.—*Wall Street Journal.*

Manchester.—A meeting of property owners and residents in Whalley Range has protested against the proposed erection by the Manchester Corporation of a transforming sub-station in Burford-road, Whalley Range. The cause of the objection is the anticipated noise. Mr. C. H. Wordingham, the electrical engineer to the Corporation, says: "The electric station which we propose to erect in Whalley Range is what is known as a transforming sub-station—that is to say, it will be a brick building of good architectural appearance, in which will be fixed transformers and rotary converters for altering the pressure from high to low. There will not be anything in the nature of steam boilers or engines, and there will be no work carried on involving dirt, noise, or vibration. The sub station could not by any possibility become a nuisance or source of danger of any kind. It would be employed merely for transforming the current, not for a generating station." The meeting evidently did not endorse Mr. Wordingham's opinion. We do.

Newington.—At the meeting of the Vestry on Wednesday last a report from the Electric Lighting Committee was presented, recommending (*a*) that the first instalment of £10,000 of the electric lighting loan of £50.000 be taken up at once from the London County Council, and repaid by 39 equal annual instalments on each

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Oct. 31 (the first instalment being payable on Oct. 31, 1902) within 42 years from the date of the loan, with interest at £3 per cent. per annum, payable quarterly, that the Vestry pay the costs of the loan, and that the seal of the Vestry be affixed to the mortgage; and (*b*) that the Vestry undertake and agree with the London County Council to set apart a sinking fund to meet the necessary maintenance charges on the electric lighting installation during the whole period covered by the loan—viz, 42 years—and will enter into a covenant, if necessary, in the mortgage deed, not to include in any future loans required for the development of the undertaking any charge for plant and machinery provided, with the proceeds of the present loan during the currency of the loan.

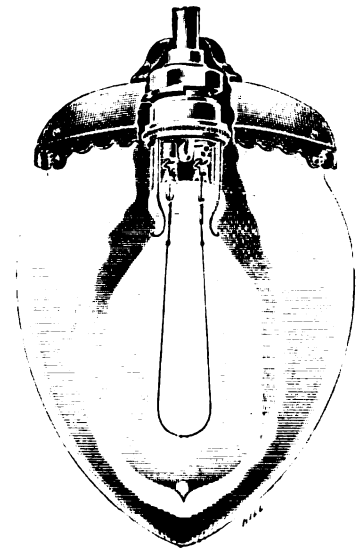
The City and the Telephones.—At this week's meeting of the City Corporation, Mr. Moojon moved that it be referred to the Streets Committee to consider the desirability of the Corporation applying for a license to establish a telephone service either solely or in conjunction with the County Council. He said that the telephone service was a matter which considerably affected them as commercial men, because it ought to be as far in advance of the telegraph as the telegraph was of the letter service. The County Council had decided to apply for a license, and he hoped some action would be taken by it as representing the classes who mostly needed the telephone. Mr. Foster M'Geagh, in seconding, said the telephone service at present was of very little use to City men, and it was his opinion that it would never be any better so long as the service was in the hands of the National Telephone Company. Mr. Morton suggested that the words "and all other local authorities within the London telephone area" be added. This was agreed to, and the motion as amended was carried unanimously. The Streets Committee later on recommended that the necessary steps be taken to urge upon the Government the extreme desirability of action being taken forthwith to give due effect to the recommendations of the Select Committee on the Telephone Service.—*Financial News.*

Catalogues.—We have received from Messrs. Drake and Gorham a copy of their latest catalogue of electric lighting plant. A notable feature of this catalogue is the method of indexing employed, by which the section which is required can be found at once. From it we gather that the sale of the Jandus arc lamp has increased very much, the firm having supplied over 10,000. The Neville patent switch, of which the firm are the sole English agents, is also very successful. The book will be found very useful for reference purposes by electricians and others. A small charge is made for the catalogue, which is credited on receipt of the first order.—Messrs. Marryat and Place, who have head offices at 28, Hatton-garden, and works at Shepherd's Bush, have sent us a complete list of their dynamos and motors. They claim to have been the first to instal electric motors for driving printing machinery, and send us a complete description of a large printing works in London which they were responsible for.—We have received from Messrs. Newsome, Pinching, and Co. a copy of their price list of cast-iron tube conduits and accessories. These include cast-iron accessible bends made on Mr. C. M. Russell's patent, and several types of connecting boxes and ceiling-rose cases. The list also includes details of the arc lamps supplied by the firm, which has its warehouse at 1, Crutched-friars, E.C.

Middlesbrough.—A special meeting of the Streets Committee of the Middlesbrough Corporation was held last week for the purpose of considering an application from the tramways company for sanction to apply for powers to extend the tramways down either Dock-street or Commercial-street, and beyond the borough boundaries, under the Light Railways Act. A letter was read from the company asking for the sanction of the Corporation, and stating that all the privileges already accorded to the Corporation, except the payment of the £3,000, would be granted in respect to the extensions. It was resolved that the tramway company should be informed that the Council preferred the Dock-street line, and that it did not matter whether it was under the Light Railways or the Tramways Act, so long as they got the same conditions. It was further decided that the linedown Dock-street should be a single line, and that in all the lines laid on the north side of the railway the company should be asked to pave the whole middle of the road from kerb to kerb. It was proposed to inform the tramway company that the Council intended to enforce the penalties if the whole of the lines for which they had obtained constructive powers were not carried out; but an amendment was carried to ask the company when they were going to complete the lines for which they had obtained powers, and the carrying out of which the Corporation could enforce.

Aston.—The Health Committee's report, approved by the District Council at its last meeting, stated that they had consulted Mr. J. C. Vaudrey and Mr. Garner, of Clayton, Manchester, with the result that they had arrived at the conclusion that it is desirable for the present to electrically light the whole of the buildings yard and fire station at Chester-street only; provide one 25-h.p. motor for grinding mill, and one 5-h.p. motor for chaffcutting and supplying steam to the disinfector. They therefore recommended that an estimate of £11,500 to carry out the necessary work be adopted, and that the Finance Committee take steps to obtain a loan for the amount. At the present moment the minimum quantity of house and other refuse to be dealt with by the destructor was about 60 tons per day of 24 hours, and which at times was increased to 120 tons per day. To meet this the committee contemplated laying down two additional pairs of cells as being the minimum means of dealing with the demands of the department, allowance being made for the growth of the district within the next few years. Thus, when the present destructor was repaired and the new plant was laid down, the Council would have faced the difficulty of dust destruction for some years to come. In connection with the new destructor it was necessary to lay down one boiler at least, and it was thought desirable to put in one equal to the full capacity of one pair of cells, which is 150 h.p.; in the opinion of the committee that should be duplicated. The work will comprise four additional destructor cells, destructor-house, an engine equal to an output of 100 h.p., but capable of being arranged for an ultimate output of 300 h.p.; elevator, engine-house, electric lighting dynamo, improvements to the old destructor, sinking a well, new steam-disinfector, covering in, paving and levelling portion of the yard with glass roof, erection of lavatory and messroom for the workmen, etc.

Edison and Swan United Electric Light Company, Limited.—The accompanying sketch shows a new method of fitting for high candle-power lamps introduced by the above Company. This fitting has been specially designed for use with lamps of 200 c.p.



and 300 c p. It appears particularly suitable for outside and shop-window illumination, the globe carrier being so arranged that the internal part of the fitting is not affected by the weather, whilst the uppermost hood of the same can be adjusted to allow of sufficient ventilation.

Canterbury.—At the last meeting of the Town Council a report of the Lighting Committee was submitted recommending that the chimney shaft be extended another 5ft., at a further cost of £15, and that the alternative design for the cap submitted be approved; that 50 additional meters be ordered at the contract price, as suggested by the engineer; that the engineer be authorised to supplement the original number of cable joint-boxes as required; that tenders be invited locally for wiring the electricity works; that the arrangements made by the engineer for a night watchman be confirmed; that having regard to the great demand for the light, and to the engineer's statements as to the capacity of the present plant, etc., application be made to the Local Government Board for a further loan of £8,000 for additional plant and extensions as per the engineer's estimate submitted with his report, and that Mr. Hammond be instructed to prepare the necessary plans, specifications, and estimates; that the cable be laid along the Whitstable-road to the corner of the Cemetery-road. The Town Clerk reported that the National Telephone Company would be willing to connect the following offices and works with their exchange for the sum of £61 per annum, the Corporation giving up their private wire between the city surveyor's office and the irrigation works — *i.e.*, police station, sanatorium, medical officer's residence, electricity works, irrigation works, town clerk's office, and surveyor's office. The committee recommend that the company be approached, and an offer of £50 per annum made for the above services. The recommendation of the committee in reference to extensions was referred back for further consideration, it being considered that it would be advisable when making the application to the Local Government Board to go for a somewhat larger sum. The position in Canterbury is phenomenal. During the laying of the mains, and before the supply has been started, 150 applications for connections have been received, to cope with which the whole of the capacity of the plant at first laid down will be required.

Dundee.—A new scheme of tramway extension, says the *Dundee Advertiser*, has been brought forward by Councillor Longair. Under it the cars would start from the Post Office, traverse Reform-street, High-street, Commercial-street, and Victoria-road as far as William-street, up which it would turn, and then proceed *vid* Alexander-street, Hilltown, Constitution-street, Dudhope-terrace, coming along in front of the infirmary, and returning to the Post Office by way of Barrack-road, Constitution-road, and Meadowside. In the circuit, it ought to be pointed out, the tramway rails are already laid for nearly half the distance—from the Post Office right on by Victoria-road to the foot of William-street—leaving to be constructed a portion equal to about 1¼ miles. It is contended that the scheme would involve no heavy expenditure, and that whatever outlay was incurred would soon be recouped by the increased traffic which would result. The steepest gradient on the route is at the infirmary gate—1 in 8·76.

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This can be modified, and from the infirmary to Dudhope-terrace the incline is 1 in 11·01. Until quite recently the idea prevailed that such hills could only be surmounted by some arrangement of the cable system, but the rapid development of electric traction, both at home and abroad, has, Mr. Longair argues, proved to demonstration that there would be no difficulty in tapping, according to his plan, the densely-populated area outlined in the sketch. There are said to be numerous cases where electric cars are at present running on gradients of 1 in 8, and even 1 in 7. Mr. Longair intends at the earliest opportunity to bring his scheme under the consideration, first of the Tramways Committee, and afterwards of the Town Council, with a view to securing approval of it and its incorporation in the Extension Bill to be promoted next session in Parliament. An alternative scheme has also been suggested, by means of which an extended circuit could be got *viâ* Victoria Bridge, Morgan-street, and Dura-street, thus making these routes, which are otherwise likely to be superseded, of practical use by connecting the East end with the high level.

Southampton.—An official trial of the electric cranes on the town quay took place last week, followed by the usual dinner, congratulatory speeches, and so forth. The contractors of the work were Messrs. Stothert and Pitt, of Bath. Three of these cranes have a lifting capacity of three tons, while another is specially designed to lift either three tons or four times that weight. The cranes have been designed by Mr. J. G. W. Aldridge, electrical engineer to the Harbour Board, to lift 30cwt. at the rate of 200ft. per minute, and they will slew or turn at the rate of 400ft. a minute. Both operations of lifting and turning can be performed simultaneously. The combination 3-ton or 12-ton crane has two sets of gear, which can be changed within two minutes. The four new cranes, as well as the two old ones, are supplied with electricity from the Corporation electric station. As to the working of the cranes, we learn from the *Hampshire Advertiser* that the driver of each crane has only two levers to manipulate, one being for lifting and lowering, and the other, which is a hand-wheel, for slewing. During the past fortnight, preceding the official trial, the ordinary crane drivers have, without any previous training, been engaged on these new cranes loading and unloading steamers which have come to the town quay without the slightest hitch, thus showing that the electric cranes do not require skilled labour, as stated in some papers. The three-ton crane lifted that weight with ease, swinging it round and round, while the 12-ton crane lifted a railway truck with a large gas buoy and weights, and turned the same with ease and almost noiselessly. This great weight was lifted at the rate of 15ft. a minute. The radius of all the cranes is 30ft., though it is somewhat shorter for the heavier weight in the combination crane. In each crane there are two separate electric motors, one being used for lifting and the other for turning, and the driver stands in such a position that he can see his load and all that is going on around in order to avoid accidents. Each crane is provided with the electric light. The cranes worked very satisfactorily in the presence of the Works Committee of the Harbour, who, with the officials, were subsequently entertained at luncheon at Radley's Hotel by the contractors, a *recherche* repast being placed on the table by Madame Brown, whose catering gave every satisfaction.

Portsmouth.—A meeting of the Portsmouth Tramways Committee was held on the 3rd inst., at which the estimate for the acquirement of the tramways by the Corporation was again considered. The following report for presentation to the Town Council was agreed to without a dissentient: "Your committee have had considerable difficulty in presenting the estimate of the cost of acquiring the existing tramlines. Owing to the fact that the price is to be determined by an arbitrator appointed by the Board of Trade, it would be undesirable as well as impolitic to venture to mention a specific amount. Under these circumstances, your committee have made enquiry in other towns, and have based the following figures entirely from information so obtained. Total expenditure: Estimate—cost of obtaining and reinstating with electrical equipment, including cost of Bill, legal, and other expenses, £210,250; purchase of 66 cars, £35,000; grand total of expenditure, £245,250. The cost per annum: Estimate of annual expenditure—annual interest and sinking fund will amount to £12,099; management, including sufficient drivers and conductors to allow a much shorter working day than is now the case, and also including the whole staff required for maintaining the roads and running and maintaining the cars, £17,500; rates and taxes, say, £2,000; stationery and stamps, say, £500; material for repairing the cars, £2,400; material for the permanent way, £1,500; charge for the electric current at 1½d. per unit, £6,627—making a gross annual charge to the borough of £42,626. The estimated income: Estimate of income—Your committee have fixed their annual expenditure upon a mileage of 1,281 000 miles, which works out at rather less than 8d. per car mile. It is stated that the present company run their cars 928,283 miles per annum, and they earn an annual revenue of £36,571, equivalent to rather more than 10d. per car mile. Upon these figures, and assuming that we can earn a similar amount—namely, 10d. per car mile—our gross revenue would amount to £53,375 per annum. But, again, assuming that we only earn 9d. per car mile—a very small amount indeed, and, in fact, less than we know of in almost any town—our gross revenue would then work out at £48,037, still largely in excess of our annual expenditure. Results in other towns: We append results of the transfer from horse to electric traction in the other towns which have been good enough to supply us with the necessary information: Clontarf—Line to Nelson's Pillar, Dublin United Tramway Company. The fares there have been reduced to about one-half what they were with horse traction. The increase of passengers has been 38 per cent. Their working expenses with horse traction amounted to 71·76 of gross receipts. The working expenses of electric traction amounted to 47·09 of gross receipts. Hamburg—Paid no dividend with horse traction. With electric traction pays 10 per cent. on a largely increased capital, and the shares have gone up to £150 premium. Montreal—In 1892 they gave up horse traction and took to electric. Receipts increased 60 per cent. The net profits, which were £20,000 with horse traction in 1892, rose in 1897 with electric traction to £110,000. City of Rouen—The returns increased from £7,000 with horse traction to £30,000 with electric traction, and with reduced fares. Dover—Averages 40,718 passengers a week. Taking the populations of Dover and Portsmouth into consideration this would give 30 000 a day in Portsmouth, or 10½ millions per annum. The committee recommend the Council to give 12 months' notice to the company of their attention to acquire the lines.—*Hampshire Telegraph.*

PROVISIONAL PATENTS, 1898.

OCTOBER 31.

22820. Improvements in the means of propelling tramcars by electricity. James Enright, 202, Holland-road, Kensington, London.

22828. Improvements in the method of arranging and distributing underground wires in connection with telephone systems. Arthur Watts, 17, St. Ann's-square, Manchester.

22836. Improvements in electric switches. Henry Simon, 70, Market-street, Manchester.

22858. Combined apparatus for regulating the supply of electricity to lamps, motors, and other electrical apparatus. Ernest Edgley Prestwich and Leslie Newman Burt, 70, Chancery-lane, London.

22870. Improvements in electricity meters. Serge Berditschewsky Apostoloff, 53, Chancery-lane, London.

22872. Improvements in electrolytical apparatus. Jérôme Loiselet, 47, Lincoln's-inn-fields, London.

22884. Improvements in or relating to means for making electrical connections. Ernst Andreas, 111, Hatton-garden, London.

22887. Improvements in arc lamps. August Bernhard Barnikol-Veit and August Wilhelm Riebel, 40, Chancery-lane, London. (Complete specification.)

NOVEMBER 1.

22928. Improvements in arc lamps. William George Heys, 70, Market-street, Manchester. (Herbert J. Linder, United States.)

22936. An arrangement to act as a meter for one or more electric lamps, the object being to register the time during which the lamp or lamps burn. Baird and Tatlock, 40, Renfrew-street, Glasgow.

22959. Improvements in telegraphic apparatus. Frederick William Golby, 36, Chancery-lane, London. (J. de Constant, Germany.) (Complete specification.)

22964. Improvements in plug switches or wall contacts for electric circuits. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London. (Complete specification.)

22987. Improvements in electric arc lamps. Alexander Stuttmann, 53, Chancery-lane. London.

23000. Automatic regulator for electric currents. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Fritz Back, Austria-Hungary.)

NOVEMBER 2.

23043. Improvements in the construction of electrical resistance balances or bridges. John Ambrose Fleming, University College, Gower-street, London.

23066. Improvements in and connected with telephonic fire-alarm and time-indicating apparatus. Serge Berditshewsky Apostoloff, 53, Chancery-lane, London.

NOVEMBER 3.

23138. A vacuum contact arc lamp. Peter Spies, Edmund Lyons O'Brien, Richard Fiennes Barrett Lennard, and Robert Heywood, 56, Grafton-street, Tottenham Court-road, London.

23143. Improvements in electrical warming pans and like articles. William Buck, 18, Southampton-buildings, Chancery-lane, London.

23155. Improvements in electric rail brakes and electro-magnets therefor. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Gesellschaft zur Verwerthung elektrischer und magnetischer Stromkraft—System Schiemann und Kleinschmidt) (Ad. Wilde and Co., Germany.)

23160. Improvements in transformer switches. Alfred Schlatter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 4.

23163. Improvements in electrical switches. Wilson Henry Sturge, 12, Cherry-street, Birmingham.

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23207. Improvements in electrical heating and melting specially applicable to the metal pots of linotype machines. William Henry Lock, John Place, and Mark Barr, 188, Fleet-street, London.

23233. Improvements relating to electric railways and tramways provided with sectional conductors or surface contacts. Jasper Wetter, 37, Essex-street, Strand, London. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert and Co., Germany.) (Complete specification.)

23234. Improvements in or connected with electric railways and tramways provided with sectional conductors or surface contacts. Jasper Wetter, 37, Essex-street, Strand, London. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert und Co., Germany.) (Complete specification.)

23243. Improvements in and relating to electric accumulators. Paul Ribb, 55, Chancery-lane, London. (Complete specification.)

23249. An improved primary battery for generating electricity. Charles Hughes Preston, 55, Chancery-lane, London.

NOVEMBER 5.

23265. Improvements in glow lamps and holders. Edwin James Preston, 77, Chancery-lane, London.

23306. Improvements in or relating to galvanic batteries. Charles Levetus, 50, Wellington-street, Leeds.

23307. Improvements in or relating to galvanic batteries and the like. Charles Levetus, 50, Wellington-street, Leeds.

23320. Electromagnetic safety apparatus for lifts, mining cages, and the like. Frederick William Golby. 36, Chancery-lane, London. (W. Suermondt, Germany.)

23334. Improvements in electricity meters for continuous and alternating currents. Albert Peloux, 23, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

1347*. Fluid for primary batteries. Coad. (Amended.)

1897.

16229. Electrically-illuminated signs, advertising media, or the like. Bell.

16428. Method of and means for employing electric traction on ropeways, railways, and like means of transit. White and White.

23267. Apparatus for the electro-deposition of one metal on another, Bryant.

23304. Magnetic circuit arrangements for dynamo-electric machines and other purposes. Wood.

23530. Bicycle holders or stands and their combination with electrical contact makers. Stuart and Ford-Moore.

23625. Electrical time-switch. Wheatley, James, and Browne.

24132. Telautographs. Imray. (McPherson.)

24829. Coin-freed mechanism, applicable to gas, electricity, and like meters. Simpson.

25402. Current collectors for electric railways. Boult. (Anderson and Anderson.)

26333. Telegraphic receiving apparatus., Dearlove.

26646. Watt-hour meters and in the means for damping in same. The British Thomson-Houston Company, Limited, and Holden.

27330. Electrical cut-outs and fittings. Sellick.

27387. Electro-therapeutic exercising apparatus. Martin. (Date applied for under International Convention, May 10, 1897.)

27725. Construction of accumulators or secondary batteries. Leitner.

27805. Electric lampholders. Watson.

27806. Electrical switches. Watson.

27807. Manufacture of switches for electrical purposes. Watson.

27875. Electric lifts, hoists, capstans, and the like. Soames.

28960. Pushes for electric bells and the like. Staveley and Parsons.

29306. Apparatus employed in wireless telegraphy. Marconi.

29390. Electrical apparatus for transmitting and receiving predetermined messages. Siemens Bros. and Co., Limited, and Holden.

29676. Union box for electric mains for lighting, traction, power, or other purposes. Black.

29778. Telegraphy. Miller.

1898.

8441. Electric recording system for navigational purposes. Jaeger.

9466. Electric switch. Brant.

18137. Contact apparatus for electric railways with underground current feed and partial conductors. Stendebach.

19418. Telephone installations. Oprendek, Kolischer, and Landmann.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Nov. 5	3,867	3,514	+ 353	—	—
Blackpool and Fleetwood Tramroad	,, 5	192	—	—	13,135	—
Bristol Tramways and Carriage Co.	,, 4	2,566	2,545	+ 21	—	—
City and South London Railway	,, 6	1,027	1,041	- 14	18,304	17,580
Dover Tramways	,, 5	165	103	+ 62	7,340	—
Dublin U.T., elec. cars	,, 4	334	†299	+ 35	9,407	6,756†
Dublin S.D. Electric Tramways	,, 4	743	494	+ 249	18,473	12,712
Halifax Corporation Tramways	,, 2	248	—	—	4,944	—
Liverpool Overhead Railway	,, 7	1,451	1,341	+ 110	—	—
South Staffordshire Tramways	,, 4	662	655	+ 7	27,886*	28,131*

* Receipts since Jan. 1. † Horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	15½-16½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10-10½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	10-10½
——	6	5⅞ 6⅛
—— Pref. Half-Shares	1	1½-1⅝
—— " "	5	4½-5
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23½-24½
—— 90,001-100,000	10	23½-24
—— 6 per cent. Cumulative Pref.	10	16½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	00	69-71
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	124 126
—— 5 per cent. Pref. Shares	10	14½ 15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co.	10	12½-13½
—— " " No. 30,000 40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅝ 2
—— 5 per cent. Debentures	–	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2⅝
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	100-102
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5⅛
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	2⅜-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7⅞-8⅛
London Electric Supply, Ordinary	3	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-6⅛
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	15-16
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7⅛-7⅜
—— £4½ Shares, New	4½	6¾-7
Oriental Telephone and Electric Company	1	⅛-¼
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-108
South London Electric Supply, Ordinary	3	2½-2⅝
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	106-111
Westminster Electric Supply, Ordinary	5	14-16

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NOTES.

Covent Garden Theatre.—We regret that in our last issue we rechristened the electrician of the theatre without his consent. The correct name of the electrical engineer is Mr. W. Crawshaw, and the whole of the work has been placed in his hands. Mr. Crawshaw has had over nine years' experience at Covent Garden, and is an adept at obtaining scenic effects.

Electric Traction in Calcutta.—The Calcutta tramway question, says *Indian Engineering*, seems to be no nearer solution than before. A short while ago, after prolonged deliberation, the Corporation offered certain final terms to the tramway company. The company has practically rejected the Corporation's offer. The Corporation stipulated for 30 years for the running of the electric traction. The company will not consent to less than 42. On various other points both sides are at discord, and there the matter stands.

The Chemical Society.—The Chemical Society gave a banquet last Friday at the Hôtel Métropole in honour of the past-presidents who have been Fellows for half a century—namely, Sir Joseph Henry Gilbert, who was elected in 1841; Sir Edward Frankland, in 1847; Prof. William Odling, in 1848; Sir Frederick Augustus Abel, in 1848; Dr. Alexander William Williamson, in 1848; and Dr. John Hall Gladstone, in 1848. Prof. Dewar, LL.D., F.R.S., the president of the society, was in the chair, and the company numbered upwards of 260 gentlemen.

Progress in Russia.—The Russian Government have lately made several changes in favour of foreign traders. The latest move is the establishment of a new section of the Moscow Museum of Applied Sciences. Foreign manufacturers and inventors are asked to forward new improvements and scientific discoveries relative to industry, which will be housed and put on view free of charge, the articles remaining the property of the exhibitor. The time allowed for exhibition is a fortnight; with the consent of the owners this may be extended up to two months. British electrical manufacturers ought to find it worth while to be well represented at Moscow.

Motorcar Club.—At the third annual meet of the Motorcar Club last Monday 87 cars paraded, only seven of which were of foreign make. This is a decided improvement, as three years ago, when the club started, only one-third of the cars was of English manufacture. The makers represented included the Daimler, Boller, de Dion, the Coventry Motor Company, the British Motor Company, and the London Steam Omnibus Company, besides a number of motor bicycles and tricycles. After a run to Staines motor races took place in the grounds. The first race was the one mile motor cyclette race, won by O. Bush in 2 minutes 51⅗ seconds. The second race, for tube ignition tricycles, was won by E. A. Gorton in the quick time of 2 minutes 15⅕ seconds, which is a record for this type of machine. Mr. S. F. Edge annexed the two following races—viz., the one mile electric ignition tricycle race (time 2 minutes 12⅖ seconds) and the two mile motor cycle championship (time 4 minutes 18⅕ seconds).

The Royal Society.—The following is a list of those who have been recommended by the president and council of the society for election into the council for the year 1899 at the anniversary meeting on Nov. 30: president, Lord Lister, F.R.C.S., D.C.L.; treasurer, Alfred Bray Kempe, M.A.; secretaries, Prof. Michael Foster, M.A., M.D., D.C.L., LL.D., Prof. Arthur William Rücker, M.A., D.Sc.; foreign secretary, Sir Edward Frankland, K.C.B., D.C.L., LL.D. Other members of the council: Prof. Thomas George Bonney, D.Sc.; Captain Ettrick William Creak, R.N.; Prof. Daniel John Cunningham, M.D.; Prof. James Dewar, M.A.; Prof. William Dobinson Halliburton, M.D.; Prof. William Abbott Herdman, D.Sc.; Victor A. H. Horsley, F.R.C.S.; Joseph Larmor, D.Sc.; Prof. Nevil Story Maskelyne, M.A.; Sir Andrew Noble, K.C.B.; Prof. Edward Bagnall Poulton, M.A.; William James Russell, Ph.D.; Prof. Arthur Schuster, Ph.D.; Dukinfield Henry Scott, M.A.; George Johnstone Stoney, D.Sc.; Prof. Joseph John Thomson, M.A.

Manchester Telephones.—The following resolution has been passed by the Telephone Committee of the Manchester City Council: "That a report be prepared in due form for presentation to the City Council setting forth the recent communications with the Postmaster-General and embodying the general conclusion that, in view of the proposed action of her Majesty's Government in this matter in the next parliamentary session, it is desirable not to proceed further with respect to the insertion of clauses in the Manchester General Powers Bill for conferring powers upon the Corporation to provide and work telephones under license from the Post Office." Further, "That the chairman be requested at the next Council meeting to ask permission to withdraw the following item from the objects of the Bills: (11) to confer powers upon the Corporation to provide and work telephones under license from the Post Office, with all necessary powers for that object, and that a similar course be also taken at the meeting of owners and ratepayers."

The Moore Vacuum Tube.—A room lighted by the Moore vacuum tubes is now on view at an exhibition in Boston. It is called the Moore parlour. The tubes are arranged right round the room just above a moulding, which appears from the photograph to be about 2ft. from the ceiling. The ceiling is also lighted by large tubes arranged in a diamond pattern with curved sides. More tubes in the centre of the diamond complete the lighting arrangements. From what can be gathered from reports the effect is pleasing, but the cost is still kept out of the papers. The glass-work alone in the present case must cost a large amount, but it is the energy cost that we all wish to get at. To talk of the vacuum tube as the light of the future is somewhat futile, when its exponents do nothing but exhibit effects and do no commercial work. It may be a small matter, but we note that in the present case visitors to the room have to pass through a dark passage before entering. This prevents a comparison of the illumination with that in the exhibition.

Electric Tramways at Liverpool.—The first section of the tramways in Liverpool to be worked electrically was opened to the public on Monday last. The line in question runs from St. George's Church to the Dingle, a distance of about 2½ miles, and its success will determine the question as to whether the rest of the extensive tramway system is also to be converted. A new feature in the line is the establishment of halting places every 200 yards or so. The trams will always stop at four of these stations, and at the others they will pull up to set down and take up passengers. When the public get used to this system it will effect a great saving of time over the stop-anywhere system. The first car started from the Dingle as early as 5.30 a.m., and the inital journey was made under the personal direction of Mr. J. A. Brodie, city engineer. The public patronised the new system most liberally, and general satisfaction was expressed with regard to the speed of the cars as compared with the old system. A four minutes' service was maintained throughout the day. The charge for the whole journey is 2d. per passenger on the motorcars and 1d. on the trailer, on which

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smoking is allowed. This premium on smoking will be a great temptation to boys to learn early, and the economic lady will also regret her lack of training in the use of the soothing weed.

Meat Cars in Buenos Ayres.—In South American cities, says the *Street Railway Review*, the methods of handling and distributing meat are far in advance of the towns of the United States. No slaughtering is allowed in Buenos Ayres except at the Government abattoirs, and thus no diseased meat can be sent out. An electric railway in the city has a contract for the transportation of meat, and has special cars constructed so that it can be distributed to all markets, shops, and storage houses. The cars are made on the same method as those used on the old horse cars, except that they are considerably larger. The old method was very slow and laborious, and with the introduction of electric traction in place of horse power, the system is being greatly improved. In the new order of things, the sides of meat are placed in so-called meat boxes, which are set upon a flat car and are thus taken to the markets without exposure. Upon arrival, a powerful crane lifts each box from the car and deposits it upon a large three-wheeled hand-car, upon which it is taken to the ice-house. The flat car then goes to other points of distribution. The principle of working these cars is greatly similar to the method used for through luggage on Continent mail trains.

Electro-Harmonic Society.—The following is the programme for the ladies' night of the above society. The concert will be held in the St. James's Hall Restaurant, Regent-street, on Friday evening, Nov. 25, 1898, at eight o'clock, under the direction of Mr. T. E. Gatehouse and Mr. Alfred E. Izard. Part I.: vocal duet, "Sweet, Wild Birds" (F. L. Moir), Miss Florence Ogilvy and Mr. Thomas Harrison; pianoforte solo, "Valse, Op. 34" (Moskowski), Mr. Alfred E. Izard; song, "The Gleaner's Slumber Song" (R. Walthew), Miss Florence Ogilvy; song, "Wake, Mary, Wake" (Henry Smart), Mr. Thomas Harrison; experiments in sleight of hand, Mr. John Warren; harp solo, "Souvenir of Wales" (Chatterton), Miss Mary Chatterton; sketch, "Actors at School" (Helmore), Mr. Arthur Helmore; songs (*a*) "Still wie die Nacht" (Carl Bohm), (*b*) "The Silver Ring" (Chamanade), Miss Greta Williams; humorous sketch, Mr. Tom G. Clare. Part II.: vocal duet, "Two Gay Owls" (Martyn Van Lennep), Miss Florence Ogilvy and Mr. Thos. Harrison; mimetic sketch, "The New Hat," Mr. John Warren; reverie, "Sognai" (Schira), Miss Florence Ogilvy; new song, "Sir Hal, the Squire" (F. Rosse), Mr. Thomas Harrison; harp solo, "Intermezzo" (Mascagni), Miss Mary Chatterton; humorous lecture, "Goosey, Goosey Gander" (Helmore), Mr. Arthur Helmore; songs (*a*) "Berceuse" (Godard), (*b*) "Cuban Serenade" (L. Kellie), Miss Greta Williams; humorous sketch, Mr. Tom G. Clare.

The Institution of Junior Engineers.—On Saturday, Nov. 12, a party, numbering over 120, visited the site of the Lombard-street station of the northern extension of the City and South London Railway. On behalf of the engineers (Sir Benjamin Baker and Mr. David Hay), they were received and shown over by the resident engineer (Mr. James Forgie), and Messrs. Collingridge, W. G. Bennett, and C. Mack representing the contractors (Messrs. Mowlem and Co.). The feature which attracted the greatest interest was the work connected with the underpinning of St. Mary Woolnoth Church, immediately underneath which the main shaft for the lifts has been sunk. The large oblong shaft is 73ft. 6in. by 84ft., divided into five bays, for the large electric lifts made by Messrs. Easton, Anderson, and Goolden. It is lined with cast-iron segments for a depth of 52ft. from the top, the remaining 28ft. being brickwork, in which are formed the entrances and exits to and from the lifts. The two station tunnels are 21ft. in diameter, and lined with cast-iron rings. The students were also much interested by seeing the great extent to which electricity was used by the contractors in the construction of this railway. The electric locomotives were seen at work drawing the subsoil from the tunnel, and electric fans for ventilating purposes have been largely employed at different times. At the conclusion of the inspection, the thanks of the institution for all that had been arranged for the members' reception were expressed by Mr. Kenneth Gray, vice-chairman.

Automatic Electric Supply.—The old penny-in-the-slot machines from which a mild and invigorating current of electricity could be obtained, or more often could not, have not been so much in evidence lately. It may be that their propensity for absorbing pence without giving any return accounts for their disappearance. A new type of electric meter which does fulfil its obligation, and gives electricity from the public mains, has arisen, and is finding support amongst certain classes. Something of this kind on a large scale is needed in our streets, by which electric vehicles can get their accumulators recharged on emergencies without returning to their regular charging stations. This has been arranged in the States, and the device is christened an "electric hydrant." It has recently been introduced by the Edison Company. It is intended to locate these hydrants at various points throughout the city. They are, says our New York namesake, to be equipped with a pre payment or penny-in-the-slot meter, and keys for opening these boxes will be given to all owners of electric wagons. When the driver of one of these wagons finds that his electricity is about used up, it will simply be necessary to stop by the side of one of these hydrants, open the door, pull out a flexible cable, and connect it to the bottom of his wagon. He will then drop the necessary cash in the slot, depending upon how much electricity he needs, and wait for his battery to be recharged. The question of a standard voltage for such vehicles should be settled if these electric hydrants are not to be unduly complicated.

Armature Winding.—The multiple-circuit system of winding an armature had been largely used in England for the large two-pole machines so common in our stations. Prof. A. L. Rice describes this system of winding in the *American Electrician*, and calls it "telescope windings." He says that the method is exceedingly useful when a large current and low voltages are required. Under these conditions it becomes difficult to make the conductors and commutator bars sufficiently large to carry the current without dangerous heating. He clearly describes the method of using several windings with the conductors and commutator bars of the several separate windings arranged side by side on the same armature, but not connected. The windings are then all put in parallel by the brushes, which extend over as many commutator sections as there are separate windings. This system has as mentioned above, been largely used in England, but owing to patent troubles has been abandoned by, at least, one firm, in favour of the following arrangement: The different windings, say three, for example, are not made independent, as before, but the number of armature conductors and commutator bars is slightly decreased, so that current has to go three times round the armature before getting over one circuit of the other. The brushes, as before, are made broad enough to approach four commutator sections at the same time, and in this way the circuitous path between the different windings is not made use of. The arrangement works equally well as one in which the three circuits are kept distinct.

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Still More Systems.—Of contact systems of electric traction there seems to be no end, but the best are not always kept to the last. The last brought to our notice is the Maxham third-rail system, as described and illustrated in the *Electrical Engineer* of New York. In this case the third rail is laid in insulated sections, but the inventor does not deign to explain how the insulation is obtained. The third rail is hollow, and the conductor at 500 volts lays in the hollow under the rail. The contact is made mechanically "by laying, parallel with the hollow rail, a guard rail, the two forming a slot or channel. Into this channel is placed an insulated depressible bar having a contact drop of 1in. This bar is held normally even with the top of the hollow and guard rails. On the top of this bar rolls a depressing wheel, which is at all times under control of the motorman. Whenever this bar is depressed to move a car, it actuates a fulcrumed rocker arm or lever, one end of which extends into the hollow rail and forms a support for and moves the electric conductor into contact with the ceiling of the rail. Each section of this hollow rail has its own conductor sealed watertight within it, yet provides a continuous electric current throughout the entire line, and leaves an absolutely dead surface rail at all times when the car is not moving." The author adds that "the importance and advantage of this feature in the way of easy and economical connection with the various lines is obvious. Bear in mind that all of the exposed parts of the Maxham third rail are absolutely safe to step or walk on without danger to persons or animals, the dangerous electric current being safely placed below the ground surface." We do bear his description in mind, but differ from him in his idea of safety. The system is a most crude one, and in its present form would be both impracticable and, if tried, dangerous to the public.

Electric Dynamometers on Switchboards.—It is not often the *American Electrician* is caught napping in the matter of electrical detail. In their November issue the following glorification of the electro-dynamometer as a switchboard instrument is given: "Modifications of the electro-dynamometer have ever been popular in electrical meters, but for some reason it is not so largely used in switchboard work as its great advantage would lead one to expect, preference being seemingly given to types containing permanent magnets or moving iron. For switchboard work a pair of dynamometer coils, with gravity for the restoring force, seems absolutely ideal. There is nothing to change. The same instrument can be used for both alternating and direct currents. It can be manufactured as a voltmeter, ammeter, or wattmeter. By the use of air dampers it can be made practically dead-beat, and by the ingenious placing of the counterbalance or the employment of several weights successively brought into play, the scale may be made with practically uniform scale provisions. Once calibrated, it becomes a standard. Indeed, many standards claim their excellence on account of their employment of this principle. It may, further, be made very delicate, and it is not an expensive construction. Properly constructed, there is not a single objection to be recorded against it. An instrument-maker properly employing this principle need only excel in workmanship and detail to largely control the market in switchboard instruments." In spite of the above, anyone who has had extensive experience with the dynamometer will know that, however excellent the instrument is for experimental work, it must not be used near conductors carrying heavy current without those conductors lie in certain definite directions with respect to the two coils. The large number of conductors on a modern switchboard hence precludes the attainment of any accurate readings from the dynamometer. Electromagnetic instruments with strong fields which will not be appreciably affected by conductors, or electrostatic instruments, are alone suitable for switchboard work.

Paris Exhibition, 1900.—The Paris Exhibition notes now occupy a considerable amount of space in Continental technical papers. Provided it ever does come off, the show is intended to eclipse everything the world has previously been treated to in this method of advertising a country, which was started by the late ever-lamented. From the *Elektrotechnische Zeitschrift* we learn that some 20,000 h.p. will be required for driving the electrical machinery. Of this power, three-quarters is to be used for lighting and the rest for motive purposes. The principle adopted is that steam will be generated in two large boiler-houses only, and power distributed by electricity. Two complete installations of 10,000 h.p. each are being arranged for. One of these will be supplied by French firms, one by foreign exhibitors. Both continuous as well as single-phase and multiphase current will be generated in both stations. In order to avoid too much variety of system, the exhibition rules prescribe that dynamos must give continuous current at either 125, 250, or 500 volts, or multiphase current at 2,200 volts, with a frequency of 50. Transformer stations must be erected for any consumer of alternating or multiphase current whose apparatus requires less than the voltage indicated above. The distribution of current inside the exhibition will be carried out by the exhibition authorities themselves. Exhibitors will be allowed to compete for the laying down of the necessary mains. The plans are not ready as yet, but the *Elektrotechnische Zeitschrift* is informed that the number of applications is very large, and that the makers of different machines will have to take their turn in supplying the load on the exhibition mains. The selection of machines admissible for that purpose is said to be nearly completed. Each of the two boiler-rooms is 350ft. by 120ft. Over 220,000lb. of steam per hour will be produced. While exhibitors will find all the engines, generators, transformers, etc., the exhibition authorities will erect the chimneys and the various pipes.

Explosions of Gases by Electric Sparks.—The *Journal* of the Chemical Society contains an abstract of a paper by Messrs. H. Couriot and J. Meunier, on the explosions of mixtures of methane by electric currents, in which extensive series of experiments were described on the action (1) of incandescent wires or filaments, and (2) of electric sparks on mixtures of methane with various proportions of air, the gas being sometimes still and sometimes in motion. A current of a mixture of 80 per cent. of methane and 20 per cent. of air could not be ignited by an incandescent wire or by the spark produced when the wire melted, owing to the intensity of the current. In contact with a flame, however, the mixture readily ignited. Whatever the proportion of air and methane, the only effect produced by an electric current, if it produces any effect at all, is an explosion. Under no circumstances, however, were the authors able to produce an explosion by means of an incandescent wire. When an explosion is produced, it is due to the breaking of the wire and the consequent production of a spark. The most readily explosive mixture contains 9·5 per cent. of methane. So long as the proportion of methane does not fall below 5·5 per cent., combustion during the explosion is complete. Slight explosions were observed with so low a proportion of methane as 4·5 per cent. The maximum limit of explosibility is 12 per cent. of methane, and the authors never obtained an explosion when the proportion was as high as 12·25 per cent. They also find that if the current by which the wire is heated is shunted with a parallel shunt, the production of the spark causes no

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ignition when the resistances in the two branches are equal. If the resistance of the shunt is high, the production of a spark always leads to the ignition of the mixture of methane and air; on the other hand, when the resistance of the shunt falls below a certain value, the production of a spark likewise causes an explosion. In order to avoid an explosion, the intensity of the current must not exceed a certain maximum, which depends on the resistance of the two branches of the conductor.

Carbon Arc Vapours.—Messrs. E. Merritt and Oscar M. Stewart give in the current number of the *Physical Review* some most interesting experiments on the conducting properties of the vapours arising from the electric arc between two carbon points. In the series of experiments carried out by the authors, the known properties of gases ionised by the action of X-rays were kept in view in order that the resemblances and differences between the two classes of phenomena might be brought out. The various experiments in discharging electrodes by means of the arc vapours, and as to the length of time which their properties required, are too long to refer to in detail. The results of the experiments, which the authors consider as preliminary only, may be briefly summarised as follows: (1) The vapours from the carbon arc possess the power of discharging electrified bodies with which they are brought in contact. In general, the electrical properties of these vapours are similar to those of gases that have been acted on by X-rays, or to the gases from a flame. Except at low potentials the rate of discharge is not proportional to the potential, but approaches a limiting value as the potential is raised. (2) This discharging power is retained even after the vapours have been passed through long tubes of glass or metal, and lasts for at least 10 seconds. (3) When caused to pass between a charged conductor and one that is grounded, the vapours in large part lose their conducting power. A similar result is obtained by passing the vapours through loosely packed asbestos wool. (4) After passing between two grounded conductors, these being only a short distance apart, the vapours are found to discharge a negatively electrified body more rapidly than one charged positively. In this respect their behaviour is similar to that of gases that have been ionised by the action of X-rays. The explanation of the phenomenon is probably that suggested by Zeleny—namely, that the negative ions diffuse more rapidly than the positive ones. (5) Positive and negative charges are in general dissipated by the vapours with equal rapidity. But experiments made with a vertical enclosed arc show that gases taken from near the lower carbon have unequal discharging powers for the two electricities; in this case that charge which is of the same sign as the lower carbon is dissipated less rapidly. This is true whether the lower carbon is positive or negative; and the effect is not altered by connecting either carbon with the earth. (6) If air or oxygen that has been saturated with water vapour is introduced into the enclosure containing the arc, the conducting power of the arc vapours is greatly increased. But this effect can no longer be observed when the body to be discharged is at a considerable distance from the arc.

The Possibilities of Electric Traction.—The *Street Railway Review* for October has an article on electric railways, its greatness and possibilities, which should be printed and issued together with the valuable London County Council report by Mr. J. Allen Baker on electric traction. The article in question, which is not signed, consists of a series of diagrammatic representations of what the trolley cars have done for the large towns of the United States. Before this system was introduced, business districts were congested and residents crowded as closely round these focal points as the value of the property would permit. Then a working or business man who lived a mile from his office or shop was within 20 minutes' walking distance; if two miles, he spent 40 minutes each morning and evening going and returning. When the horse-car lines were built, one could afford to live 50 per cent. further away, for that much time would be saved over walking. Then the trolley lines came into use, and the man who cared to spend but 20 minutes on the cars could now live from three to four miles from his place of business. Maps are given of New York, Boston, and Chicago with circles running through them, representing approximately the distances from the centre of the town at which a man can reside and still reach his office in 30 minutes. The inner circle has a radius of $1\frac{3}{4}$ miles, which indicates the limits of convenient walking distance; the second is three miles, the limits of horse-car traction, and the outer one is six miles, indicating the expanded area which is served by the electric cars in the same time The areas of the three circles represent 9·6, 28·3, and 113 square miles respectively, as available residential districts for a business man under the conditions of going to and from his office each day by walking, by horse cars, and by trolley cars. The maps also show how much the towns have spread during the past 10 years. The author estimates that the present value of the State railways in America is more than the total debt of the United States. He goes on to say that 2,660,000,000 passengers are carried each year, which is about five times more than are carried on all the steam railways in the States. Even these figures do not stop the author from further calculations. Thus he finds that the track rails would make a band around the earth at the equator, and would also provide for an iron axis extending from the North to the South Poles. The horse-power in the stations he puts down at 500,000, and the coal consumed at 2,300,000 tons. As regards the safety of the passengers carried, only one in 23,000,000 is killed and one in 800,000 injured in any way. Hence, to have a reasonable chance of a damage claim against the company, a man would have to travel for an hour every day for 31 years and spend £220 in car fares.

Leakage Currents.—The electrolytic effects of the currents leaking from tramway rails to the metallic pipes near them formed the subject-matter of two papers recently read before the American Institution of Electrical Engineers. The first was by Mr. A. A. Knudson, entitled "An Electrical Survey in the Borough of Manhattan, New York City," and the other was on the "Electrolysis of Cast-Iron Water-Pipes at Dayton, Ohio," by Mr. Harold P. Brown. In both cases great damage was proved to have been done. It must, however, be remembered that in America a 25-volt drop in the earth return is allowed, as against seven volts in this country. It appears from the tests made by Mr. Knudson that an open-conduit system, or one in which an insulated metallic return is used, effectually confines the current to the conductors provided for it. Mr. H. P. Brown, in conclusion, offers the following comments and practical suggestions on the matters generally to water and gas engineers: Do not imagine because your pipes are not leaking and bursting that they are safe from electrolysis. If the electrical conditions are against them, they are getting weaker day by day. On the other hand, do not antagonise the railway companies the moment that the subject of electrolysis comes up in your city. The best course for all concerned is to take mutual action. Do not put down any more lead or wrought-iron service pipes, as these are the first victims of electrolysis, and their replacement means ruin to pavements. Use instead

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wooden pipe, banded with a close spiral of hoop iron and covered heavily with asphaltum. This will stand the heaviest pressure in use, and is not affected by electrolysis, since the hoop iron is low in conductivity, and is not electrically connected at the joints. Its cost is said to be reasonable, and it has a successful record of many years' service. Use the same kind of pipe for new mains in any district in which a railway power-house is likely to be erected, and heavily paint the lead caulking of cast-iron mains, using asphalte or petroleum wax. In the danger district along the lines of electric roads, and on intersecting streets, put into your water and gas mains two or more consecutive lengths of these wooden pipes so as to break the electrical continuity of the mains, and thus make their resistance greater than that of the rails. Fill in the space around them with broken stone, and connect with drain if possible. Midway between the wooden sections on each main attach insulated pilot wires leading to a central office. Connect similar wires to the rails nearest the pipe wires and make daily electrical tests at times of heavy load. If any section shows positive to the rails cut it at once into smaller sections, and call upon the railway to rebond its line upon that street. This, with the proper electrical management of the railway feeder wires and apparatus, will effectively protect your mains. Mr. Brown does not add that the street railway company will be pleased to pay the costs of the changes.

The Electricity Works at Washington, U.S.A.—The *Electrical Engineer* of New York publishes in its issue for Nov. 3 a very full description of the new works of the United States Electric Lighting Company, of Washington. The history given of the concern dates back to 1881, when the first temporary arc-lighting plant was laid down. The new station has several points of interest to central-station engineers. The first of these is the coal-weighing plant and the mechanical conveyors to the boiler stokers. The coal is brought from Georgia's Creek mines, and is discharged from the outside into a chute leading direct to a crusher operated by an electric motor of 25 h.p. It is then conveyed by an automatic bucket carrier to the iron coal-bins and hoppers over the boilers having a capacity of 1,200 tons. The fuel, ground to the proper fineness, is allowed to fall into a Clark automatic scale, suspended under the delivery pipe, where it is weighed and delivered in 200lb. charges upon pulling a lever, doing away entirely with hand weighing on the barrow. Provision is made for a complete installation of the automatic scales, one to each furnace, making the entire handling of the coal mechanical. The "checking" tests of these scales, by means of a platform standard, have proved very satisfactory. The stoking is automatic, and is effected by a link belt grate of Babcock and Wilcox design, operated by shafting in combination with a small oscillating engine. The boilers work at 160lb. pressure. The engine-room arrangements are a curious combination of direct driving and belt driving. There are four large engines of the tandem horizontal type, with overhung cranks. Two of these are of 1,600 h.p., and two rather smaller. Each of the engines has two direct-current multipolar dynamos coupled to the shaft on the further side of the flywheel. These two dynamos in every case generated at 160 volts each, and deliver current one to each side of the three-wire network. The capacity of six of them is 1,500 amperes, and the other two can give 3,000 amperes each. In addition to this load the two large engines are belted to a countershaft running the full length of the engine-room. These belts are each 5ft. broad. The countershaft is below the floor, and from it the various arc lighting dynamos are driven by smaller belts coming up through belt races in the floor. There are eight Brush arc machines of the four-circuit type and 125-light capacity. The machines run at 500 revolutions per minute, producing at this speed a current of 9·6 amperes, at a potential difference of 6,250 volts. By means of these large multi-circuit machines, says our contemporary, "the company are able to develop their arc lighting business to great advantage over their old underground circuits, with all the economies due to the bigger generating units, in spite of the fact that they were of course unable to put any higher voltage on the underground mains than the familiar 2,000 to 2,500 volts." From this it will be seen that overhead wires for electric lighting purposes are allowed to be erected in Washington, and that a potential of 6,250 volts may be used in them. We cannot understand why such dangerous practices should be allowed in the Capitol town of the United States.

The Value of Scenery.—The latest report of the commissioners for the State Reservation at Niagara brings up again in an acute form the old discussion over the value of scenery to the world. The report discusses the recent notable changes that have taken place at Niagara through the utilisation of part of its energy, and falls foul of Lord Kelvin for his frankly avowed wish to see the whole of the energy of the great cataract turned to some useful purpose. His Lordship on the occasion of his last visit suggested that the scientific man witnessed the present waste of power "with more or less conscious disturbance or disapproval." He is therefore set by the commisioners in the same pillory of reprehension as the stone blasters along the Hudson River palisades and the lumbermen in the Adirondack clearings. Viewing what has been done in developing the Niagara power electrically, the report says: "The question may well be asked, Has the interest in natural scenery of exceptional grandeur that prompted and approved the establishment of the State Reservation at Niagara and the Queen Victoria Niagara Falls Park wholly disappeared? or has the interest in the development of electrical power and manufacturing enterprises became so general and so dominant as to produce indifference to the future of Niagara Falls, and even tacit approval of scenes that cannot but be effective in diminishing the volume of the cataract, and defacing it as a world-famous spectacle? At any rate, it must be admitted that the river and falls are at present not safeguarded from diversion and destruction. And the only power that can provide absolutely sure protection is the combined power of the Government of the United States and that of Great Britain." Our New York namesake, in commenting on the report, says that the privileges at present granted for tapping the river above the falls are about 500,000 h.p., and of that amount certainly not more than 50,000 h.p. to 60,000 h.p. is being converted. The power at the falls has been estimated on various bases, but never less than 6,750,000 h.p. Hence the legal limit at the present moment is less than one-twelfth of the capacity of the water flowing over the falls. The thickness of the sheet at the Horseshoe is over 16ft., so that even when 500,000 h.p. is developed, it will only be 1½ft. thinner, with a proportionate shallowing towards each bank of the river, and a like scaling down in the thickness of the sheet of the American Fall. Who would ever notice such a slight diminution as that? A drought along the lakes, an ice blockade, or a light wind blowing up into the neck of Lake Erie at Buffalo probably makes more difference several times a year. Hence we think that the commissioners put their complaint much too strongly. We might ask them another question, namely, whether it is not better on purely æsthetic grounds to generate that much power from running water rather than by burning an equivalent quantity of coal with all its grime and pollution?

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THE LLANDUDNO ELECTRICITY WORKS.

The electricity works at Llandudno are to be doubly blessed in the matter of opening ceremonies, and, in fact, we are not sure that thrice blessed is not the more correct term. They were opened to supply light earlier in the autumn, and on Nov. 5 Mr. T. T. Marks, the chairman of the Urban District Council, formally switched on the light. Mr. W. H. Preece was present, and the speech-making was supplemented by refreshments. Still, the final opening is to come in the spring, when more extended formalities and rejoicing will take place.

At the function on the 5th inst., Mr. MARKS said that it was an important day in the history of Llandudno. A great deal had been said about the dilatoriness of the Council in carrying out the scheme, seeing that the order was obtained several years ago. But he wished to say publicly that their critics should remember that there were several causes of delay. First, there was the difficulty of the refuse destructor. The Council had to bring that question into line and carry it out in conjunction with the electric lighting. There were other incidental difficulties, so that on the whole he did not think there was much fault to find. They had been very fortunate in securing the services of one of the leading electricians of the day—Mr. W. H. Preece; and then they had also Mr. A. H. Preece, his son, who had given every satisfaction to the Council. Perhaps he might inform them that Mr. Preece, sen., had been elected to the highest position in the engineering world—president of the Institution of Civil Engineers, and he was the first Welshman who had ever held that distinguished position. He had much pleasure in declaring the works open, and he was sure they all wished success to the installation.

Mr. W. H. PREECE said that, although he might be the first Welsh president of the Civil Engineers, he was not the first Welshman who had distinguished himself as an engineer, because it happened that the first engineer of any eminence in history was Sir Hugh Middleton, who established the New River works in the neighbourhood of London. He need not tell them that he had taken great interest in the introduction of the electric light to Llandudno. He was sure it would succeed, because there was no instance on record where the light installed by a local authority like theirs had failed. His own belief was that local authorities who were empowered to do so neglected their duty to the ratepayers when they failed to supply their towns with well-regulated electric tramways and electric lighting installations.

The Llandudno provisional order was obtained in 1895, and early in 1896 Mr. A. H. Preece was instructed to report on the prospects of success an electric light undertaking would have in the town. His report was adopted, and the work has gone steadily forward but for the few hitches referred to in the speech of Mr. Marks. In the work, Mr. A. H. Preece has had the energetic co-operation of Mr. E. P. Stephenson, the engineer and surveyor to the Council. Thus, the building for the joint electric lighting and dust destructor works were designed by Mr. Stephenson, and were afterwards erected under his supervision. These buildings can be seen in plan and section in the following illustrations (Figs. 1 and 2), but as the drawings are prepared to show the engineering work, full justice is not done to the architectural features.

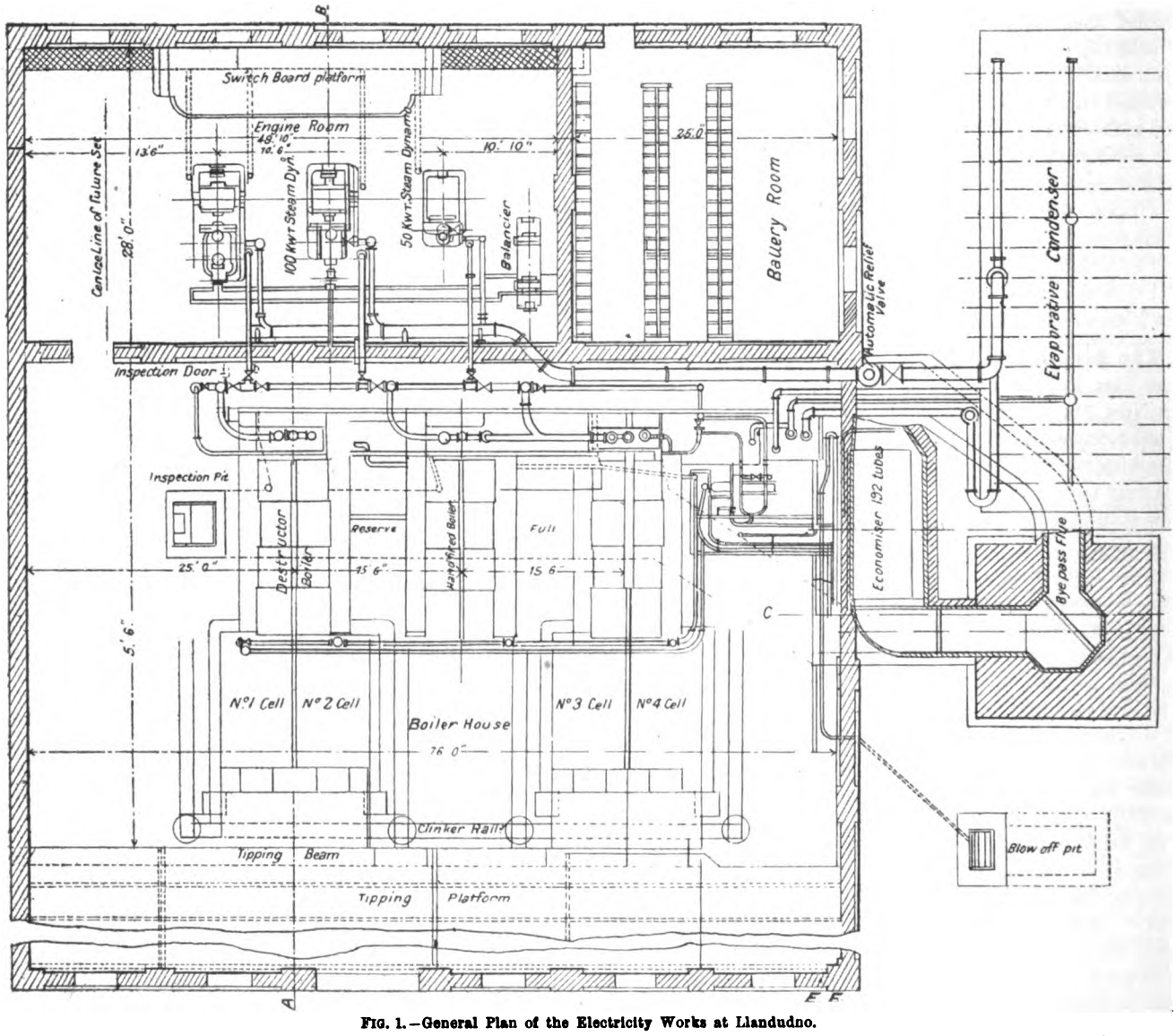

FIG. 1.—General Plan of the Electricity Works at Llandudno.

The electric light building consists of an engine-room, 50ft. long by 28ft. internally, and a battery-room, 25ft. by 28ft., besides the usual offices, storeroom, and lavatory, etc., which are placed over the battery-room. The destructor and boiler house is 76ft. long by 69ft. 4in. broad. It con-

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tains two pairs of destructor cells of the Beaman and Deas type. The tipping platform is 76ft. by 24ft. Under the tipping platform, which is 10ft. above ground-floor level, there are two bathrooms, men's room, coal store, and a room containing the motor and pump for forced draught to furnaces of destructors. The destructor and boiler house is divided from the engine-room and battery-room by a running longitudinally and spaced to carry slates. A portion of the roof is glazed with Helliwell's patent glazing. Each span is ventilated with louvres. The main flue, which is above ground (Fig. 2), is 6ft. 6in. by 4ft. inside, and is built of brick with a 4½in. firebrick lining, semi-circular arched. The reserve flue (which is below ground) is 6ft. by 4ft., and is of same construction as main

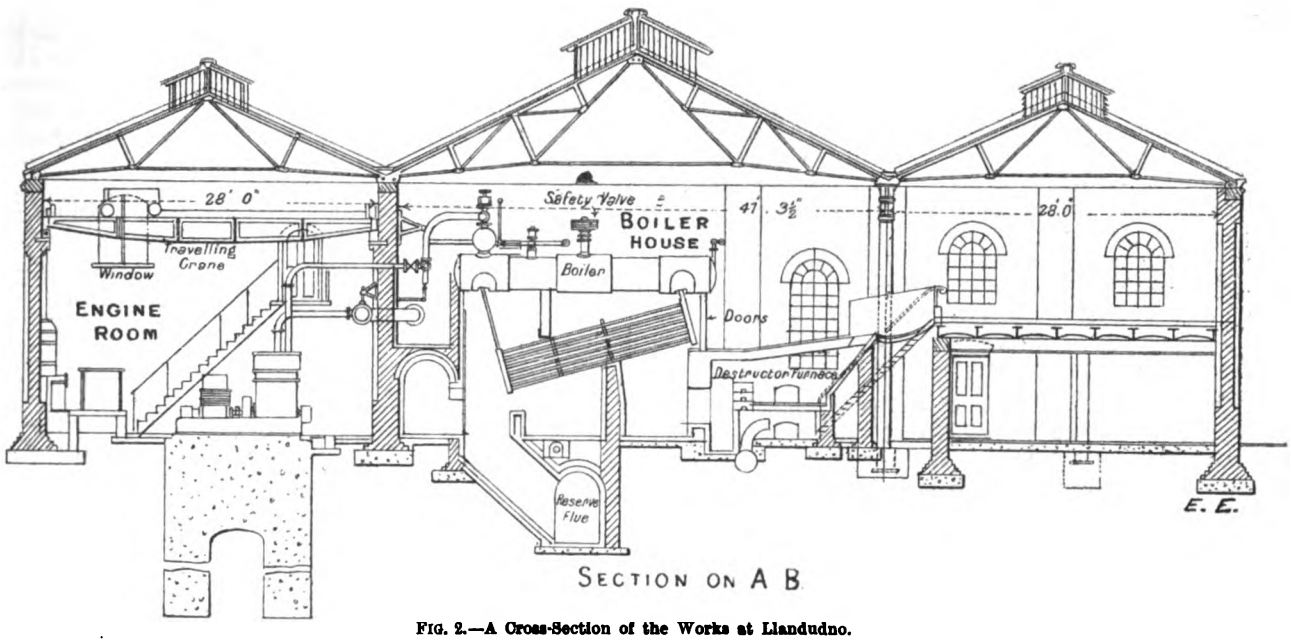

FIG. 2.—A Cross-Section of the Works at Llandudno.

14in. brick wall. The wall is strengthened with piers 3ft. wide by 1ft. 10½in. thick, and placed 9ft. 6in. apart. The external walls are in brickwork throughout, 14in. thick, and strengthened with piers as above described, 9ft. 3in. apart. The height from ground floor to eaves is 20ft. 9in. The ground upon excavation proving to be bad, a foundation was formed with concrete 5ft. wide by 12in. thick, with three continuous rows of railway metals

flue. The gases from main flue can be either carried direct to chimney stack or passed through a Green's 192-tube economiser.

The chimney stack has a height above ground of 120ft. To secure a good foundation, it was found necessary to sink to a depth of 17ft. below the surface. At this depth a solid bed of concrete was laid, 30ft. square by 7ft. thick. The brick footings commence at 26ft. 4in. square and taper

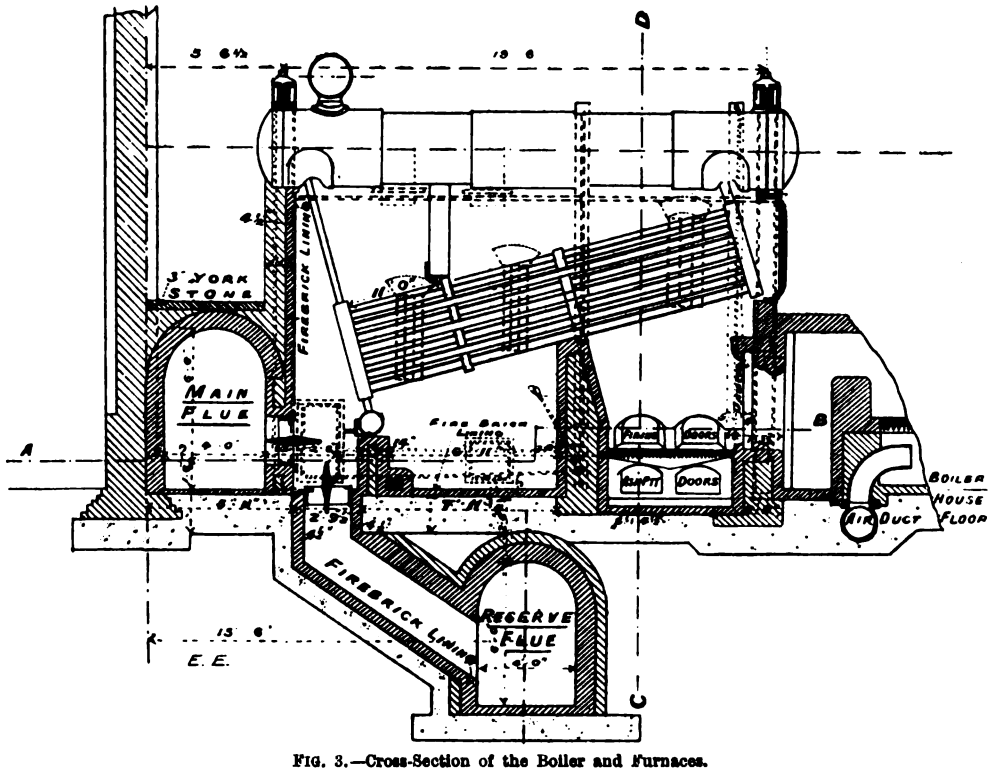

FIG. 3.—Cross-Section of the Boiler and Furnaces.

embedded therein. The engine-room is paved with wood blocks, and the accumulator-room with blue Staffordshire bricks. The whole of the station forms a rectangular building, which is roofed over in three spans: one span over engine and battery room, and two spans over destructor and boiler house. The central gutter over the latter is carried on four 12in. diameter columns. The roof is constructed with steel principals, with 3½in. by 2in. rafters

to 18ft. 2in. square in a height of 6ft. The base of stack below the plinth is 17ft. 9in. square, and above plinth 15ft. 9in. square. The base of stack is 20ft. high above ground, and is pointed on each face and finished off with stone plinth and moulded pediment. Above the base the stack assumes an octagonal form, and tapers upwards to the cap at a batter of 1 in 30·4. The thickness of red brickwork at the base is 3ft. 9in. 25ft. above

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base it is 2ft. 4in. The thickness then decreases as follows: next 50ft., 1ft. 10½in.; next 75ft., 1ft. 6in.; and the rest, 1ft. 2in. The internal width at the top is 6ft. The cap at the top of the shaft is formed of ornamental projecting brickwork, with two cast-iron moulded rings and a heavy cast-iron moulded cap, with wrought-iron ornamental

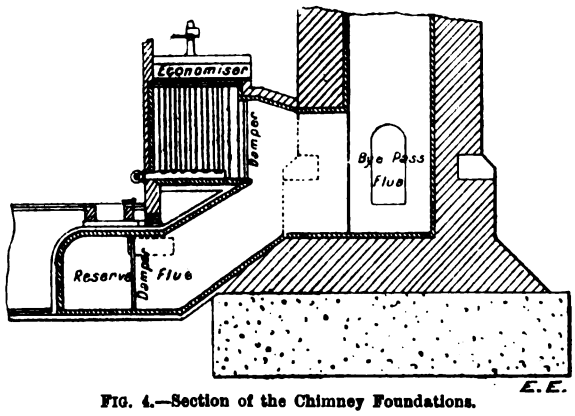

FIG. 4.—Section of the Chimney Foundations.

railings fixed on top. For 45ft. above ground line the chimney is lined with 4½in. firebrick, with a mid-division for main and reserve flues. The lining is 7ft. internal diameter at bottom, tapering to a 6ft. 6in. diameter at top.

The tipping platform in the building is approached with an inclined road, made by forming a bank. The gradient of road is 1 in 16, and the road is macadamised with sett channels formed on each side.

THE STEAM GENERATING PLANT.

The combination of a refuse destructor and an electric light station is not a novel one, but in the arrangements at Llandudno many new points have been introduced. There are in the destructor-house four cells for the cremation of refuse and three Babcock-Wilcox boilers. The two outside

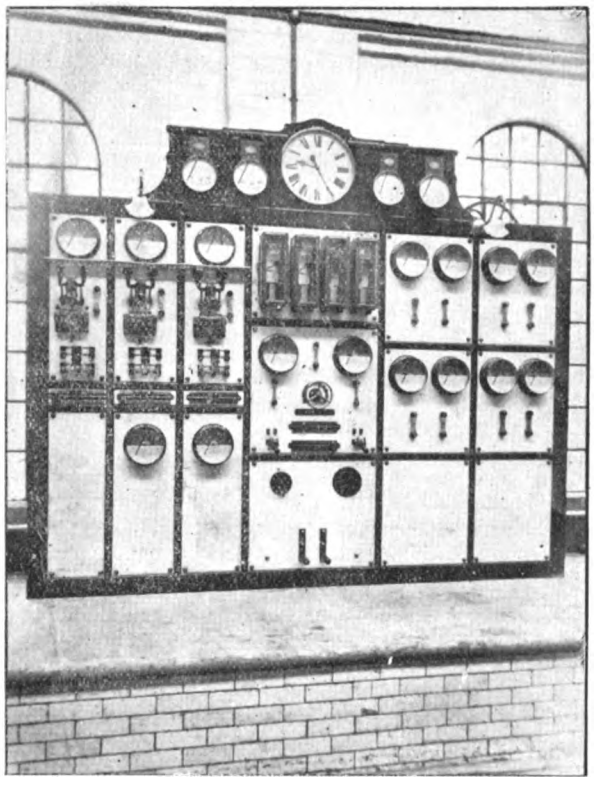

FIG. 5.—View of the Main Switchboard.

boilers receive heat from the destructor cells, while the centre boiler is used for hand firing with coal only. The two boilers which take the destructor gases can also be fired by hand with coal should necessity arise. The arrangement for the coal fire cannot be seen in Fig. 2, but in Fig. 3 the fire-bar and furnace doors are shown. These doors open out at the sides of the boilers, and not at the front, as is usually the case. In this arrangement the destructor furnace gases get a fairly straight path to the boiler, and have not to be deflected, as is done in some other designs. The destructor work was carried out by Messrs. Beaman and Deas, who have had a large experience in such matters. The arrangement for feeding the furnace with refuse can be seen in Fig. 2, which also shows the forced-draught conduit led into the closed ashpit. The three boilers at present erected are each capable of evaporating some 5,000lb. of water per hour at a working pressure of 150lb. per square inch. The flues from the boilers and destructors are arranged in duplicate, so that they can be cleaned out without shutting down the plant.

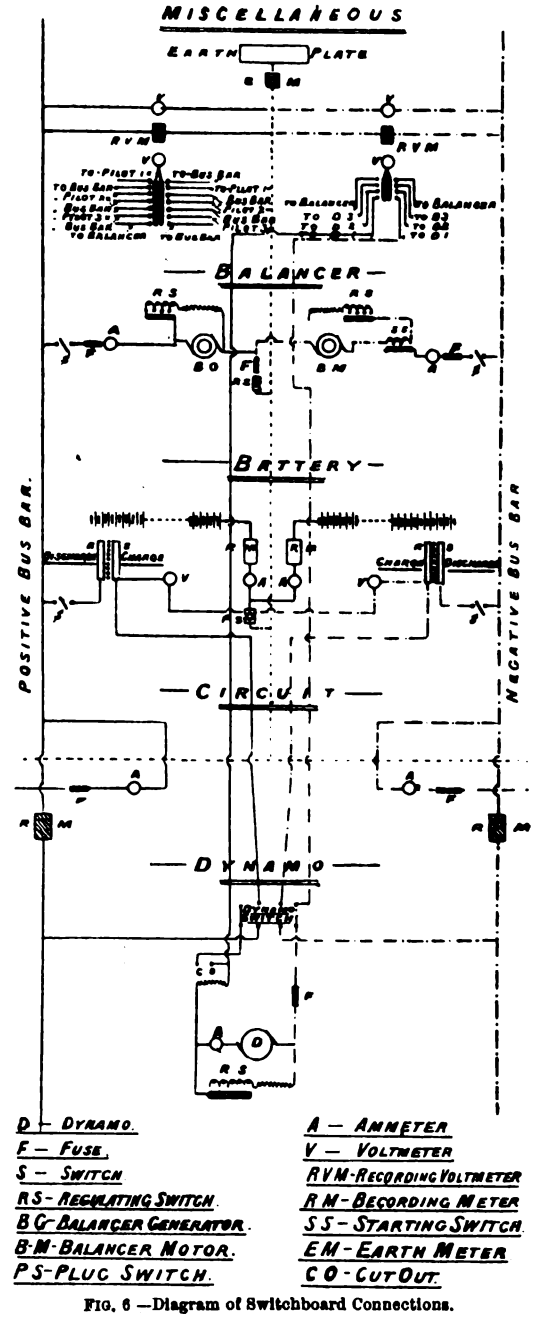

FIG. 6.—Diagram of Switchboard Connections.

The whole of the steam and exhaust pipes at Llandudno were supplied and erected by the Sunderland Forge and Engineering Company, Limited. The general arrangements of these can be seen in the illustration. The steam-main is of wrought iron, 6in. diameter, ¼in. thick, with steel flanges screwed on, recessed at the back and brazed. All the valves on the steam-main are of Hopkinson's patent parallel slide type. All the T-pieces are of cast steel, with deep water-pockets. A connection from the bottom of the water-pocket in each T-piece is taken to a Geipel steam-trap, which discharges into the hot-well. All the bends are of solid-drawn copper, with flanges brazed on. The auxiliary steam-main is 2½in. diameter, having separate connections from each boiler, and coupled at each end to the steam-main through cast-steel separators. The feed pipes are arranged on the ring main system, with pipes of wrought iron and connections of copper. The pipes are so

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arranged that the feed may be direct or through a Green's economiser (shown in Fig. 4). The scrapers on this are driven by a small motor. The main exhaust pipes are 12in. diameter, and are supported from the engine-room wall by cast-iron brackets and hangers, with connections from each engine. The main exhaust is carried outside the building, and provided with an automatic valve, so that the exhaust may go either to the condenser or the atmosphere. The condenser is of the evaporative type, having a total number of 300 radiating pipes of oval section with radiating fins cast upon them, they are arranged in tiers, the ends of each pipe being coupled together by means of a junction-box. Each tier is coupled at the top to the exhaust pipe, and at the bottom to the air-pump suction pipe. The top three rows of tubes are fitted with an internal pipe, which distributes the steam more evenly over the inner surface of radiating tube. The condenser tubes are built up on girders and mounted over a cast-iron built-up water-tank. The circulating water is drawn from this tank, and discharged from the pump to a main pipe, passing over the centre of the condenser tubes. From this main, a wrought-iron perforated pipe at right angles passes over the top of each radiating tube, the condensing water being thus sprayed on to the top tube and trickles down over each tube, and that not evaporated goes back into the cast-iron tank at base.

The pump chamber for the air and circulating pump is in one casting, having gunmetal liners. The air-pump is double-acting, with a barrel 1ft. 1in. diameter. The pump plunger is of gunmetal, and Delta metal pump rods are employed. The valves are of rubber, with gunmetal seats, screwed into pump chamber, and fitted with gunmetal guards. The circulating pump is single acting, 9in. diameter. The pump liner is of gunmetal, with foot-valve screwed into the base. The engine for driving the pumps is compound, with high-pressure cylinder 5in. diameter, and low-pressure cylinder 9in. diameter. The high-pressure cylinder is fitted with a piston valve, and the low-pressure cylinder with ordinary D slide valves. The cylinders are mounted over the pump on wrought-steel columns; the piston rod having projecting arms, to which are coupled the pump rods.

Electrical Plant.

The generating plant, which has been supplied by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, consists of two Belliss compound two-crank self-lubricating engines, of their E. C. 7 standard pattern. Each of these is direct-coupled to a Silvertown S. D. 220 single horseshoe undertype dynamo, with drum bar armature, each set giving an output of 100 kw. at 440 to 500 volts when running at a speed of 450 revolutions per minute. The engines, which are supplied with steam at 140lb. pressure, are arranged to exhaust either into a condenser or to the atmosphere. There is also a third generating set, composed of a Belliss E. C. 4 type engine, coupled to a Silvertown single horseshoe undertype dynamo, with Gramme-wound armature, and capable of giving an output of 50 kw. at 600 volts when running at a speed of 550 revolutions per minute. A balancer is provided, consisting of two machines mounted on the same bed-plate and coupled together, each armature being capable of carrying a current of 100 amperes, and working at a voltage varying between 220 and 256 volts, so that it can transfer 25 kw. from one side of a three-wire system to the other. These machines are also single horseshoe undertype machines, with drum bar armature.

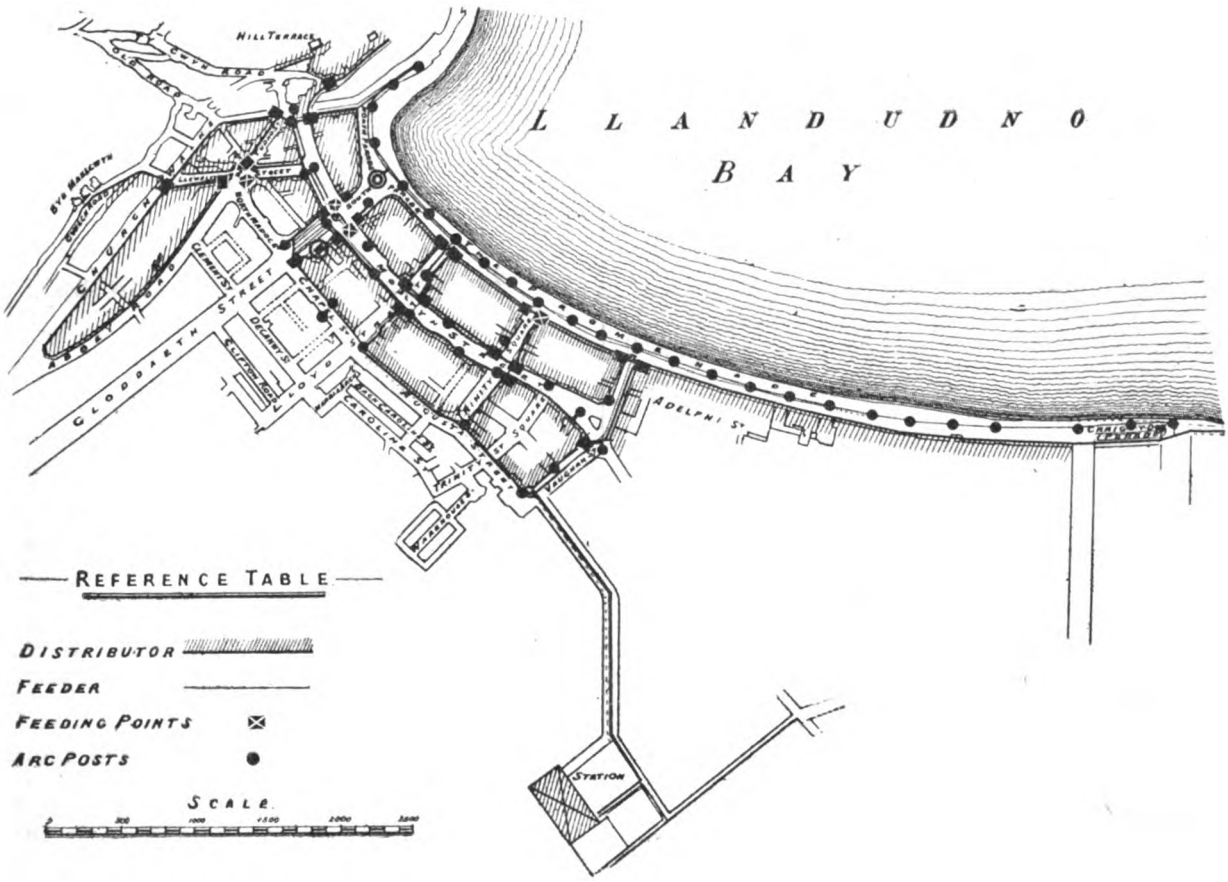

Fig. 7.—Map of the Mains.

The accumulators are of Pritchetts and Gold's standard type. Each battery consists of 240 cells in glass boxes, each cell containing 19 plates. The output of the battery is 50 amperes for 10 hours, or 200 amperes for one hour.

The Switchboard.

This part of the equipment was supplied by Mr. James White, of Glasgow. The general appearance of the main board is shown in Fig. 5, while Fig. 6 gives the diagram of the connections. To the left of the main board are the dynamo panels, and below these are the dynamo field regulators. Each dynamo panel has fitted on it a double-pole change-over switch, an automatic cut-out, and an ampere gauge. At the top of the centre panel are two Kelvin recording ammeters and two Kelvin recording voltmeters. The middle centre panel contains the balancer ampere gauges, starting switch, and field regulating resistance slides. The lower centre panel contains the middle-wire plugs and double-pole voltmeter switches. To the right are four circuit panels, each containing two Kelvin ampere gauges and a fuse for each pole. There are also two spare circuit panels. The whole

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board is fitted on a steel framework about 3ft. from the wall. The panels are of polished white marble, and the joints between the various panels are covered with a polished teakwood moulding. The whole board is surmounted by an ornamental teakwood panel, carrying the dynamo and feeder voltmeters and an 18in. dial clock with electric winding gear. The ampere gauges used throughout are of Lord Kelvin's sector pattern, and the feeder and dynamo voltmeters are of Lord Kelvin's small-dial engine-room type. The firm's contract also included the connections between the main switchboard, battery switchboard, dynamos, and cells.

MAINS.

The contractors for the cables and all the work in laying the mains were Messrs. W. T. Henley's Telegraph Works Company, of London and North Woolwich. The system comprises triple-concentric feeders and three-cored distributors, both of these types being insulated with impregnated fibrous material, lead covered, and armoured with steel

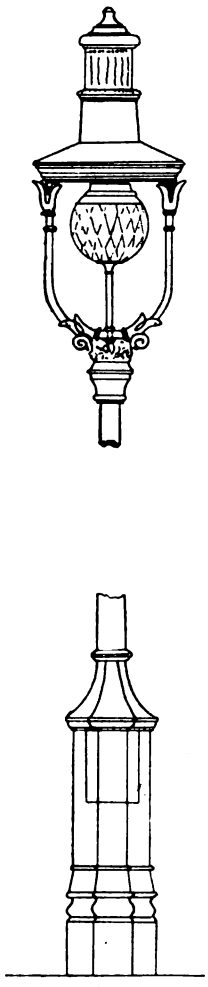

FIG. 8.

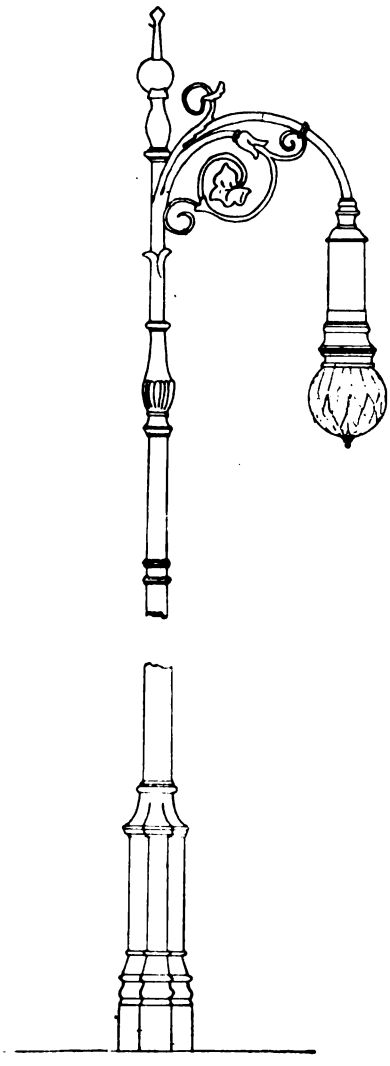

FIG. 9.

tape. The arc light cables are insulated with pure and vulcanised indiarubber, lead covered, and protected by an armouring of steel tape. The map (Fig. 7) shows the extent to which the mains have been laid at present, and also the arc lamp-posts. Of the latter 48 have been erected, of which 30 are along the sea-front.

There are altogether 48 lamps erected on cast-iron pillars. These and the lamps at important crossings are fixed in carriers (Fig. 8), so arranged that the lamp itself is immediately over the centre of the pole, a canopy being provided to protect them from the weather and to give them a good appearance. The remaining 18 lamps are all fixed along the kerb at the side of the road, and are suspended from overhanging brackets (Fig. 9). Three of the pillars are also fitted with double incandescent brackets. The lamps are run in groups from the low-tension network at 440 volts. Each group consists of eight lamps in series. Each of the six circuits is provided with main fuses and a main switch, the switches being so grouped that the total number can be turned on or off from three columns, two controlling switches being in each column. The lamps themselves are of the well-known Crompton-Pochin type. They are single-carbon, and burn for 18 hours without retrimming, and are fitted with opalescent globes. These lamps are similar to those largely used in Edinburgh and many other important towns. Each lamp is provided with an automatic cut-out, which, in the event of the rod of the lamp hanging up from any cause, immediately short-circuits it, so that the other lamps in that particular circuit will not be extinguished, nor will any damage be done to the lamp itself. In the base of each lamp-post is fixed an isolating switch, which, in the event of an attendant having to do anything to the lamp, can be turned off, thereby entirely disconnecting the lamp from the circuit and bridging the lamp mains to enable the current to pass on to the next post. This arrangement enables a man with safety to examine or retrim any particular lamp without disturbing the others. Access to the carbon-holders for trimming is obtained by lowering the globes. In the case of the bracket lamps the globes are merely dropped until their weight is taken by a pair of chains, but in the case of the central carrier lamps a rod is provided, down which the globe slides. The current of the lamps is 10 amperes, and the height of the arc from the ground level is 20ft. The lamps on the sea-front are fixed at distances of about 50 yards apart, and those in the town are a little farther apart, and so arranged as to distribute the light to the best advantage.

INSTITUTION OF CIVIL ENGINEERS.

Presidential Address.

BY WILLIAM HENRY PREECE, C.B., F.R.S., PRESIDENT.

LIGHTHOUSES.

The introduction of electricity into our lighthouses has not been such an unqualified success as into our ships. No new electric light has been installed on the coast of Great Britain since St. Catherine's (Isle of Wight) was fitted up in 1888. Other electric lamps are to be found at the South Foreland, at the Lizard, and at Soutar Point, only four lighthouses in all upon our coasts. This is due chiefly to the great prime cost of its installation and to the annual expense of its maintenance. But the sailor himself is not enamoured of it. It does not assist him in judging distances. It is too brilliant in clear weather, while in bad weather it penetrates a fog no further than an ordinary oil lamp. Moreover, great modern improvements have rapidly followed each other in other apparatus, lenses and lamps. A third-order light of to-day can be made superior to a first-order light of 10 years ago. Oils have improved and gas has been introduced. Lord Kelvin proposed that lighthouses should signal their individuality to passing ships by flashing their number in the Morse alphabet. But the Morse alphabet, in 1875, was as unknown as Egyptian hieroglyphics to our nautical authorities. The same end was obtained with less mental exertion by occulting and group-flashing systems.

A new and very promising plan has recently been introduced in France, called the "Feux-éclairs" or "lightning flash" system. It has been installed in many places, but especially at the two capes dominating the Bay of Biscay. Nothing more brilliant or more effective is to be seen anywhere than the lights that rapidly sweep across the horizon, like well-directed flashes of summer lightning, with the motion that conveys the idea of a wave of some illuminated spirit arm warning the navigator away from the rocky dangers of Ushant.

Our Trinity House has not yet introduced this plan. Any change of our well-considered and deeply-important coast-lighting system is not to be hastily effected. We are very proud of our well-guarded shores. Every headland and landfall, every isolated rock, all dangerous shoals and banks and narrow channels in lines of trade, are so illuminated that navigation by night is as safe and easy as by

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day. Lighthouses and lightships stud our channels. Most of them are placed in direct communication with our Post Office telegraph system, so that the speediest help can be secured in moments of difficulty and danger.

We, however, want improvement in fogs and storms. Here electricity steps in. I wrote, in 1893, of wireless telegraphy: "These waves are transmitted by the ether; they are independent of day or night, of fog, or snow, or rain, and, therefore, if by any means a lighthouse can flash its indicating signals by electromagnetic disturbances through space, ships could find out their position in spite of darkness and of weather. Fog would lose one of its terrors, and electricity become a great life-saving agency." We are nearing that goal.

Traction.

Electrically-worked railways originated in Europe. The first experimental line was constructed by Dr. Werner Siemens in Berlin in 1879. When I visited America in 1884 there was only one experimental line at work in Cleveland, Ohio. Now, there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom. The reason for this is not difficult to comprehend. The climatic influences of the States, the habits of the people, the cost of horseflesh, the necessity for more rapid transit, soon proved the vast superiority of electric over every other form of traction. Horses and cables will soon disappear. In England the Tramways Act of 1870 has been restrictive. It deferred the real solution of the question for 21 years. Its avowed tendency has been to throw the industry into the hands of the municipalities. Private enterprise has therefore not been encouraged, and municipalities have not taken it up. Local authorities have now been educated. The successful progress in the States and on the Continent has proved contagious, and everywhere our great cities are rising to the occasion. Indeed, to neglect to supply tramways where they would be useful, healthful, and valuable, is to a certain extent an abuse of the trust confided to the municipality by the Legislature. Rapid and convenient suburban transit is a social factor of great importance to the working classes, who can be readily transported from close quarters to pure air and healthy dwellings. Hamburg is one of the best-trammed cities on the Continent. The trams were constructed by private enterprise under lease from the Municipality. The latter supplies the electric energy. The tramway company is bound to take the current at a fair and reasonable price, but they have also to pay a tax on the gross receipts, which is set aside by the local authority as a sinking fund, so that on the expiry of the agreement the town will have the capital to purchase the tramways. Corporations in this country who have secured a provisional order for the installation of electric light have secured also legal powers to supply electric energy for all purposes. It is therefore their right, and it may become a very valuable property. The duplication and multiplication of central electrical stations is likely to become a serious evil. It is absurd to see two buildings erected where only one is needed, and two causes of nuisance perpetuated where none need exist. I have already pointed out the economy of combining electric lighting and tramway working. The relative merits of overhead and underground conductors, and the use of storage batteries, are practically the only important engineering questions under discussion. The underground conduit system has been materially helped by the practical object lesson to be seen in New York, where the tramways are being very successfully worked on this plan. The trolley system is much more economical. Its erection does not interfere with the traffic of the streets. The principal objection to it is its anti-æsthetic appearance, but it is wonderful how ideas of utility and the influence of custom make us submit to disfigurement. What is more inartistic than a lamp-post, or more hideous than the barn-like appearance of many a railway terminus?

The corrosion of water and gas pipes, the disturbances of telegraphs and magnetic observations, are serious questions arising from the introduction of powerful currents into the earth, but fortunately the remedies are simple, easily attainable, and very effective.

I have alluded to the proposed working of our underground railways. The success of the Mersey Dock line, and of the South London and Waterloo lines, have placed the question beyond controversy. The problem to be solved is how is the conversion from steam to electricity to be effected without interfering in any way with the existing traffic or with the existing permanent way? This is not to be solved on paper. It must be determined by actual trial, and this is about to be done on the short line connecting Earl's Court and High-street, Kensington. Electric traction as an economical measure in all cases of dense traffic is so certain that every great railway company must consider, sooner or later, the working of their suburban traffic by electricity. This experiment on the Metropolitan Underground Railways, therefore, should interest them all. It is a question deeply affecting the interests and comfort of the public and the condition of the congested traffic of our streets.

The storage battery fulfils a very important function in the economical working of an electric railway. It equalises the pressure on the circuits. It meets the fluctuations of the load. It takes in current when the load is light; it lets out current when the load is heavy. It thus secures the continuous working of the engines at their full constant and most economical conditions, and it enables the engines to be shut down altogether when the load is very light, as it is at night, in the early morning, and on Sundays.

In Buffalo the battery is charged by energy from Niagara, 21 miles away, and the local engines are shut down for 12 hours every day, and for 10 hours on Sunday.

Electric traction is invading even our streets. The number of unstable and week-kneed cab-horses seems destined to be reduced by their electric competitor; while the pride of London—the fleet hansom—will be freed from an obstructive and not always sweet-smelling *avant courier*. When the real storage battery is produced, the automobile problem will be solved. At present steam and oil are active competitors.

Electro-Chemistry.

The transference of electricity through liquids is accompanied by the disintegration of the molecules of the liquids into their constituent elements. The act of conduction is of the nature of work done. Energy is expended upon the electrolyte to break it up, and the quantity thus chemically decomposed is an exact measure of the work done. Every electrolyte requires a certain voltage to overcome the affinity between its atoms, and then the mass decomposed per minute or per hour depends solely upon the current passing. The process is a cheap one and has become general. Three electrical horse-power continuously applied deposit 10lb. of pure copper every hour from copper sulphates at the cost of 1d. All the copper used for telegraphy is thus obtained. Zinc in a very pure form is extracted electrolytically from chloride of zince, produced from zinc blende, in large quantities. Caustic soda and chlorine are produced by similar means from common salt. The electroplating of gold, silver, and nickel is a lucrative and extensive business, especially in Birmingham and Sheffield. Gold and silver are refined by this electrolysis in Russia, and nickel in the United States. Sea-water is decomposed in this way for disinfecting purposes by the Hermite process.

The passage of electricity through certain gases is accompanied by their dissociation and by the generation of intense heat. Hence the arc furnace. Aluminium is thus obtained from cryolite and bauxite at Foyers by utilising the energy of the falls. Phosphorus is also separated from apatite, and other mineral phosphates. Calcium carbide, obtained in the same way, is becoming an important industry.

It is remarkable that our coalfields have not been utilised in this direction. Electrical energy can be generated on a coalfield, where coal of good calorific value is raised at a cost of 3s. per ton, cheaper than by a waterfall, even at Niagara.

Electro-metallurgy is now a very large business, but it is destined to increase still more, for the generation of electrical energy is becoming better understood and more cheaply effected.

The Transmission of Power.

The energy wasted in waterfalls is enough to maintain in operation the industries of the whole world. Great

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TABLE III.

Place.	Electric power generated.	Pressure on line.	Distance transmitted.	Remarks.
	Kilowatts.	Volts.	Miles.	
Eschdorf-Grünberg, Schleswig	225	10,000 (three-phase)	15	One 80-h.p. Siemens and Halske dynamo, driven from waterwheel; one 220 h.p. S. and H. dynamo, driven from turbines (above driven through countershafting); one 220-h.p. S. and H. dynamo, direct-coupled to engine.
Ogden, Salt Lake City, Utah	3,750	15,000 (three phase)	36	Plant consists of five 1,000-h.p. 24-pole three-phase generators, driven by Knight waterwheels running at 300 revolutions per minute.
Big Cottonwood, Utah	1,800	10,000 (three-phase)	14	Plant consists of four 450-kw. three-phase General Electric generators, each one directly coupled to a Pelton wheel.
Folsom-Sacramento, California	3,000	11,000 (three-phase)	22½	Plant consists of four 1,000-h.p. three-phase generators built by the General Electric Company, coupled direct to the turbine shafts.
San Antonio Creek to Pomona..... To San Bernardino, California ...	480	10 000 (single-phase)	13¾ 28¾	Plant consists of four 120-kw. 12-pole Westinghouse alternators, driven by a Pelton water-power plant.
Rand Central Electric Works, Brakpan to Johannesberg, Transvaal	3,200	10,000 (three-phase)	18	Plant consists of four S. and H. rotary-phase machines, coupled direct to 1,000-h.p. to 1,200-h.p. engines.

cities, as a rule, are not located near great falls; nor has a beneficent Providence provided great cities with waterfalls as, according to the American humourist, He has with broad rivers. There is but one Niagara, and we are seeing how industries are rather going to the falls than the energy of the falls is being transmitted to the industrial centres. The arbitrament of money is limiting the distance to which energy can be profitably transmitted. The cataracts of the Nile can be utilised in irrigating the waste lands of the upper regions of the river, but their energy cannot compete, at Alexandria, with that of coal transported in mass from England.

At Tivoli, 15 miles across the Campagna, the energy of the falls are economically utilised to light Rome and to drive the tramways of that city. The electric railways at Portrush and Bessbrook, in Ireland, are worked by water power, and Worcester, Keswick, and Lynton use it in this country, but on a very small scale. It is not used more, for the simple reason that there are no more falls to use. Water power is used very extensively in Switzerland, because it is so abundant there, and in our Colonies, especially in South Africa; but it is in the United States, especially in Utah and California, where the greatest works have been installed, especially for the transmission of energy to mines.

In mines electricity is invaluable. It is used for moving trams and for working hoists. It lights up and ventilates the galleries, and by pumping keeps them free of water. It operates the drills, picks, stamps, crushers, compressors, and all kinds of machinery. The modern type of induction motor, having neither brushes nor sliding contacts, is free from sparks and safe from dust. Electrical energy is clean, safe, convenient, cheap, and it produces neither refuse nor side products. It is transmitted to considerable distances. In mountainous countries the economical distance is limited by the voltage which insulation can resist; 40,000 volts are being practically used between Provo Canyon and Mercur, in Utah, in transmitting 2,000 h.p. 32 miles. The accompanying Table III. records some interesting installations.

It is effecting a great economy in coal consumption in our workshops and factories. The efficiency of steam-driven shafting is known to be very poor. Scattered steam-engines and long steam-piping run away with money by their continuous waste of energy. The motor is used only when and where it is wanted, its efficiency is very high, and it costs nothing when it is idle. It can be used either for the small power required by machines and tools at present worked by hand, or for a goods locomotive of 2,000 h.p., such as is now being used at Baltimore.

This utilisation of energy at a distance is reinstating many home industries, to the great advantage of the working classes, whose time is wasted in long excursions to the factory, and whose health, morals, and well-being are not improved by herding in great numbers, and by incessant association with the grievance-monger and the professional agitator.

Conclusion.

I have touched lightly—I fear too lightly—upon some of the applications of electricity. I have confined myself, in a very general sense, to those with which I have been personally associated. I have shown how electricity began its beneficent career by protecting our lives and property from the disastrous effects of Nature's dread artillery, how it facilitates intercommunication between mind and mind by economising time and annihilating space. It

> "Speeds the soft intercourse from soul to soul,
> And wafts a sigh from Indus to the Pole."

By its metallic nerves it brings into one fold not only the scattered families of one nation, but all countries and all languages, to the manifest promotion of peace and general goodwill. Not only does it show us how to utilise the waste energies of Nature, but it enables us to direct them to the place where they are most wanted and to use them with the greatest economy. It opens to our view Nature's secret storehouses, presenting us with new elements, new facts, and new treasures. It economises labour and purifies material. It lightens our darkness in more senses than one, and by enabling us to see the unseen, it tends to aid the gentle healing art and to alleviate both suffering and pain. It aids us in the pursuit of truth, and it has exploded the doctrine that the pursuit of truth means the destruction of faith.

I have occupied your time sufficiently I hope to impress upon you the universality of electricity. Its flood-gates were opened when our good Queen ascended the throne, and during her glorious reign it has overflown all the fields cultivated by the engineer. Though its followers are now regarded as specialists, the period is not distant when it must cease to be a speciality. Its facts and tenets, its science and practice, must form the framework of the profession of the engineer. Every engineer must ultimately become an electrician; and electricity will be the most general, the most useful, and the most interesting form in which he applies the fundamental principles of energy to the wants, the comforts, and the happiness of mankind.

At the ordinary meeting on Tuesday, Nov. 15, Mr. W. H. Preece, C.B., F.R.S., president, in the chair, the paper read was on "Electrical Transmission of Power in Mining," by Mr. W. B. Esson, M.I.C.E.

The disadvantages attendant upon expensive transport of ore had been to a large extent neutralised by the electrical transmission of power. By using electrically-transmitted power the crushing mills could be placed at the mine, and the serious expense of transporting the ore to the site of the water power could thus be saved. Generally, electricity furnished the only practicable means for transmitting power for mining operations, and the ease with which a copper wire could be carried over any kind of country, together with the plastic nature of the material,

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rendered the electrical conductor the simplest and most reliable of all vehicles for power transmission.

Before deciding whether power transmission should be adopted, it was generally necessary to compare the cost of the alternative methods of (*a*) bringing fuel to a mine to work the machinery by steam, and (*b*) transmitting power electrically to a mine from a generating station situated at some convenient position for utilising existing water power. The working expenses, added to the interest on the capital invested, made up in both cases the annual cost; but the question as to which alternative should be adopted depended largely upon the hours of working. For working 12 hours a day a result in favour of steam might be shown, while for a 24 hours' day the evidence might be largely in favour of water, depending upon the capital required to be expended in the hydraulic works.

The plant erected at the Sheba Gold Mining Company's mine for the electrical transmission of power to the crushing mills, five miles distant, was described, and the cost of milling was shown to be 1s. 8d. per ton of ore, as against 6s. 1d. per ton when aerial ropeway transport was used, and £1. 12s. 6d. per ton during the time of ox-wagon transport.

The water power was obtained by a dam across the Queen's River, two miles above the generating station, to which the water was conveyed partly in open race and partly in tunnel. The maximum head derived was 32ft. The turbines were of the Victor horizontal type, driving a countershaft at 300 revolutions per minute by ropes, and were together capable of developing 396 h.p. They were provided with Snow governors, acting directly upon the turbine gate.

The generating plant consisted of three alternating-current dynamos supplying current at 3,300 volts. Each generated two alternate currents having a phase difference of 90deg., and was capable of giving an output of 150 e h.p. The armature was stationary, and the field magnets rotated at a speed of 400 revolutions per minute. The stationary high-pressure coils were mounted on laminated iron sectors, which were laid close together in a strong cast-iron cylindrical shell made in halves to form the armature. This was 54in. in internal diameter by 12in. wide, and within it the field magnet rotated. Each coil was wound on a former, and had 63 turns of double cotton-covered wire 0·12in. by 0·09in. in seven layers. The adjacent layers are carefully insulated by micanite cloth, while the complete coil was boiled in paraffin, and was afterwards heavily covered with impregnated tape to a thickness of $\frac{1}{16}$in. In addition, during the process of mounting a trough of fibre was interposed between the coil and the iron core. There were 14 coils on the armature—the seven upper coils being for one phase and the seven lower coils for the other. Each therefore contributed about 470 volts to the circuit. The coils were displaced to give the phase difference by the interposition of idle laminated sectors.

The field magnet was excited by a single coil, and consisted of a steel wheel, from the rim of which projected two series of poles, N on one side of the coil and S on the other. The poles were expanded on the face and were curved to form a circle of 16 alternate faces, which were presented to the armature core, and with an air-gap of 0·33in. The exciting coil was wound on a cast-iron drum placed in the middle, between the projecting poles, and was positively driven by a couple of pins screwed into the steel casting. It terminated in a pair of gunmetal rings lying side by side upon, and insulated from, a substantial cast-iron bush, which in turn was keyed upon the shaft. The exciters were ordinary two-pole upright machines. For throwing the alternators into parallel the incoming alternator was plugged on to the synchronising bars, and when approximate synchronism was indicated by the hot-wire voltmeters it was thrown into the main circuit by closing, through a large choking coil, a path between the synchronising bars and the main omnibus bars. The choking coil prevented a large rush of current, due to difference of phase, between the alternators, though at the same time allowing sufficient current to pass to pull the new machine into step.

The current was transmitted by cables to the mine, and at the receiving house the pressure was reduced to 100 volts for driving motors and lighting the workings. The frequency at which the plant worked was 53·3 per second. The conductors were laid underground, and consisted of concentric cables insulated with impregnated jute covered with lead and armoured. There was no fall of potential due to self-induction in the cables, nor had the current in one pair of conductors any inductive effect on the neighbouring pair. But when overhead wires were employed, the conductors being of necessity some distance apart, there was not only a fall of potential due to self-induction in the lines, but, unless precautions were taken, the mutual induction of the circuits carrying currents of a quarter-phase displacement tended to produce inductive dissymmetry throughout the system. Every length of cable was tested to a pressure of 10,000 volts before leaving the maker's works. Lightning guards were fitted at each end of the line to prevent accidents to the machinery from the effects of the induced charge. At the receiving house there were four transformers of 50 kw. capacity, two for each phase; these reduced the pressure from 3,000 volts to 100 volts. The use of oil for the transformers had been discarded after the experimental trials. The motors were of the induction type; their construction was fully described, and the author also explained their working under varying conditions, and gave a brief account of the laws which governed their action.

The crushing mill at Sheba worked night and day; and in one year, of the possible 365 days of 24 hours each, the pressure had been cut off the conductors for only 4 days 8 hours 22 minutes, which had been chiefly occupied in inspecting the water race, overhauling the belts, ropes, etc., and in executing general repairs to the machinery. The efficiency of the plant from the turbine shafts at the generating station to the motor shafts at the mine might be taken as 70 per cent.

AN AMPERE BALANCE.*

BY PROF. W. E. AYRTON, F.R.S., AND PROF. J. VIRIAMU JONES, F.R.S.

The report of the Committee on Electrical Standards for 1897 ended with the following paragraph: "It thus appears to be a matter of urgent importance that a redetermination of the electro-chemical equivalent of silver should be made, and that the general question of the absolute measurement of electric currents should be investigated. . . ." This work we were asked by the committee to carry out, and a grant of £75 was voted in its aid. We were thus led to examine into the methods which had been employed by Lord Rayleigh, Prof. Mascart, and others, for determining the absolute value of a current, as well as to consider some other methods which have not, as far as we know, been hitherto used.

After much consideration we decided to adopt a form of apparatus which, while generally resembling the type employed by some previous experimenters, possessed certain important differences, and before expending any part of the grant of £75 to construct, without expense to the British Association, the following preliminary ampere balance.

On a vertical cylinder about 17in. high and 6·8in. in diameter we wound two coils about 5in. in height separated by an axial distance of 5in. The coils consisted each of a *single* layer of about 170 convolutions of wire, and were wound in opposite directions. From the beam of a balance there was suspended, inside this cylinder, a light bobbin, about 4in. in diameter, on which was wound a coil about 10in. long, consisting of a *single* layer of 360 convolutions, and the whole apparatus was so adjusted that when the beam of the balance was horizontal the inner and outer coils were co-axial and the top and bottom of the inner suspended coil were respectively in the mean planes of the outer stationary coils.

This arrangement was adopted because with coils consisting of only one layer the geometrical dimensions could be accurately determined, and because the shapes of the coils lent themselves to the use of the convenient formula,

* Paper read before the British Association at Bristol.

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readily expressible in elliptic integrals, for the force, F, between a uniform cylindrical current sheet and a co-axial helix—viz.:

$$F = \gamma \gamma_h (M_1 - M_2),$$

where γ is the current per unit length of the current sheet, γ_h the current in the helix, and M_1 and M_2 the coefficients of mutual induction of the helix and the circular ends of the current sheet.*

The value of a particular current of about 0·63 ampere having been determined *absolutely* by means of this apparatus, the rate at which it would deposit silver under specified conditions was ascertained indirectly by observing its silver value on a Kelvin balance, which had been kept screwed down in a fixed position for several years past, and which had been calibrated many times during that period by reference to the silver voltameter.

The result of this preliminary investigation showed that the silver value of the *true* ampere was so nearly equal to the reputed value—viz., 1·118 milligrammes per second—as to require the use of an apparatus still more perfectly constructed, and therefore of a much more expensive character to enable the error, if any, in this value to be ascertained with accuracy.

We therefore started on the design of the instrument, of which we now submit the working drawings, and for the future construction of which we would ask for a grant of £300, including the unexpended grant of £75 voted last year.† And we anticipate that this new piece of apparatus may prove worthy of constituting a national ampere balance, the counterpoise weight for which will be determined purely by calculation based on the dimensions of the instrument, the number of convolutions of wire in the three coils, and the value of the acceleration of gravity at the place where the instrument may be permanently set up. In this particular it will differ entirely from the "Board of Trade ampere standard verified, 1894," which has had its counterpoise weight adjusted so that the beam is horizontal when a current passes through the instrument, which will deposit *exactly* 1·118 milligrammes of silver per second under specified conditions. In fact, the proposed ampere balance and the existing ampere standard will differ exactly in the same way as do a Lorenz apparatus and the "Board of Trade ohm standard verified, 1894."

We have to express our thanks to Mr. Mather for taking charge of the construction and use of the preliminary apparatus, for checking all the calculations in connection with the determination of the electro-chemical equivalent of silver that was made with it, as well as for superintending the making of the working drawings of the new ampere balance. We have also to thank Messrs. W. H. Derriman and W. M. Wilson, two of the students of the City and Guilds Central Technical College, for their cordial assistance in carrying out the work.

ELECTRIC TRACTION.‡

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE IV.

At the commencement of this course of lectures I reminded you that it would be impossible in so short a time as we have at our disposal to cover any but a small part of the wide field of electric traction, so I propose to-night to take up one of the many questions that might engage our attention, and to confine my remarks entirely to the discussion of a problem that has already presented itself for solution to electrical engineers.

A good illustration of this problem is to be found in the new Central London Railway. Heavy trains have to be started from rest and moved through comparatively short distances in correspondingly short times. Full speed is rarely, if ever, reached. The whole process consists of getting up speed and then putting on the brakes.

In the case of the particular railway that I have quoted the trains weigh about 150 tons, and have to cover an average distance, from station to station, of rather less than half a mile, in a time, including stops at the station, of about 115 seconds.

You will at once see that this is an entirely new problem. The old methods by which we designed a motor to run at a uniform speed will be of no service to us here. The question turns entirely upon the action of the motor during the period of acceleration. Since the speed is continually varying, it will be of no use to define the horse-power of the motors, as may be done when the speed is uniform. We have to design an equipment that will start the train from rest, and carry it through the given distance in the given time. I propose then to direct your attention this evening to some principles which should guide us in designing motors to fulfil these peculiar conditions.

And first let me state briefly the problem and the data that we have given to us. We have W, the weight of the train in tons; this has to be moved through a distance of D feet in t seconds from start to stop. We know the resistance to motion, including track and gear friction; we have the tension of the line in volts, and the internal drop in the motors at full speed.

I should like to make it clear to you that we have not simply got to design the motor or motors—that is only one part of our problem—we have to design a complete equipment. Let me explain what I mean by that term. I mean that the subject of our consideration is the complete apparatus upon which the motion of the train depends. You will see at once that the motion of the train depends quite as much on the diameter of the driving wheel, for instance, as upon the speed of the motor. It also depends equally upon the ratio of the gearing. I hope that before the end of the lecture I may have shown you that these three quantities are all possible variants, so to speak, in our problem, and that successful design depends upon the proper choice of all three.

I prefer, then, to speak of the design of an equipment, including in that expression (1) the motor itself, (2) the driving wheel, and (3) the gearing. We are, or should be, at liberty to adjust all these in order to get the best results. Unfortunately it is very often the case that certain restrictions are imposed upon the designer by those who are in ignorance of the real elements of successful design, and who think that the question of the design of the motors is quite the last thing to be considered.

For instance, there may be some latent prejudice against the use of gearing, and this may be prescribed in the specification; this may so curtail the powers of the designer that motors may have to be installed resulting in a permanent loss of 10 or even 20 per cent. of energy. Again, in the case of tunnels, the head-room may be so restricted that it may be impossible to use driving wheels of the right diameter. When the engineers were deciding upon the size of the tunnels, they probably never thought for a moment that the economy of running might depend upon the available head-room.

In the preceding lectures I have used d to denote the diameter of the driving wheels, v the velocity ratio, and M the induction factor of the motor. I shall adhere to these symbols throughout. We may now consider ourselves at liberty to adopt any value for any of these quantities, our aim being to comply with the specification as to time and distance in the best possible manner.

And here I must answer a question that will occur to you when I use the expression, "the best possible manner." What do I mean by this? What is to be our standard of excellence of design? In designing a motor for ordinary work we look to the efficiency, and specify that the motor shall run with a given load at such an efficiency. In the problem before us such a statement would be meaningless, since the motors rarely, if ever, attain their full speed, and for most of the time are accelerating and, consequently, running with an efficiency that may be anything down to zero at the moment when motion commences. Hence, to specify that the motors must give such a horse-power at such a speed with such an efficiency, though it may secure that efficiency at that speed, leaves the much larger question of the economy of the whole performance entirely vague.

The best way to state the efficiency question in such a case as this is to say that the whole performance, from start to stop, requires so much energy. This may be conveniently put in the form of so many foot-pounds or watt-hours of energy per ton-mile. Of course, this leaves out of account altogether the efficiency at any particular speed, but it states the really important thing for us to know. It is of no use specifying a high efficiency at a certain speed when the economy of running may be anything from 80 to 160 watt-hours per ton-mile.

But there is another aspect of the question which you must not overlook, which is that to specify beforehand the horse-power and speed of the motors, as in the case of a line where uniform speed is the rule and not the exception, is to impose most serious limitations on the designer, and to oblige him to adopt a design that may be 20 or 30 per cent. less economical than would be possible without such restrictions. In discussing our problem, then, I shall assume that we are quite free from

* *Proceedings* of the Royal Society, vol. 63, "On the Calculation of the Coefficient of Mutual Induction of a Circle and a Co-axial Helix, and of the Electromagnetic Force between a Helical Current and a Uniform Co-axial Circular Cylindrical Current Sheet," by Prof. J. V. Jones.

† This grant of £300 has since been made.

‡ Cantor lectures, delivered before the Society of Arts,

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all requirements as to horse-power and speed, and that we are at liberty to select those values of M, v, and d that give us the best results when expressed in terms of watt-hours per ton-mile.

Let us now take each of these three quantities and see how far they influence the final speed of the train or car when uniform speed has been attained. If we denote by s the speed of the car in feet per second, we see that if M and v are constant, s will increase with d—*i.e.*, the speed will increase with the diameter of the driving wheel. So that if the whole of the rest of the equipment is unaltered, an increase in the diameter of the driving wheel will mean an increase in the final speed. On the other hand, it is obvious that if d is kept constant, the final speed will diminish as M is increased, and will also diminish as v is increased. Hence we can say that s varies as $\frac{d}{M\,v}$. Now if the tension of the line is constant and the drop at full speed given—*i.e.*, if we are at liberty to adjust R—the resistance of the motor, so that whatever the current at full speed may be the drop is the same, then the induced volts, which we may denote by e, is also constant. Thus our equation for the speed may be written, s varies as $\frac{d\,e}{M\,v}$. To make this equation of use for actual calculation we must select the proper numerical constant, and we obtain finally—

$$s = 0{\cdot}262\,\frac{d\,e}{M\,v} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This equation tells us exactly how the final uniform speed is affected by any alteration in any of the quantities M, v, or d.

with this equipment is shown in Fig. 26, that is now on the screen before you. We may suppose the curve terminates where the enclosed area equals 200 yards—*i.e.*, the car will then have covered a distance of 200 yards.

Now what will be the effect of altering the diameter of the driving wheel, say, to 30in., without making any other change? From our equations we see at once that the acceleration will be increased from 1·5 to 2·0 feet per second per second, but the final speed will be reduced from 30ft. to 22·5ft. per second. The acceleration curve is thus completely altered, and you will notice that precisely the same change could have been effected by a proportional increase in either M or v, since the ratio $\frac{M\,v}{d}$ enters into both our equations.

I have drawn the acceleration curve with the 30in. wheel until the area enclosed is the same as it was with the 40in. wheel—*i.e.*, until the car has covered a distance of 200 yards—and you see that the time of covering this distance has been increased from 30 to 32 seconds. A 20in. wheel would take 43 seconds to cover the same distance, and a 10in. wheel would take nearly 100 seconds.

The points on the acceleration curves giving the time required to cover equal distances lie on a curve that we shall call a time curve. You see from the figure that this curve is convex to the speed axis—that is to say, there is a certain value for the diameter of the driving wheel that covers the distance in a shorter time than any other. In this case the best diameter is 40in., ior you see that a 50in. wheel again takes a longer time. Hence with this particular equipment a 40in. wheel will cover 200 yards in a shorter time than any other wheel. You must, however, observe that for any other distance 40in. will not be the best diameter; thus for 400 yards the best diameter is 50in.

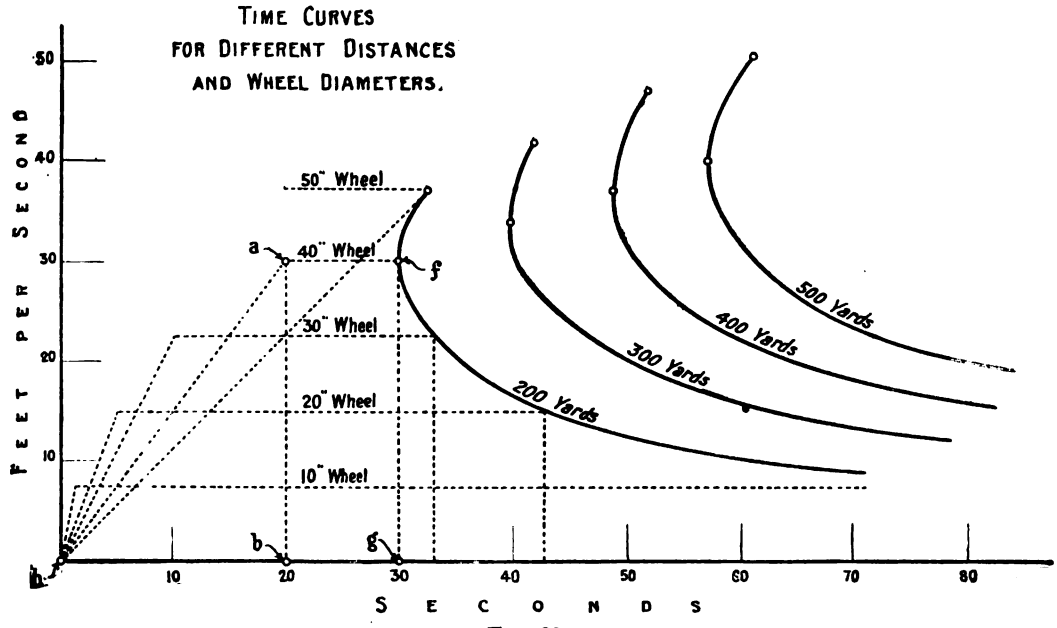

FIG. 26.

Now, how do variations in these same quantities affect the rate at which uniform speed is attained? That is to say, if we alter d, for instance, what will be the effect on the acceleration? You will see at once that an increase in the diameter of the driving wheel will diminish the acceleration, other things remaining the same. Similarly an increase in M will increase the acceleration, so will also an increase in v, so that if W, the weight of the car, is given, and C_a the current available for acceleration, we know that a, the acceleration, varies as $\frac{M\,v}{d}\,\frac{C_a}{W}$. If you want to use this relation in your calculations you must select the right numerical constant. Since a is expressed in feet per second per second, the constant will be 0·04, and we have the equation—

$$a = 0{\cdot}04\,\frac{M\,v}{d}\,\frac{C_a}{W} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

You are now in possession of complete information as to the effect upon the curve of acceleration of any change in the values of M, v, or d. Imagine to yourself an equipment of any kind you please. With a given accelerating current your car will start with an acceleration given by equation (2), and will speed up with that acceleration practically until full speed is reached, this speed being given by equation (1). Suppose that your car is so equipped that it speeds up with an acceleration of 1·5 feet per second per second on a 40in. wheel, the final speed being 30ft. per second. The acceleration curve

If you examine the acceleration curve for the 40in. wheel more closely, you will see that of the whole 200 yards one-half is covered during the process of aceeleration and one-half at full speed. Now this gives us a very important result—namely, that to cover a given distance in the shortest time our equipment must be so designed that one-half the distance is covered when running at full speed, the time of full-speed running being necessarily one-third of the whole time. It follows from this that when we have to cover a given distance in a given time, we shall do so with least accelerating current when half the given distance is covered at full speed in one-third the given time.

To make this clearer, let us take a definite case. Suppose that we have to design an equipment that will start a car weighing 10 tons and carry it through 600ft. in 40 seconds. Two motors are to be used connected in parallel throughout; the tension of the line is 500 volts. The drop at full speed is to be nine volts. The frictional and other forces retarding the motion amount to 3,580 inch-pounds of torque on each axle.

Tramway Cost.—We are compelled to hold over an interesting article on this subject from our New York contemporary, the *Street Railway Journal*, with Mr. J. Allen Baker's comment on the same.—ED. *E. E.*

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SHOREDITCH.

The number of people who have been anxiously awaiting the official figures of the Shoreditch installation is very large, but it is doubtful if they will be perfectly satisfied now they have the figures. Far too much has been promised and expected from Shoreditch, and we think that the figures ought rather to be read as a promise of the future than as a fulfilment of the past. It will be only recapitulating what has been said before if we point out the unbusinesslike method of procedure in expecting a handsome profit to commence with the first day's work, or even the first year's work, of any installation. An installation of electric light really does not arrive at a normal condition of working during its first year. Experience teaches a lot of things during the first season of heavy load, and that experience is used to lessen the troubles of succeeding seasons of heavy load. But we need not enter into the discussion of these questions. Our readers are familiar with them. What we have to do now is to direct attention to the figures of Shoreditch. However they be examined—and they may and should be criticised severely—they show excellent promise for the future. Mr. Kershaw distinctly affirms that the figures are not those of a balance-sheet—only those of a trading account. If a balance-sheet were aimed at, we should object to various items, but with a trading account it is but right to enter cross items so that they may be examined. Reading the two accounts, it will be seen that a loss of one thousand seven hundred and fifty-eight pounds is shown against the destructor. The report explains that "with regard to this debit balance of one thousand seven hundred and fifty-eight pounds, this is represented by steam used in the lighting station, library," etc. It would have been better, perhaps, to have incorporated in the accounts the cost of the steam used in the lighting station. This would have correspondingly reduced the debit balance against the destructor, and would not have reversed the balance of the light installation. We cannot agree with Mr. Baker in assuming certain figures as to bank balances, nor do we think that any criticism should be hurled against what has previously been claimed. The figures are now given officially, and they show that the installation is effective, and has not only paid its expenses, but has paid two thousand six hundred pounds interest and redemption during its first year of work—an achievement that has seldom or never been equalled. This is an exceedingly good result, and, as we say, the best view is to take it as an exceedingly good promise for the future. In the official accounts, again, we do not notice any items for interest and repayment on account of the dust destructor, but the joint committee recommended that this amount—one thousand four hundred and thirty-five pounds—should be paid out of the general rate. Finally, even Mr. Baker admits that there is a balance of income over expenditure of three hundred and forty-four pounds. When we see that an income of over eight thousand pounds has been earned in the year from sale of current,

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that expenses, interest, and repayments have been paid, and that (taking into consideration the one thousand four hundred and thirty-five pounds just mentioned) there is a favourable balance for this combined scheme, there is no doubt but that Shoreditch may claim its work to have been eminently successful.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SHOREDITCH JOINT SCHEME.—ELECTRIC LIGHTING AND DUST UTILISATION.

SIR,—Referring to the recent controversy on this question, the items for the year June 24, 1897, to June 24, 1898, showing the income and expenditure, are now before me, and I find the following to be the correct reading of them as a joint scheme:

Revenue Accounts for the Financial Year from June 24, 1897, to June 24, 1898.

(1) ELECTRICITY WORKS.

Dr. Expenditure.	£	s.	d.
Coal (490 tons, £432. 15s. 9d.), stores, water, and insurance	1,328	19	9
Wages (562,167 units)	1,472	13	10
Engineer's salary (proportion) and expenses	469	10	9
Parochial rates, £125. 2s.; and sub-station ditto, £33. 10s. 3d.	158	12	3
Interest and redemption	2,641	13	1
Ditto on temporary loan (overdraft from bank)	815	9	4
Balance carried down	1,707	16	0
	£8,504	15	0

Cr. Income.	£	s.	d.
Sales of current to consumers, etc.	8,254	2	1
Miscellaneous income	120	4	7
Sales of stores to other departments	130	8	4
	£8,504	15	0

Dr. (2) DUST DESTRUCTOR STATION.	£	s.	d.
Wages (25,404 tons)	2,746	1	7
Engineer's salary (proportion)	83	6	8
Stores and charges	411	16	4
Cost of removing clinkers	612	10	5
Insurance	43	4	2
Interest and redemption	1,435	13	4
Ditto on temporary loan (bank overdraft)	79	10	4
Balance carried down	344	9	2
	£5,756	12	0

Cr.	£	s.	d.
Balance of income brought down	1,707	16	0
Destroying trade refuse	238	1	9
Amount of money saved by use of dust destructor instead of the old method of barging the refuse (25,404 tons at 3s.)	3,810	14	3
	£5,756	12	0

Balance of income over expenditure £344 9s. 2d., exclusive of the following items and charges—viz., depreciation and bad debts; also management charges, such as proportion of salaries of vestry clerk, accountant's department, collectors, etc., estimated by the London County Council valuer to be at least £500 per annum (see official minutes.)

I note that these items do not emanate from the accountant of the Vestry, but from the Electric Lighting Committee, although individually I have reason to believe them to be correct.

I will leave the results to the judgment of your readers to find where the profit occurs of £2,000 and upwards that has been claimed for this joint undertaking, and enlighten some other public authorities.—Yours, etc.,

T. E. BAKER.

Broad-street House, E.C., Nov. 15, 1898.

P.S.—I have taken the bank overdrafts as they occur at March, and assume them to be the same in June.

FORTHCOMING EVENTS.

FRIDAY, NOV. 18.

Institution of Civil Engineers.—Students' meeting, at 8 p.m. "The Production of Liquid Air, and its Application to Chemical and Other Industries," by Cecil Lightfoot, Stud. Inst. C.E.

North-East Coast Institution.—At Lit. and Phil., Newcastle-on-Tyne, at 7.30 p.m., "Some Features of the Repairs and Construction of Iron and Steel Ships," by M. W. Aisbitt.

MONDAY, NOV. 21.

Society of Arts.—At 8 p.m., Cantor Lecture by Prof. Vivian B. Lewes on Acetylene. First of four lectures.

Rontgen Society.—Conversazione in St. Martin's Town Hall from 8.30 to 12.

TUESDAY, NOV. 22.

Institution of Civil Engineers.—At 8 p.m., discussion on Mr. W. B. Esson's paper on "Electrical Transmission of Power in Mining."

WEDNESDAY, NOV. 23.

Society of Arts.—At 8 p.m., "Long-Distance Transmission of Electric Power," by Prof. Geo. Forbes, F.R.S.

THURSDAY, NOV. 24.

Institution of Electrical Engineers.—At the Institution of Civil Engineers, at 8 p.m., discussion on Prof. Silvanus P. Thompson's paper on Rotatory Converters.

City of London Tradesmen's Club.—At the Albion Hotel at 7 p.m., Mr. T. H. Brorke Hitching, president, on "Shall London Purchase the Undertaking of the City of London Electric Light Company."

FRIDAY, NOV. 25.

Physical Society.—At Burlington House, at 5 p.m. "On the Properties of Liquid Mixtures," by R. A. Lehfeldt; and "On certain Diffraction Fringes as applied to Micrometric Observations," by L. N. G. Filon.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 10.

Before the reading by Prof. S. P. Thompson of his paper on "Rotatory Conductors," the PRESIDENT (Mr. J. W. Swan) spoke in touching terms of the loss the Institution had sustained since the last session by the deaths of Dr. J. Hopkinson and Mr. Latimer Clark. Both these gentlemen, he said, were past-presidents of the Institution, and both were shining lights in the electrical world. Mr. Clark was one of the pioneers of the electrical industry, and for a great many years had been identified with telegraphy. His labours were not, however, confined to this alone, but were spread over many other fields of invention. By the death of Dr. Hopkinson the Institution had lost one of its brightest lights. His earliest papers were connected with glass lenses for lighthouses, after which he prepared papers relating to the adaptation of the electric light to lighthouses. In a later paper he gave his ideas about dynamos, and in its practical results this paper was the most important he ever prepared, it, in a great measure, leading to the construction of the present dynamo. He was a real engineer-philanthropist in this matter, as he never received any payment for the information which resulted so beneficially to everyone in the production of the dynamo. He was as thorough a sportsman as he was an engineer, and it was in pursuit of one of his favourite sports that he was cut off in his prime.

Mr. H. A. TAYLOR then spoke, and said that he had been very intimately connected with Mr. Latimer Clark in his submarine work. He had been with him in the wreck of the liner "Carnatic," which nearly ended disastrously for both of them. Mr. Clark had done great work, and had produced, after many experiments, the Clark cell. In a partnership lasting for 25 years he never had a cross word with him, and he never knew Mr. Clark to say an unkind word to any human being.

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Rotatory Converters.

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.,
VICE-PRESIDENT.

(*Continued from page 629.*)

Examination of these diagrams shows several interesting points. At the instant when the alternating current is reversing, and has zero value (at position 0deg.), the armature is operating simply as a motor with 50 amperes in each half of the winding, and is being accelerated. At the 90deg. position, when the alternating current is at its maximum (200 amperes), the armature is operating wholly as a generator, and with an equal current of 50 amperes in each half of the winding, and the acceleration is negative. The armature is thus adding 100 amperes to the 100 amperes coming in from the primary mains. Nothing has here been allowed for the extra power needed to make up for the frictional and other losses. Suppose that an additional four amperes were needed for this, making 104 amperes as the motor current: in position 0deg. the two downward currents would be 52 each instead of 50, increasing the positive acceleration; in position 90deg. the upward currents would be 48 instead of 50, decreasing the negative acceleration. The output current at that instant would still be 200, being made up of 104 incoming plus 96 generated in the windings.

On further examining these diagrams it will be seen that the currents in the armature windings consist of a set of four currents, each in position 0deg. being 50 amperes. But as the armature turns these change. They increase in the two arcs that are shortening as the points where the slip-ring connectors approach toward the positions occupied by the commutating brushes. But in the two other arcs that are lengthening, the currents first decrease to zero, then increase again to 50. Further, the individual coils in different parts of the ring winding have very different currents to carry. A coil that is midway along the winding between the two connectors has to carry never more than 50 amperes. Four times in each revolution it carries 50, and four times it carries 0 amperes, with values intermediate in intermediate positions. (This will obviously set up four armature reactions in each period.) But a coil that is situated next to either of the two connectors has to carry a current which when it is close to the brush position rises to a maximum of 150 amperes, and changes abruptly to 50 in passing the brush; rising thus gradually twice to 150, or else rising twice abruptly from 50 to 150, and being zero twice, in one revolution. The necessary consequence of this is that the coils which are close to the slip-ring connectors are much more heated than those which lie midway along the periphery between the connectors. The distribution of the heating is here quite different from that which would obtain in either armature of the motor-dynamo machine (Fig. 3). This unequally distributed heating effect is in total somewhat greater than that in the same armature if used purely as a continuous-current motor or generator, but is less than the total heating effect (for equal power) if used purely as single-phase generator or motor; the ratios of the heating being as 1 : 1·366 : 2 in the three cases. Or, if we consider the output of an armature to be limited by equal heating effects, the several outputs which would give equal total heating in the same armature would be: as continuous-current generator or motor only, 100 kw.; as single-phase generator or motor only, 50; as single-phase converter, 85 kw. Fig. 6 exhibits this unequal heating effect in the case of a single-phase converter. The first line represents graphically by the outline diagram the varying current (irrespective of direction) which a coil midway between the connectors will carry in one revolution; and the outline curve of the darkened area within it is drawn with ordinates squared so as to be proportional to the heating effect at different instants. The total area blackened represents the total heating effect in that coil. The second line represents similarly the current and heating for a coil 30deg. further towards the connector. The third line represents current and heating for a coil 60deg. further. Whilst the fourth line represents similarly the current and heating in a coil that is next to the connector. The relative heatings in these four coils are about in the proportions 10, 21, 50, 86. The curves in the fifth line depict the case of one of the coils next to a connector when there is, in consequence of self-induction in the circuit, a lag of 30deg. in the phase of the current. The result of such phase difference is an increase of heating for the whole armature, but an extra increase for those coils which are near the connectors.

We may now pause to consider what differences will be made in the preceding considerations if the distribution of the magnetic flux around the periphery of the armature does not follow a sine law. It will be noticed that when any arc of the winding (and this applies to two-phase and three-phase cases) lying between two slip-ring connectors is acting as generator, it produces its greatest E.M.F. when its mid-point is passing the mid-point of any pole. Hence, if the poles are narrowed so as to concentrate the field, even though the average E.M.F. for continuous-current purposes remains unchanged, the root mean square value of the E.M.F. will be increased, and the curve of induced E.M.F.'s will be more peaked than a sine curve. If the machine is being used to convert continuous current into

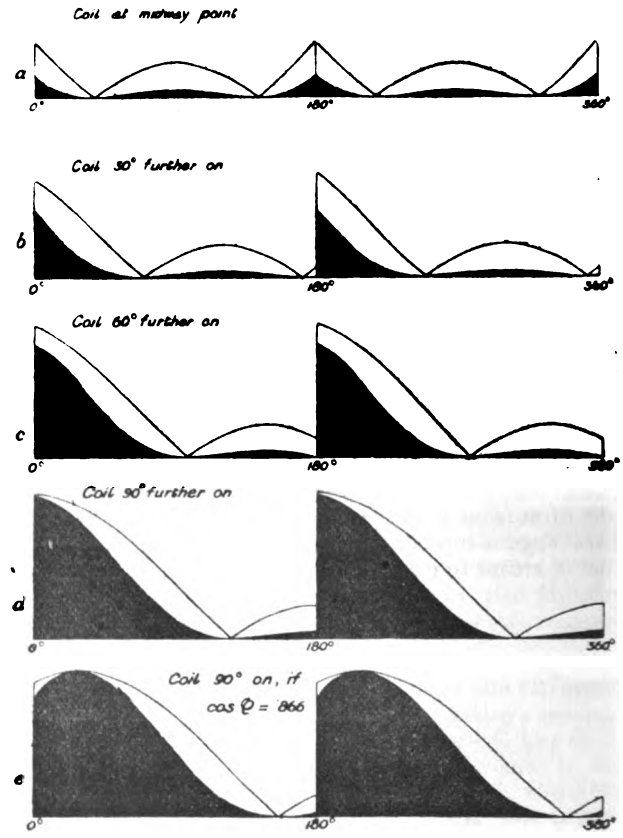

FIG. 6.

alternating, the effect will be to raise the relative alternating voltage and lower the relative alternating current, and on a non-inductive circuit the current also will have a more peaked curve. If the machine is being used to convert alternating into continuous currents the converse result takes place, the relative value of the alternating voltage being lowered. An eight-pole converter at the Technical College, Finsbury, constructed in 1891 by the Allgemeine Elektricitäts, of Berlin, has a curve of induction which is remarkably close to a sine curve, and its relative voltage for continuous and three-phase currents is practically identical with the theoretical value. Herr Friese, in the article already referred to, gives the following tabular comparison for three machines with ring armatures constructed by Messrs. Schuckert:

Nature of service.	Voltages as measured — Machine No. 1.	Machine No. 2.	Machine No. 3.	Voltage calculated.
Continuous current	100	100	100	(100)
Single-phase	71·0	71·8	—	70·7
Three-phase	61·3	62·0	61 8	61·2
Two-phase	71·0	71·8	—	70·7
Four-phase	49·8	50·7	—	50·0
Six-phase	35·0	35·8	—	35·4

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M. Hanappe has published a careful analysis of a Schuckert converter, capable of yielding alternating currents in one, two, three, four, or six phases, and suitable for laboratory experiments.

If the machine is being used to convert a single-phase current into a continuous one, the form of the impressed voltage curve, and the distribution of the flux around the periphery, are of even greater importance. The current delivered, though certainly continuous, will not be uniform, but will have a periodic fluctuation superimposed upon it by departures from the sine law. Armature reactions will, as we have seen above, impose fluctuations of a frequency double that of the primary current. Indeed, in any case the single-phase converter is a less satisfactory apparatus from several points of view than the two-phase or the three-phase converter. It has more considerable variations of armature reaction, a greater and more unequable heating, and requires a more accurate setting of the commutator brushes than the polyphase converters. Moreover, it is not self-starting from the alternate-current side. Notwithstanding these disadvantages, single-phase converters are in satisfactory use—for example, several constructed by the Elektrizitäts-Aktiengesellschaft (Schuckert and Co.) are in operation on the city circuit at Cologne.

A single-phase converter when standing still can act partly as a mere stationary transformer. When running at a certain speed in a field with a given number of poles it will act as a converter, converting into continuous current those currents only which come to it with a frequency corresponding to the frequency of the movement of revolving conductors past the poles. Any alternating currents or components of alternating current of any other frequency that may be superposed can affect the continuous-current output at the other side by producing superposed fluctuations.

Passing on then to the case of the two-phase converter, we may at once apply the same principle of superposition of instantaneous currents to study the flow of current through the windings. Fig. 7, which gives the corresponding series of diagrams, requires no further explanation. The generator action during one-eighth of a revolution is illustrated by the four figures on the right of the upper line. The superposed action is exhibited in the lower line. Inductive reactions and energy losses are, as before, supposed to be absent. In position 0deg. the converter is acting neither as motor nor as generator, the current at that instant simply running through from the commutator to the slip-rings. In the position 15deg. it is observed that the currents in the armature windings consist of six sets. Two short portions are carrying a motor current of 85·35 amperes each; two others of somewhat longer arc are carrying a motor current of 14·65 amperes; whilst two quadrantal parts are delivering generator currents of 11·24 amperes. On the whole, in this position the armature is acting as motor, increasing the acceleration. In the next position, at 30deg., the motor action has decreased. In the position at 45deg. the action is chiefly generator, the current in that part of the field which is strongest being at its maximum and flowing with the E.M.F. It will again be noted that the currents in those coils of the armature which lie close to any of the four connectors will be more heated than those midway along the intervening quadrants; the maximum current for the former being 100, for the latter 50. The inequality of the heating is much less, however, than in the single-phase armature. Also armature reactions are more nearly balanced throughout, and there is much less tendency to impart a periodic fluctuation to the continuous current. Such machines will be self-starting, and will give little trouble from sparking at the commutator.

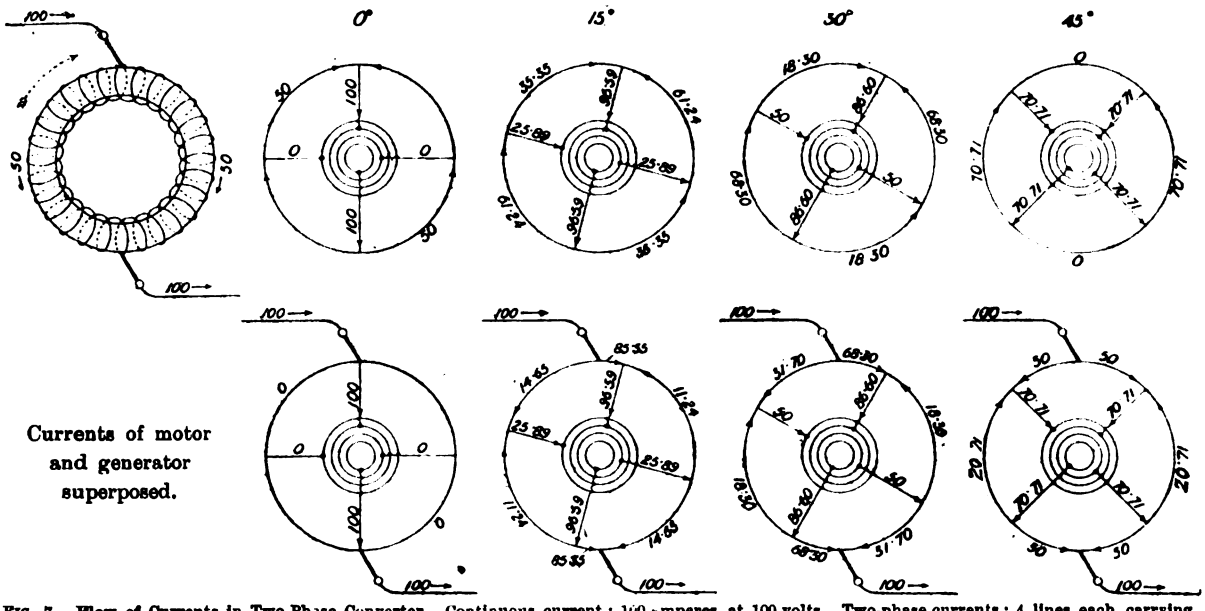

FIG. 7.—Flow of Currents in Two-Phase Converter. Continuous current: 100 amperes, at 100 volts. Two-phase currents: 4 lines each carrying 70·7 virtual amperes; line voltage, 50 virtual volts.

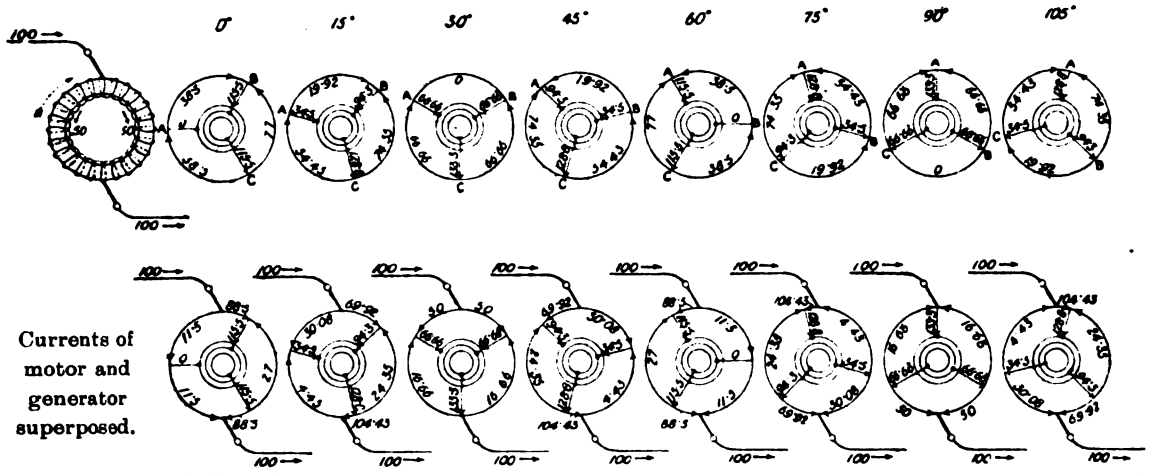

FIG. 8.—Flow of Currents in Three-Phase Converter. Continuous current: 100 amperes, at 100 volts. Three-phase current: 3 lines each 94·3 virtual amperes; line voltage, 61·2 virtual volts.

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Fig. 8 exhibits the flow of currents in the armature of a three-phase converter. Comparison of the successive positions will bring out several points. The current in any one of the three lines is at its maximum (on a non-inductive circuit when generator, or when, as motor, the field has normal excitation) when the connector for that line is just passing a commutator brush; and its maximum is $1\frac{1}{2}$ times the continuous current. In certain positions of symmetry—for example, in position 30deg.—the motor and generator actions resulting from the flow are bilaterally similar. In other positions—for example, in position 0deg.—one side (the left here) is acting wholly as motor, the other side partly as generator and partly as motor. A coil which lies midway between two connector ends will carry a current that has a maximum of 27 in one part of its revolution, and another maximum of 50 in another part of its revolution; there being two each of these maxima in one revolution. A coil situated close to a connector has 133·3 as its maximum twice in each revolution, with an abrupt change to or from 16·66 just as it passes the brush. The inequality of heating of coils is less in a three-phase converter than in a single-phase, but it is greater than in a two-phase converter. The inequality of heating in the case of two-phase converters has recently been examined analytically by Messrs. Woodbridge and Child in recent numbers of the *Electrical World* (Jan. 1 and Feb. 12, 1898). Their paper, which is one of great skill, concludes with the interesting deduction that, assuming a power factor of unity, if such a converter is driven mechanically so as to be generating both a continuous and a two-phase current at the same time, the heating of the armature will be less than would be the case if with same output it were used as either a continuous-current generator alone or a two-phase generator alone.

Amongst Continental firms Messrs. Alioth, of Basle, have been prominent in the application in the industry of rotatory converters, which they designate as *commutatrices*. Mr. R. B. Ritter, one of their engineers, has kindly furnished many particulars of these machines and of their application. Articles by him on this subject have appeared in *L'Industrie Electrique* for 1896. He points out that in the application of these machines to charge accumulators from an alternating-current supply means are necessary for changing the voltage as between charge and discharge. There are several ways of meeting this need—by the use of choking coils, or of auto-transformers of variable ratio in the alternating side of the circuit, or by throwing in or out of circuit of a supplementary armature. The solution preferred by M. Ritter is the latter, a small auxiliary continuous-current machine in series with the continuous-current side being either mounted on the same shaft or driven by a pulley from it. The desired variations of voltage can be obtained by varying the excitation of the separate field magnet provided for this auxilary machine.

A large 100-kw. two-phase converter, constructed by Messrs. Alioth for Geneva, is described in the *Electrician* of Jan. 8, 1897, with sectional drawings. This is a 14-pole ring armature machine, having an armature 1m. in diameter, running at 385 revolutions per minute. As it is designed to supply continuous currents to a three-wire distribution, it is wound with two independent converter windings, each capable of supplying 450 amperes at 110 volts, and is furnished with four slip-rings, and with a commntator at each end. It has an efficiency of 90 per cent.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

116. What is the relative efficiency of belt driving as compared with rope driving? Compare three kinds of belts—viz., solid, link, and balata—with three kinds of ropes—viz., cotton, manilla, and solid leather (square).—H. B. S.

117. Compare the efficiencies and life of incandescent lamps of large and small candle-powers respectively.—P. T.

ANSWERS.

Question No. 110.—Is it better to use motor-generators or accumulators as "boosters" at the end of feeders in electric traction work?

Best Answer to No. 110 (*awarded* 10*s.*).—In deciding on a matter of this character it is advisable to take into consideration the various circumstances of the case—viz., (1) capital outlay; (2) the working of the generating plant at the main station; (3) efficiency; (4) reliability.

The adoption of accumulators in electric traction work is of recent date, and practically no reliable information as to the working of such plant has as yet been given. So far, however, accumulators have not been used as "boosters" in the correct sense of the word, but more in the character of "stand-by" plant, and, further, the use to which a motor-generator is put is usually rather that of a transformer than a booster.

Whichever plant be adopted, mains or feeders will be required to transmit the requisite energy. The cost of these may therefore be taken as being the same in either case. Assuming that an output of 25 kw. at 500 volts is required at the feeding point, a motor-generator capable of supplying this demand would cost about three-fifths of the cost of a battery of the same kilowatt capacity. (The cost of buildings or chambers is not included in the above ratio.)

The question now becomes, "What is to be gained by adopting accumulators?" In the majority of systems now at work in this country the effects of the fluctuations in the load are thrown directly upon the engines driving the generating plant, and unless means of minimising these effects are utilised, the maintenance and repairs of the plant, together with possible interruptions of the traction system, soon assume a serious aspect. Experience has shown that a battery of accumulators coupled up in parallel with the main generator on to the traction system, acts as a very serviceable "buffer" between the cars or "trains" and the engines, and obviates to a very great extent the effects of the variations of the demand. The manner in which the accumulators act is as follows: As soon as there is a heavy demand for current—*i.e.*, a number of motors starting up—the E.M.F. between the positive conductor of the system and earth immediately falls, the cells thereupon commence discharging, and being in parallel with the main generator materially aid the latter to maintain the usual working pressure on the system. When there is little or no demand the E.M.F. is consequently high, and the cells automatically commence to charge up, continuing to do so until they are either at the same E.M.F. as the system, or are again called upon to aid in supplying a sudden demand.

The working efficiency of accumulators cannot be maintained as high as that of a motor-generator; and this point, together with the relative efficiencies of the two plants, should be considered. The efficiency of accumulators usually falls (due to deterioration) more rapidly than the efficiency of a motor-generator falls, due to wear and tear.

Accumulators may always be looked upon as a comparatively safe "stand-by" in cases of emergency, thereby helping to keep up a reliable service on the system. A battery is available for use, when charged, at any moment, and, if of suitable capacity, could supply a traction system for a reasonable period, in event of a breakdown or other trouble at the generating station. It can also maintain a light-load traction service—*i.e.*, in early morning and late at night—when it would be unnecessary, as well as expensive, to run the station plant on a light load. Taking a summary of the relative advantages and disadvantages in capital outlay, efficiency, and maintenance, the advantage is undoubtedly with the motor-generator; on the other

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hand, for smooth working, reliability, and for a ready stand-by, adopt accumulators.—H. B. S.

Answer to No. 110 (*awarded* 5*s.*).—Figs. 1 and 2 show roughly the two cases that we have to consider. Suppose, for example, that the line is 10 miles long, then it would be a good arrangement to have the central station at the centre and a sub-station at each end of the line. On comparing the two diagrams, we see that when accumulators are used we only need to take a single feeder from the central station to the sub-station instead of two feeders when a motor-generator is employed. Let us suppose for the present that the efficiency of the motor-generator and the battery is the same. In this case, if the sub-stations

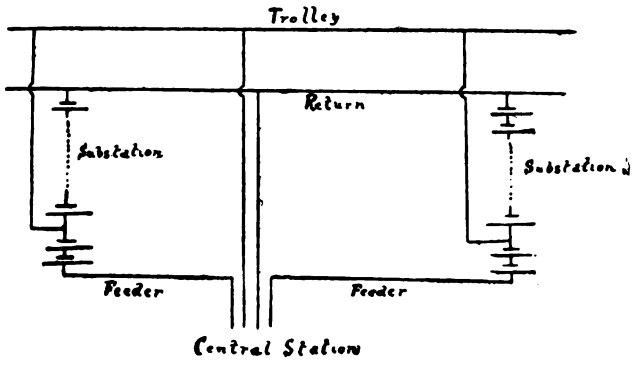

FIG. 1.

were near the central station it would be more economical to employ accumulators; but if they were far off, then the saving in copper due to the higher voltage we can employ with the motor-generator will more than compensate for the increased expense of a well-insulated twin cable, and it would be better to use motor-generators.

When batteries are employed at sub-stations, as in the Leeds and Douglas and Laxey tramways, then complicated automatic charging and discharging switches must be used. One switch is used for charging cells and automatically cutting out the regulating cells when fully charged, and another is used for keeping the potential difference between the overhead conductor and the rail constant at 500 volts. At Hamburg batteries are used at sub-stations, but, in addition, small motor-generators are employed for the purpose of regulation. It will be seen, then, that accumulator sub-stations must require almost constant supervision. With motor-generators much less supervision is required. Their efficiency also is probably higher than that of batteries.

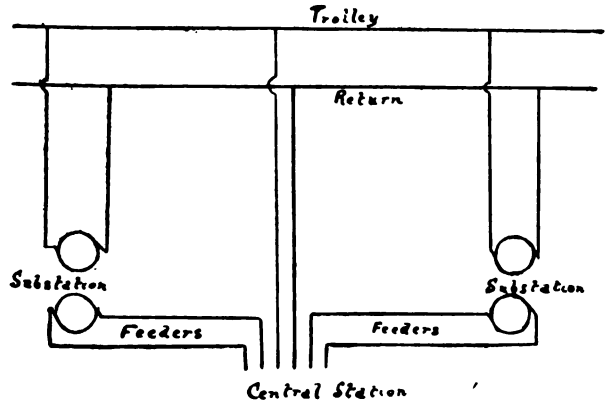

FIG. 2.

A 90 per cent. efficiency with a large motor-generator would be accepted by engineers as nothing very extraordinary, whilst such an efficiency with a battery of accumulators is never heard of. The answer, then, to the question is, if the tramway line be a short one, a battery sub-station is possibly more economical than a motor-generator sub-station, but for long lines motor-generators are more economical. Owing to the high efficiency of the alternating-current transformer, it would be still better in very long lines to use three-phase currents and rotary transformers for the feeding mains.—J. C. R.

[The apparent saving in the feeders with the accumulators is not a realisation, as with the motor-generator a smaller section can be used.—ED. *E. E.*]

Answer to No. 110 (*awarded* 5*s.*).—The advantages accruing from the use of accumulators in traction work are becoming more and more recognised, as is seen by their adoption in nearly all recent schemes. From the following remarks it will be gathered that accumulators at the end of feeders have the preference over boosters.

Briefly stated, some of the leading disadvantages of using boosters are: (1) The generating plant must always be running, if only to drive the motor side of the booster. (2) Should a heavy call be made upon the section of the line the booster is feeding, the generator must respond with sufficient current to drive the motor side for the increased output. Under such circumstances the generator will be subjected to widely varying loads, a serious disadvantage with some machines, apart from the very uneconomical running of the plant. (3) A disablement of part or whole of the generating plant renders the booster useless, more or less interfering with the service, unless ample reserve be provided. (4) Boosters will spark under varying loads and will have variable voltage at the feeding points. (5) The feeder must be of sufficient section for all demands of current, entailing great expense if the feeder be long. This last item (5) is perhaps the most important feature obviated by using accumulators.

Not only are these disadvantages overcome when a battery is used, but several additional advantages are obtained which are enumerated below. Briefly, the function of a battery is analogous to the rim of an engine flywheel—when the demand is light the excess power is absorbed, and given out when the demand is heavy. The application of this fact is the fundamental principle for obtaining highest economy in working. A battery put in parallel with the trolley wire will cause the load on the generator to be fairly constant by levelling off the peaks, and filling up the dips of the load curve of the line; if the generating plant be arranged for highest efficiency at this load, the greatest economy is obtained. (*a*) Since the output of the generator is only the *average* load of line, it will be obvious that the size of plant can be greatly reduced; (*b*) the batteries act as a "stand-by" in case of breakdowns, and, further, the generating plant can be shut down for longer periods; (*c*) early and late cars can be run without using the generators, thus minimising operating expenses; (*d*) the size of feeder to the accumulators need be only of sufficient section for the currents to the battery and the normal current to the trolley, the batteries being arranged by a differentially-wound booster, as described further on, to respond to the excessive demands; (*e*) lighting in conjunction with traction generating plant; (*f*) use of motor-alternators permissible, enabling large or scattered areas to be lighted.

With reference to (*d*), the accumulators are usually charged independently of the line by means of a small booster. The booster usually comprises two machines—a motor and a generator—with their axes coupled together, and mounted on a common bed-plate. The motor is fed off the station 'bus bars. The generator is arranged with two windings on the magnets, one shunt and fed off 'bus bars, and the other series, through which passes the charging current. The function of these two windings is that when the load on the line is light, the shunt predominates, and sufficient voltage will be generated to charge the battery. Now, when the load on the line becomes excessive, there is a tendency for the feeder to take part in supplying the excess current and easing the battery. This is not what is wanted, and is avoided by the series coil coming into action, which reduces the strength of the shunt, and consequently the voltage of the booster, thereby leaving the battery alone to meet the abnormal demand.—FEEDER.

Question No. 111.—It is sometimes desirable to reduce the pressure of steam in order that an engine requiring low-pressure steam may be worked with high-pressure steam. How is this best done?

Best Answer to No. 111 (*awarded* 10*s.*).—In order to feed an engine requiring low-pressure steam, from pipes circulating high-pressure steam, it is necessary to insert a steam-pressure reducing valve in the branch connection to the low-pressure engine. A very good form of valve for this purpose is Auld's steam-pressure reducing valve. The action of this valve is as follows: The inflowing high-

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pressure steam is admitted between the valve, V, and piston, P, which is covered by an indiarubber disc, I R. The piston and valve are in equilibrium on the inlet side of reducing valve; a column of water, W, is interposed between the steam and indiarubber disc, so that the steam has no effect on the indiarubber; this column of water is

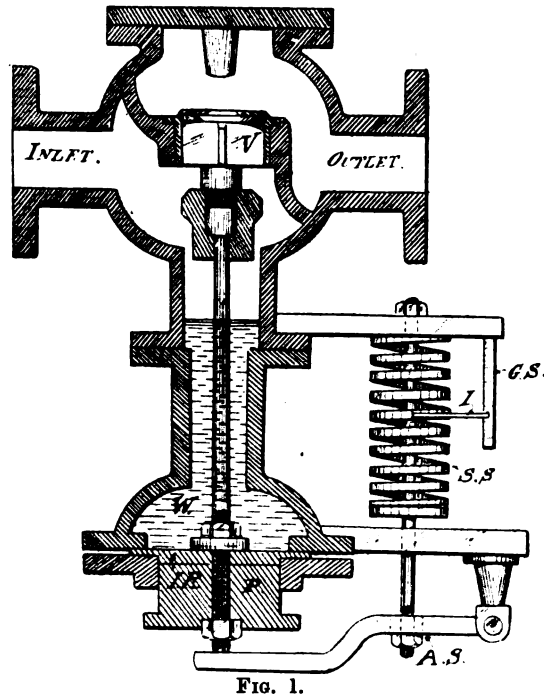

FIG. 1.

supplied by the condensation in the steam-pipes. The desired pressure on the outlet side of valve is obtained by compressing or releasing the steel spiral spring, S S, by adjusting the screw, A S, until the index, I, is opposite the figure required on the graduated scale, G S. The valve being thus opened, the steam passes through the outlet to the low-pressure side of the valve until the pressure of the steam pressing on the upper surface of the valve balances the force exerted by the spring, S S.

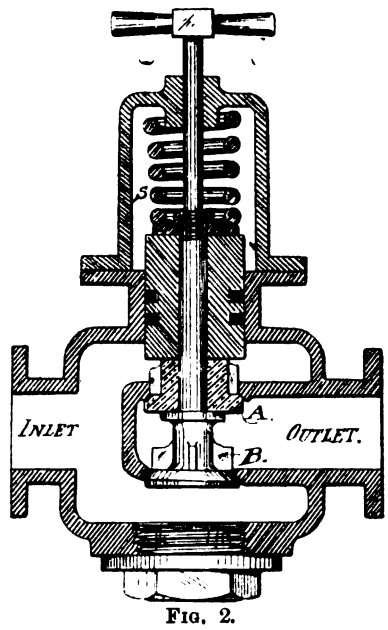

FIG. 2.

Another good form of valve for the same purpose is shown in Fig. 2. In this case the difference in pressure is obtained by the difference in pressure on the valves A and B, which are on the same spindle, together with the pressure exerted by the spring, S. The action of this valve will be easily understood from the sketch. When a reducing valve is required to supply steam to weak steam chests or pipes, a safety valve should be placed on the low-pressure side of valve as security in case the reducing valve should not act.—R. B. B.

Answer to No. 111 *(awarded* 5*s.).*—When it is required to work an engine taking steam at a low pressure from the mains that are supplying steam to other engines at a high pressure, the usual practice is to put in a reducing valve. Two examples of these valves are given. The first (Fig. 1) is made with a dead-weight control valve, and is patented by John J. Royle, of Manchester. In Fig. 2 the control valve is loaded with a spring. This valve is manufactured by Messrs. Holden and Brooke, of Manchester. Referring to Fig. 1, D is the control valve loaded by the weights, W. P is a piston working loosely in the cylinder, C. The high-pressure steam enters at A, and passing through the main valve, V, accumulates in the body of the valve until the pressure exceeds the weight on valve D, when it will commence to escape at D. When the amount of steam escaping at D exceeds that which leaks past P, P will begin to rise and will adjust valve V by means of the lever, L, until the steam leaking past P just equals that

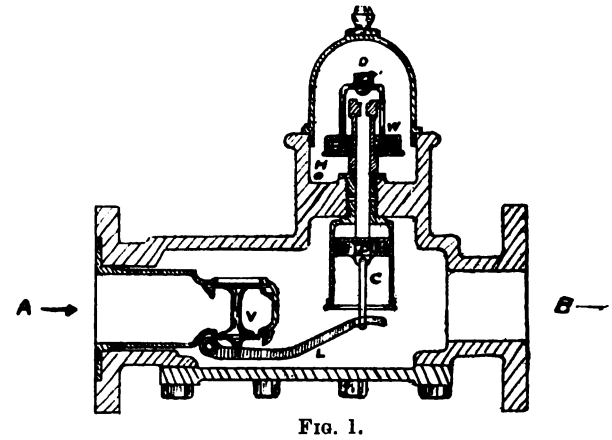

FIG. 1.

escaping at D, when P will remain stationary. The reduced pressure is regulated by varying the weights, W, and is not affected by any fluctuation of boiler pressure.

In the valve illustrated by Fig. 2, the spring, S, is adjusted to the required reduced pressure, and the pressure on the piston, P, varies with the boiler pressure. An example will serve to illustrate this. Let the boiler pressure = 120lb. and the required reduced = 60lb. The spring, S, will be adjusted to keep back 60lb., therefore

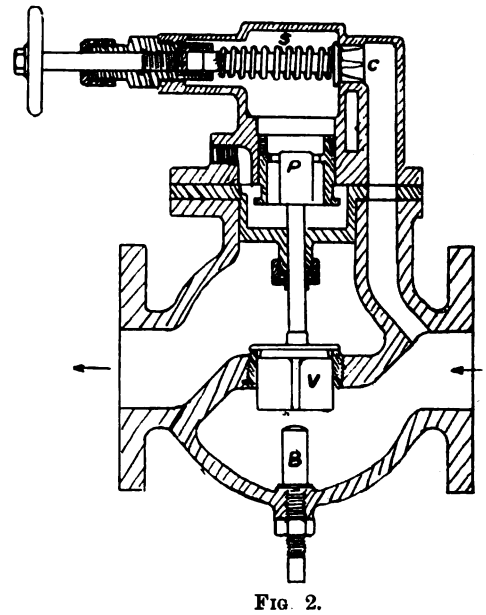

FIG. 2.

the pressure on the top of valve V is 120 – 60 = 60, and the pressure on the underside = 120, therefore the steam passing through V = 60lb. pressure. Now, supposing the boiler pressure fell to 100lb. The spring, S, is still loaded to keep back 60lb., therefore the pressure on the top of V = 100 – 60 = 40, and the pressure on the underside = 100, therefore the reduced pressure = 100 – 40, or 60lb. as before. This valve can also be made to act as a by-pass by lifting V from its seat by means of the screw, B.—F. A.

Answer to No. 111 *(awarded* 5*s.).*—The method usually adopted to effect this is by means of a reducing valve, which consists essentially of an automatic throttle valve,

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which, however much the pressure may vary on the high-pressure side, always keeps constant on the low. There are a number of different types of valve on the market, most of which adopt the principle of regulating the amount of opening of valve by means of a piston actuated by the steam at the reduced pressure. Some valves also are unbalanced, whilst others are of the equilibrium or double-beat type. The chief fault of reducing valves is that they are difficult to keep steam-tight when they are closed—that is, when no steam is being used on the low-pressure side. The steam leaks past the valve, and eventually assumes a pressure equal to that on the high-pressure side, thus producing an element of danger, for with radiators or small auxiliary engines working at very low pressures the results might be serious. In the sketch (Fig. 1) is shown a good

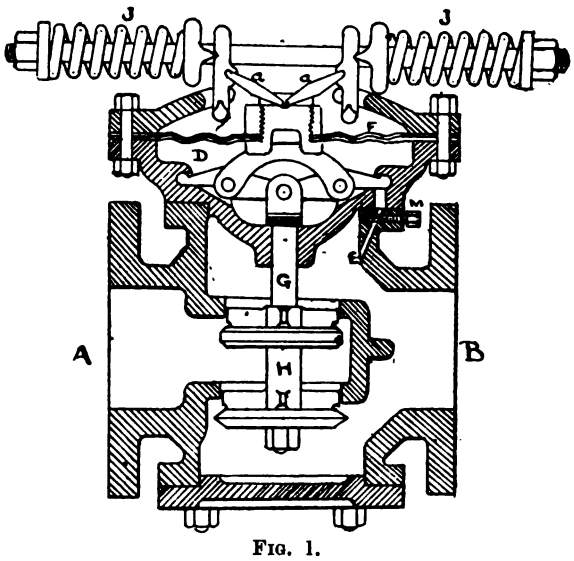

FIG. 1.

form of reducing valve of the equilibrium type, which is supposed to obviate this difficulty. The action of the valve is as follows : A is the inlet and B the outlet. Steam at the reduced pressure enters the chamber, D, through port, E, and presses upon the diaphragm, F, causing it to rise and lift the spindle, G, to which is attached the double-seated valve, H ; the springs, J J, which are capable of adjustment, act in opposition to this force. If the reduced pressure increases, the greater force acting on the diaphragm overcomes the resistance of the springs and draws the valve towards its seat until equilibrium is restored, or conversely, if the pressure falls, the spring overcomes the force on the diaphragm and opens the valve further until equilibrium is again established. One of the principal features of this valve is the arrangement for keeping the counteracting force exerted by the springs constant independently of their amount of compression. This is effected by means of the two toggles, *a a*, which the nearer they are to a straight line the more effective their leverage. The set screw, M, is for closing the passage, E, to the chamber, D, should the diaphragm or either of the springs break, when they can be repaired while the valve is in action. By the use of a reducing valve it is possible to get steam of unvarying pressure at the engines, while that at the boilers may vary within wide limits owing to bad firing or other causes.—F. E. B.

PHYSICAL SOCIETY.

At the ordinary meeting of this society on Friday, Nov. 11, the president, Mr. Shelford Bidwell, F.R.S., in the chair, the discussion on Mr. Albert Campbell's paper on "**The Magnetic Fluxes in Meters and other Electrical Instruments**" was resumed.

Prof. Ayrton said he wished to offer some remarks on behalf of Mr. Mather and himself. The paper would perhaps have received more adequate discussion at the Institution of Electrical Engineers, for it was chiefly of a technical character. The importance of neutralising the effect of leads when using instruments with very weak fields, such as a Siemens electro-dynamometer, should be emphasised. In instruments of the Kelvin balance type, where two opposed coils carry two opposed currents, the field spreads at the edges ; the true "working" flux is not that directly between the coils. Mr. Campbell would have done better if he had used a long search coil wound round one of the swinging coils, forming part of a vertical cylinder. It would have been well also to have supplied some experimental proof that the astatic arrangement of the swinging coils of the Kelvin balance makes the instrument independent of the earth's field. The effect of the earth's field is of the order 0·2, so that with instruments of the Weston type, with a field of the order 1,000, it was sometimes assumed, erroneously, that the readings were practically independent of the earth's H. Prof. Ayrton's own tests showed that by turning a Weston voltmeter towards different points of the compass, the errors in a particular case were far greater than might be predicted from the above ratio ; the induction in the voltmeter pole-space due to the earth's field was much higher than 0·2 ; the earth's field was exaggerated by the iron pole-pieces ; it was not necessary to suppose that the magnetism of the permanent magnet caused the variation. The error observed was about 0·2 per cent. in a horizontal field, and 0·8 per cent. when the field of the voltmeter was parallel to the earth's induction. Here the induction in the gap was 1,200, and H = 0·2. In tests relating to the Ayrton and Perry magnifying-spring voltmeter, it was more important to know the B in the air space *near* the iron than the B *within* the iron. Eddy currents might account for the extraordinary results obtained with the Shallenberger meter.

Mr. J. H. Reeves described a method he had adopted for measuring the effect of stray fields upon ammeters and voltmeters. The instrument to be tested is first mounted on a stand, and is brought under the influence of a large coil carrying a current. In this way, fields of known magnitude can be superimposed on the working field. throughout the range of the instrument, and the change of deflection due to them can be observed. From these known values the working field can be deduced. For let the current in the solenoid of the instrument at any moment be A amperes, producing a corresponding unknown working field of magnetic force, X, then X is proportional to the solenoid current, as measured by the indications of the instrument. If a magnetic force, x, is superimposed on X, then x is measured by x/X of A. If x is known, the working field, X, can be calculated from the change of deflection produced by the superposition. With Evershed ammeters, the field measured in this way was in one instrument 200 and in another 226, or about one-third of Mr. Campbell's figure (700) for the Evershed ammeter. Mr. Campbell's value of B did not represent the working field, but the field at the end of one of the fixed pieces of iron.

Mr. Campbell, in reply, said he thought the theory of electrical instruments to be well within the limits of physics, and he had for that reason presented the paper to the Physical Society. The position chosen for the search coil in the Kelvin balance tests may not have corresponded to the working flux, but it was near to the right position, and he had carefully specified the position chosen. His results as regards the Weston instrument differed from those of Prof. Ayrton ; the errors he had observed for the particular ammeter used were under 0·1 per cent. The earth's field probably produced an effect different for different Weston instruments, according to the degree of saturation of the permanent magnet. In Mr. Campbell's tests the Weston instrument did not have an iron case.

A paper by **Prof. W. B. Morton**, on "**The Propagation of Damped Electrical Oscillations along Parallel Wires,**" was then read by Prof. J. D. Everett. In a paper published in the *Phil. Mag.* for September, 1898, Dr. E. H. Barton compared the attenuation of electrical waves in their passage along parallel wires, as experimentally determined by him, with the formula given by Mr. Heaviside in his theory of long waves. He finds close agreement as regards the effect of a terminal resistance, but large discrepancy in the case of the attenuation-constant. Prof. Morton now investigates how far the results should be modified when it is supposed, as under actual conditions, that the oscillations propagated from the origin are damped, and that the circuit is not balanced, as in the ideal case of distortionless transmission. He finds (1) that the velocity of propagation is increased, while (2) the attenuation is increased, and (3) with infinite resistance between the ends of the wires, the waves are, as before, reflected completely with phase unchanged. As the resistance is diminished the amplitude of the reflected waves is decreased, and a phase difference is introduced. For a certain value of the resistance the reflected amplitude is a minimum, and the phase-difference is $\pi/2$. When the resistance is zero there is again complete reflection, with phase-difference π—*i.e.*, the waves are reversed. The result is that the reflection factor for amplitude *seems* to pass continuously from (+1) to (−1) *without* passing through zero. Using the numbers given by Dr. Barton, it is found that the corrections to the simple theory are extremely small, so that in actual cases the damping may be ignored, and the circuit may be regarded as distortionless.

Mr. Oliver Heaviside (*Abstract of Communication*).—Mr. Heaviside, using his own notation, exhibits mathematically the connection between the case investigated by Mr. Morton, of a wave-train arising from a damped source, and the standard case of an undamped source. The cause of the attenuating coefficient coming out twice as great in Dr. Barton's experimental conditions as when the resistance is calculated by Lord Rayleigh's formula, is attributed to lack of correspondence between the experimental conditions and those of the ideal theory. For (1) the external resistance of unknown amount is ignored. (2) It is not certainly to be expected that the formula in question is true for millions of vibrations per second. It may, however, be concluded from the experiments that the theory furnishes an approximation to the real resistance. (4) The magnetic vibrations to which the wires are subjected are not long continued and undamped, as assumed by the formula. When a wave-train passes any point on a wire its surface is subjected to an impulsion vibration lasting only a

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very minute fraction of a second, a vibration, moreover, which is very rapidly damped, so there is no definite resistance, and the resistance is greater than according to Lord Rayleigh's formula. (5) Perhaps, also, the terminal reflections involved in Dr. Barton's calculations may introduce error.

The **President** proposed votes of thanks to the authors, and the meeting was adjourned until Nov. 25.

BLACKPOOL CORPORATION ELECTRICITY WORKS.

The following is an abstract of the accounts of the above electricity works for the year ended March 31, 1898:

EXPENDITURE.

Dr.		£	£
Coal, including unloading, shunting, etc.	Generation.	2,586	
Oil, waste, and stores, £398; water, £390		788	
Wages of stokers, drivers, and electricians		1,494	
Repairs to buildings and plant		500	
Tools, works lighting, and medical attendance		153	
			5,521
	Distribution.		
Repairs to cables, transformers, meters, etc.			468
	Management.		
Rents, rates, and taxes, etc.		255	
Salaries of engineers, clerks, and finance department		640	
Printing, stationery, stamps, travelling expenses, etc.		268	
			1,163
Total expenditure for year			7,152
Balance, being gross profit			5,675
			£12,827
Interest and sinking fund on capital outlay			3 856
Balance, being profit on year's working (carried to rates)			1,819
			£5,675

Cr.	Income.	£
Sales of current (private lighting)		9,010
Meter rentals		278
Sales of current (public lighting)		2,056
Sales of current (tramways)		1,286
Sundry receipts		197
		£12 827
Amount of gross profit		£5,675
		£5,675

THE BRADFORD TRAMWAY DISASTER.

BOARD OF TRADE REPORT.

The report of Major Cardew to the Board of Trade upon the fatal tramway accident which occurred at Bradford on Sept. 19 last has just been issued. Major Cardew says that the accident was due to the following causes: "(1) That the cars were not run within the limit of speed required by my report to the Board of Trade—namely, not exceeding six miles an hour on the down journey. (2) The unfortunate combination of a driver with very little experience and a conductor with none at all, but with a little knowledge, which is a proverbially dangerous thing; a slippery road and extra pressure on traffic due to Barnum's show. The driver certainly used the brake power provided in an injudicious manner. The conductor put on the hand-brake, and thus deprived the driver of the full control of the brake power; and he also caused the trolley to be disconnected, thus depriving the driver of the power of reversing, which might have prevented the accident. I consider the brake power ample, and that by means of the graduation of the electric brake the speed can be regulated with ease and certainty, provided that a speed of six miles an hour be not exceeded. I approve of the addition of a slipper brake, as recommended by the coroner's jury, not, however, as an emergency brake, but as a brake to be continuously in use, since by it also exact regulation of speed can be obtained, and its use will diminish the strain on the motors and the excessive wear of the wheels. With reference to another recommendation of the coroner's jury in this case—namely, that two sand-boxes be fixed to each platform to enable the driver to sand both rails—I think these should be arranged so that one can be used alone, otherwise difficulties may be caused on the up journeys from occasional loss of electrical contact with the rails. It would, perhaps, be more judicious to station men to attend to the sanding of both rails at the dangerous points on the down journey. I adhere to the opinions expressed in my report of inspection that the speed on the down journey should not at any point exceed six miles an hour, and that trailer cars should not be allowed on this line, and provided that the requirements of that report are complied with I recommend that the line should be certified by the Board of Trade as fit for traffic. It must be fully recognised, however, that on this line the greatest caution and strict attention to regulations are essential to safety. The time occupied on the down journey should be at least 35 minutes, and more time should be allowed for this than for the up journey. I wish to add that although the accident was in great measure due to the inexperience and injudicious action of the driver and conductor, in my opinion they both did their duty to the full extent of their skill and ability."

Major Cardew describes experiments he has made with the brakes, and says that from these tests "it appears that the slipper brake alone as now fitted is the least effective of all as an emergency brake. This is, I consider, to some extent due to the flat pitch of the screw by which the brake is applied, but considering the small fraction of the whole weight of the car that can be possibly brought to bear upon this brake, I doubt greatly whether it can be made as effective an emergency brake as the other brakes which act upon all the wheels, and which therefore bring into play as a retarding force a friction due to the whole weight of the car. Is has, however, an advantage in that it applies a surface of wood to the steel rail, the coefficient of friction between wood and iron or steel being generally greater than that between iron and iron. The fact is that if a car be allowed to acquire such a speed as 20 miles an hour on a steep gradient, no brake acting by friction on the running rails will stop it in a distance that could be considered safe." Major Cardew adds, with regard to the curve where the tramcar left the line and overturned, that the Corporation have arranged a fixed stop just above this curve on the down journey. He says this is perhaps desirable, as tending to ensure that the curve is taken at a slow speed, but it is of course no security if the car is allowed to get out of control.

SHOREDITCH.

At the ordinary meeting of the Vestry of the Parish of St. Leonard, Shoreditch, held in the Council-chamber of the Shoreditch Town Hall on Tuesday, Nov. 15, 1898, the subjoined report and statement of accounts of the electric light undertaking and the dust-destructor undertaking were submitted for adoption by the Lighting Committee, and were the subject of considerable discussion.

LIGHTING COMMITTEE'S REPORT, NOV. 2, 1898.

Your committee have pleasure in now submitting their accounts for the first complete year of actual working to June 24, 1898, as follows:

ELECTRIC LIGHTING UNDERTAKING.—Accounts for Year ending June 24, 1898.

Cr.	£	s.	d.
September quarter, 1897, to sale of current to consumers	549	14	2
December quarter, 1897, ditto	2,141	16	0
March quarter, 1898, ditto	3,410	18	9
June quarter, 1898, ditto	2,151	13	2
	8,254	2	1
Sale of current to dust destructor from June, 1897, to June, 1898	536	5	8
Miscellaneous receipts, ditto	120	4	7
Sale of stores to other departments, ditto	130	8	4
	£9,041	0	8

Dr.	£	s.	d.
Coal	432	15	9
Water	217	11	3
Stores, etc.	362	12	6
Insurance	226	0	3
Wages	1,472	13	10
Engineer's salary proportioned	145	16	8
Miscellaneous expenses	323	14	1
Rent, rates, and taxes—principally on sub-stations	33	10	3
	3,214	14	7
Interest and redemption	2,641	16	2
Net balance	3,184	9	11
	£9,041	0	8

leaving a surplus for the year of £3,184. 9s. 11d. It will be seen from the above that the excess of income over expenditure of this part of the undertaking was £5,826. 6s. 1d., and that after providing for interest and redemption of capital on this account of £2,641. 16s. 2d., it leaves a surplus balance, being profit, of £3,184. 9s. 11d., which your committee cannot but regard as a very highly satisfactory result in view of the fact that in the first quarter a loss of about £500 was actually incurred, when the demand for electricity was small. The charge for interest and redemption of capital is more than sufficient to provide for the depreciation on this undertaking, as it is really redeeming the cost of buildings and land, which will be a clear asset to the Vestry in 42 years; independent of which all charges for the up-keep and maintenance in full working order of the plant has been included in the expenditure items of the above accounts.

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DUST DESTRUCTOR ACCOUNTS—Year ending June 24, 1898.

Cr.	£	s.	d.
Work done for electric lighting department	59	0	0
Trade refuse receipts	238	1	9
Charged to scavenging department, at 2s. per ton on 23,137 tons	2,313	14	0
Debit balance	1,758	14	6
	£4,369	10	3

Dr.	£	s.	d.
Wages (including proportion of engineers and clerical salaries)	2,829	8	3
Stores, etc.	130	8	1
Carting clinker	612	10	5
Insurance	43	4	2
Current for light and power used in destructor, 128,708 units at 1d.	536	5	8
Sundry expenses (including water and rates, etc.) ...	217	13	8
	£4,369	10	3

leaving a debit balance of £1,758. 14s. 6d., against which is to be set off the cost of steam supplied to the lighting station and library. It will be observed in the above accounts that your committee have agreed with the Scavenging Committee that a fixed charge of 2s. per ton should be made against that department for the cost of disposing refuse, which will result in a saving to the Vestry (on its previous expenditure of 3s. 1d. per ton) of a sum of £1,253. 5s. 1d. With regard to the debit balance of £1,758. 14s. 6d., this is represented by steam used in the lighting station and library, etc. In future, this item will be much decreased by the cost of steam supplied to the baths, which at the present has been sent up the chimney, owing to the baths being ready. Even if this debit balance be charged against the surplus of the electricity undertaking the following would be the net result to the Vestry of the combined scheme:

Credit balance on electricity undertaking	£3,184	9	11
Add saving on previous expenditure of barging refuse	1,253	5	1
	£4,437	15	0
Deduct debit balance on destructor	1,758	14	6
Net profit and saving	£2,679	0	6

In view of the high initial cost of disposal of clinker, and the sale of electricity being very small at the commencement of the year, your committee think the above result one upon which they can well congratulate themselves, and they are advised that no previous municipal electrical undertaking has ever yielded such a result in the first year of working. Moreover, it is manifest from the increased supply of electricity now being given, and the reduced cost of disposal of clinker and the use of exhaust steam for heating the baths, that the result for the second years' working should show an immense advance upon the above accounts, although it must be borne in mind that the prices have been reduced 25 per cent., which is the lowest charge in London, and compares favourably with any provincial station. In the above accounts all charges for repairing and maintaining the destructor, cells, building, etc., have been included.

Your committee therefore recommend that the above report be received, and that it be referred back to your committee to allocate the disposal of the profits.

Mr. H. E. Kershaw, chairman of the Lighting Committee, in moving the adoption of the report, said he believed he was right in saying that there would be no objection whatever to this committee's report, because the committee were fairly unanimous in recommending that the accounts should be sent to the Vestry. This was the report of the 12 months' working of the two schemes, or the joint scheme, whichever they liked to call it; it was just the bare trading account of what this undertaking had accomplished in 12 months. The figures were set out very clearly, and he felt sure the whole thing would commend itself to the Vestry. He should be glad to answer, as far as he was able, any question any member of the Vestry might wish to put to him on the subject.

The report having been seconded,

Mr. J. Cox said he had been comparing the figures on the agenda paper with the figures that were laid before the committee, and he found that in the figures laid before the committee it said, "Leaving a surplus for the year of £1,758 to be dealt with as directed by the committee," and on the agenda paper it said, "Leaving a surplus of £3,184. 9s. 11d." He should like to have some explanation of the difference between the figures on the agenda paper and those presented to the committee.

Mr. Kershaw said the difference in the figures referred to represented the cost of steam at 1d. per unit supplied to the lighting station and library. That had been omitted so as to have the actual result in the summary. The difficulty was, if they charged 1d. per unit for the steam now, on future occasions, when the boilers in connection with the baths and wash-houses were at work, it would be impossible to tell what steam came from the dust destructor and what from the boiler, and, therefore, they would not know what to charge. The difference in the figures was the difference between 1d. per unit for the steam and no charge at all. Under the dust destructor accounts, it was stated that the £1,758. 14s. 6d. would be charged to the Lighting Committee as cost for steam, and if Mr. Cox would take the trouble to add the two amounts together, he would find they came to the figure in question.

Mr. H. Wells asked what had become of the money that had been received. The chairman of the Finance Committee said it was nowhere to be found, the accountant knew nothing about it, and no one knew anything about it. He thought it ought to be shown in the estimates. He wished to know whether the street-lighting was suffering in any way from it.

Mr. A. C. Hodder did not wish to say anything against the balance-sheet which had been presented, because he might be told he was opposing the scheme. He had no wish to do that in any way, but he was bound to say that the balance-sheet could not be accepted as a reliable balance-sheet.

Mr. Kershaw replied that he distinctly stated that it was not a balance-sheet, but a trading account.

Mr. Hodder, continuing, said that, in order to arrive at anything like a fair balance-sheet with regard to a scheme of that kind, they must take into consideration the question of the dusting and scavenging account for the year, and also the cost of public lighting. Mr. Kershaw, at the opening of the lighting station, had stated that the Vestry would make a profit of £2,200. He ventured to say, looking at the accounts, that the opinion which Mr. Kershaw then expressed had not been realised. In 1897-8 the amount of money saved in barging was £618. 5s. 4d., but there had been an increase, according to the surveyor's report, of about £200 in the dust collecting. The barging account might perhaps show a much larger sum than £618, but, still, it would not affect the dusting and scavenging account to the extent of £2,200. Again, looking at the cost of public lighting, in 1897 they paid £6,078 for gas, and in 1898 they paid £4,323. 9s. 2d. for gas and £3,471. 0s. 1d. for electric light, or a total increase in the cost of public lighting of about £1,718. He admitted the light was much better, and that they ought to expect to pay more for electric light than for gas. But in attempting to arrive at a fair balance-sheet they ought to take into consideration the whole cost of public lighting, and the cost of scavenging and barging as compared, with previous years. They must also remember that when they had electric lights over the whole of the parish, the number of units consumed would be far greater than it was now. Still, he believed the electric light undertaking would be a great success in the future, and he hoped the remarks he had made were not calculated to disparage the scheme, but would rather tend to promote its success.

Mr. J. J. Freeman said he was not going to oppose the report, but he thought the accounts ought to be put before the Vestry as accurately as possible. He did not remember the report coming before the committee in its present form. He had distinctly stated on the Lighting Committee that the dusting department were only paid 3s. per ton for barging, and not 3s. 1d., as stated. The report stated that the disposal of the refuse by the destructor would result in a saving to the Vestry, on its previous expenditure of 3s. 1d. per ton, of a sum of £1,253. 5s. 1d.; that was not the case, because, as he had already pointed out to the Lighting Committee, it cost the parish much more to take the dust to the destructor than it did to take it to the wharf. During the year previous to taking the dust to the destructor they had used 14 vans per day in the summer months and 20 per day in the winter; but last year, since taking the dust to the destructor, they had required 20 vans in the summer and 26 in the winter. That made a difference of six horses and vans and 12 men, and that would discount very much this so-called saving of £1,253. If they took the cost of seven horses, their keep, 12 men's wages, and the extra rolling-stock, they would find it amounted to the sum of £1,712. 16s. He had taken the figures from the books at the wharf. The cost of taking the dust to the destructor was very much increased by the loss of time due to the men having to wait owing to the insufficiency of lift accommodation. It was unfair to say they were saving the ratepayers £1,253, and it was untrue. It was only a certain class of people, the consumers of electric light, who got the benefit of any profit there might be, whereas the whole of the parish had to contribute towards the loss on the dust department.

Mr. J. Hepburn said it was a well-known fact that there was about 200,000 units of light consumed at the dust destructor and electric lighting station combined; but in the accounts they had charged £536. 5s. 8d. to the dust destructor, and nothing at all to the lighting department. Then he would like to know who was responsible for the allocation of the rates and taxes. He noticed that £33. 10s. 2d. was charged to the electric light undertaking, principally on sub-stations, and £217. 13s. 8d. was charged to the dust destructor. Mr. Kershaw knew as well as he did that the dust destructor was rated at £83. 4s. 3d. If Mr. Kershaw replied that it contained other items, then he (the speaker) said it was a false statement. It seemed to him that the aim right through had been to load the dust destructor with every item they possibly could, and to keep them off the electric light account in order that they might show a profit. He was as anxious as Mr. Kershaw or anybody else that the electric lighting should be a success, but he wished to see that success achieved in a fair manner. He had no companies to float.

Mr. G. W. Howlett said he was another member of the committee who failed to see the accounts at the last meeting of the committee. There were several items in the report which he considered wrong. He understood that the accountant had been asked to send a copy of the report to the Board of Trade, and it certainly ought to be accurate before being sent in They ought to decide what they were going to charge for burning the stuff and what they were going to get for their steam before sending in the Board of Trade return. He agreed with Mr. Freeman that the £1,253 was not a saving to the Scavenging Committee; it certainly had cost the committee more, because they had now to get a regular supply of refuse. Before, if the weather turned out wet, the men could work on slopping; and it was well known that people would not have their dust removed in wet

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weather, and, therefore, the men had more trouble in collecting the refuse. Of course, from a sanitary point of view, it was better that the refuse should be destroyed instead of being left about; but that was no reason why they should endeavour to get a bogus profit. It was unwise looked at from another point of view, and also made a loss, because they must remember they would have to pay income tax on the profits at the rate of 8d. in the pound. They ought to save that if they could. He believed the only motive for trying to show an inflated profit was for the simple reason of showing it to the electrical papers. The whole scheme ought to stand on its own merits. He believed it was a big success, but they ought to put it before the public fairly. They had nothing to be ashamed of; why, then, should they try to lead the public astray? He certainly thought the report ought to be referred back to the Lighting Committee, in order that they might get a fair and square account, and then they could face the public.

Mr. H. Wells asked what was the meaning of the sentence in the report, "Referred back to the committee to allocate the disposal of profits." Did it mean among the various, or did the committee want the power to do what they liked with the money?

Mr. H. Winkler said the figures in the accounts were only an addition to what they had received from Mr. Kershaw before, and they made him more shaky than ever about believing any of his statements—they were a perfect farce. At the bottom of the accounts of the electric light undertaking there was a line which said, "Leaving a surplus for the year of £3,184," but there was nothing allowed for steam there. Speaking plainly, he called it "cooking" accounts. He had gone through the figures, and he believed there might be a small profit of about £300 or £400. But they had to make allowances for depreciation and bad debts, and also to bear a proportion of the charges for office expenses. If they took these and other little items into consideration, they would find that the so much boasted surplus was simply "gas" and not "light."

Mr. E. J. Wakeling remarked that there was one item in the report which never ought to have appeared, and that was the paragraph which said: "With regard to the debit balance of £1,758. 14s. 6d., this is represented by steam used in the lighting station and library, etc." So far as he had been able to understand, the steam used in the library was exhaust from the pumps. The report then went on to say: "In the future this item will be much decreased by the cost of steam supplied to the baths, which at the present has been sent up the chimney, owing to the baths not being ready. Even if this debit balance be charged against the surplus of the electricity undertaking, the following would be the net result to the Vestry of the combined scheme." Then, on the other side, they recommended that the above report be received, and referred back to the committee to allocate the disposal of the profits. Well, that did not commit them to much; but they ought to know that something would be charged to the baths for the supply of steam. The bulk of the steam that would be used by the baths would be the exhaust steam that could not be used at the present time by the lighting station, and one of the conditions, when the Baths and Wash-houses Act was adopted before purchasing the site, was that the steam should be supplied free of cost, therefore that paragraph ought not to appear in the report. Although he was not going to oppose the adoption of the report, he did object to statements appearing in it that were not there when it came before the committee for consideration, and he moved that the words, "In future this item will be much decreased by the cost of steam supplied to the baths, which at the present has been sent up the chimney owing to the baths not being ready," be struck out.

Mr. Kershaw, replying to the various criticisms, said the majority of the Lighting Committee were present, and could substantiate the fact that they did have the figures before them at the last meeting of the committee; they spent an hour discussing them, and finally decided to recommend them to the Vestry in the form in which they were now presented. What surprised him was that the majority of the speakers were the members of the Lighting Committee, and yet when the matter was before the committee they were comparatively silent, with the exception of Mr. Freeman and Mr. Wakeling. Mr. Winkler, who made such sweeping charges, was present, and did not say a single word, and he asked if it was fair treatment for a member of the committee to hear the whole of the particulars fully explained and not say a word, and then to come there and spring upon the Vestry matter absolutely extraneous to the whole thing. In reply to Mr. Hodder, he acknowledged that the statement he (the speaker) had made at the opening of the lighting station had since proved to be erroneous, and he honestly admitted it. He had based his remarks on the report that had been submitted to them by the contractor. They found the destructor would do the work the contractor said it would, and he thought he was therefore justified in taking this view. They must also remember that they had increased the cost one-third by taking the men off 12-hour shifts and putting them on an eight-hour shift. That explanation alone would repudiate the figures he had given them. He was not going to shield the contractors at the expense of truth. If the dust destructor had not done what they said it would do, it would be for the Vestry to decide what steps should be taken in the matter, and he was willing to render them all the assistance in his power. Personally, he was not satisfied that they had fulfilled all their obligations to the Vestry. As regards the cost of public lighting, he did not want that to creep into this discussion at all. They were not discussing the question of public lighting; but he would remind Mr. Hodder that they had reduced the cost of the electric light 33 per cent.: they had dropped it from 5d. per unit to 3½d., and it would now bear comparison with any station throughout England for public lighting. Not only that, but the Vestry, against the recommendation of the Lighting Committee, had resolved that all public institutions should be charged at that rate. If there was a weakness about the scheme, it was the delay which occurred in the delivery of the dust at the station, as pointed out by Mr. Freeman; that was the crux of the whole question. But that was owing to the insufficiency of the lift accommodation, and surely they could not be blamed for that. He gave Mr. Wakeling credit for being the only man who said they ought to have four lifts instead of two. But the committee had taken that matter in hand, and he hoped, with more lift accommodation, that defect would be remedied. Mr. Freeman asked why 3s. 1d. was mentioned instead of 3s. That was the vestry clerk's figure. Twelve months ago the Scavenging Committee were paying 3s. 2d.

Mr. Freeman: No, they were not.

Mr. Kershaw said he had Mr. Freeman's own figures stating the fact, so they might take them as being correct. That lasted for six months; then the new contract came in at 3s., and the vestry clerk very honestly divided the two and put the price down at 3s. 1d. But he would remind them that before the dust destructor came into existence they were charging 3s. 5d.

Mr. Freeman said that was hardly a fair statement, because one year it was only 2s. 8d.

Mr. Kershaw answered that they all knew that was a long time ago, and they also knew wages had increased since then. Mr. Hepburn had made the remark that they were trying to load the dust destructor with all possible costs; that was the reverse of what they were doing. They knew the one scheme was an absolute success, but the other was an experiment, and they were anxious as far as possible to do nothing to load it with expense. Mr. Wakeling had raised an important point in reference to the steam as supplied for lighting. That was important because the Vestry would be called upon one of these days to settle the question. For Mr. Wakeling to say that the bulk of the steam for the baths was exhaust, and of no good to the lighting station, was entirely erroneous. For 18 months that exhaust steam had been sent up their chimney, whereas if they had known that the baths would not have wanted it all that time they would have put in a condenser and utilised it. The value of their steam would have been 25 per cent. more had they used it, and that meant the profit would have been increased. He firmly believed that in future the scheme would be far more successful than it had been during its first year of working. It was not to be wondered at if they encountered difficulties at first, and he thought the Vestry was to be congratulated that so large a scheme had gone through successfully without any serious accident or any loss to the ratepayers, taking them as a whole. He accepted Mr. Wakeling's amendment, and moved the adoption of the report.

The **Chairman** then put the resolution to the meeting, and declared it carried, 30 voting for the motion and 11 against.

LEGAL INTELLIGENCE.

OBTAINING GOODS BY FALSE PRETENCES.

At the Exeter Assizes on Wednesday, before Mr. Justice Kennedy, the case was heard against Ernest John Thomas, *alias* Ward Thomas, 35 years of age, described as an electrical engineer, of Laira, Plymouth, and late of Heavitree Bridge, Exeter, who was indicted for obtaining by means of false pretences goods from the Candy Belt Manufacturing Company, Seacombe, Cheshire; George Craddock and Co., Wakefield; Telegraph Manufacturing Company, Helsby, near Warrington; Messrs. Hill and Smith, Brierley; and Messrs. Walker Bros., Walsall.

The proceedings were undertaken in the first instance by the Public Prosecutor. Evidence was given to show that the prisoner carried on a most extensive fraud. He made it a practice to send out circulars, or rather headed note-paper, to various firms, representing himself to be carrying on a genuine business, whereas he was carrying on no business at all. On the head of some of the letters he described the firm as the Western Counties Electrical Company, Barbican, Plymouth, and it was on the strength of the manufacturers in question considering that they were dealing with a genuine firm that they forwarded the goods asked for. It appeared that no sooner had the goods been received than they were disposed of for considerably less than the sum charged, thereby showing that prisoner was not carrying on a genuine business. He simply wanted the goods for the purposes of turning them into money. Evidence was called to show that there was no such firm as the Western Counties Electrical Company, Barbican, Plymouth. The prisoner printed upon his note-headings particulars of wharves and sidings to give firms the idea that his place was one of great importance and the seat of a flourishing trade, but he had no wharves or sidings, and occupied a small house in a poor neighbourhood of Plymouth. When apprehended the prisoner told Sergeant Crooke in reply to the charge that he could stand it like a man. He asked how many firms were proceeding against him, and said he supposed it would be the same as it was on the last occasion. He could plead under the Debtors' Act. This he now did, and said he admitted obtaining credit on false pretences.

Mr. McKellar, on behalf of the Treasury, accepted that plea, and said he had some doubt as to whether the prosecution could prove the other and more serious charges.

Accused was sentenced to 12 months' hard labour for each offence, the sentences to run concurrently.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Warsaw.—Tenders are invited for transforming and working by electricity the present horse trams. Particulars are to be obtained from, and tenders addressed to, the Municipal Authorities.

Middlesbrough.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Nov. 29.

Beckenham.—The Urban District Council invite tenders for the various works in connection with their proposed electric light station, particulars of which appear in another column. Tenders by Dec. 17.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. For particulars see our advertisement columns. Tenders by Dec. 1.

Leatherhead.—The Urban District Council intend to sell the lease of their electric lighting order for a number of years. Details may be obtained at the office of the Clerk to the Council. The offer is open until Nov. 21.

Glasgow.—The Corporation invite tenders for providing and erecting switchboards and instruments at the new electricity works, Port Dundas, particulars of which appear in another column. Tenders by Dec. 5.

Blackpool.—The Corporation are prepared to receive tenders for trolleys, wire, and other material in connection with the conversion of their present conduit system to the overhead system, particulars of which will be found in our advertisement columns. Tenders by 22nd inst.

Waterloo (Lancs.).—The Urban District Council invite tenders for the supply of 16 electric arc lamp columns and carriers. Specification may be obtained on application to Mr. F. Spencer Yates, A.M.I.C.E., surveyor to the Council, Town Hall, Waterloo. Tenders to be delivered by 12 noon on 28th inst.

Cuenca (Spain).—Tenders are invited for the establishment and exploitation of a telephone system in the town. The deposit required is £20, to be raised to £40 within 30 days of acceptance of contract. Particulars, etc., are to be obtained from, and tenders addressed to, the Civil Government of the province of Cuenca.

Glasgow.—The Glasgow Corporation invite tenders for the supply of about 800 lineal feet of cast-iron pipes, 21in. diameter, and certain cast-iron pipes, 22in. and 29in. diameter, with special castings, for the new electricity works at Port Dundas. Specifications, etc., may be had on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street. Tenders by 22nd inst.

Amsterdam.—The Consul-General of the South African Republic at Amsterdam demands tenders for the supply of iron telegraph poles. Tenders not received before 19th inst., Nicolaas Witsenkade 9, at Amsterdam, will not be regarded. Specifications (No. 17) will be procured after cash at Mr. F. J. Belinfante, Paveljoensgracht 17 and 18, The Hague, at the price of 1 sh.

Dublin.—The Dublin United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, etc., during year ending Dec. 31, 1899. Forms of tender (price 1s. each), conditions, etc., can be obtained at the Company's Offices, 9, Upper Sackville-street, Dublin, from 15th inst. to Dec. 2. Tenders by Dec. 5.

Sutton (co. Dublin).—The Great Northern Railway Company (Ireland) invite tenders for erection of buildings for an electric power station, brick chimney, etc., near to Sutton railway station, co. Dublin. Specifications may be seen at the office of the Company's Engineer-in-Chief, Amiens-street, Dublin, or at the office of the District Engineer, Belfast, from either of whom copies may be obtained on payment of £2. 2s. Tenders by 10 a.m. on Dec. 5.

London, E.C.—The East Indian Railway Company being desirous of introducing electrically-controlled block instruments on their system, invite proposals from makers only for the supply of (for single line) 18 instruments for nine blocks; (for double line) 80 instruments for 41 stations and six spare instruments. Tenders will be received up to 1 p.m. on Nov. 23, and particulars can be obtained on reference to Mr. A. P. Dunstan, secretary, Nicholas lane, London, E.C.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Tunbridge Wells.—The Corporation have received the following tenders for wiring and fitting 10, Calverley-parade for electric lighting: Storey and Preston, Calverley-road, £27. 15s.; T. A. Wood, Mount Pleasant, £21. 12s. (accepted).

London, N.—The Guardians of Edmonton Union have accepted the tender of Messrs. T. Metcalfe, Limited, Phœnix Foundry, Bradford, Yorks, at £2,485. 15s., for the supply and erection of the whole or part of (1) engines and dynamos, condenser and pipework, including all engineering; (2) wiring for about 600 lamps, including switchboard, battery, etc.

Rathmines and Rathgar (Ireland).—The Township Commissioners have decided on the recommendation of the consulting engineer, Mr. Robert Hammond, to accept the following tenders for the plant for the township electricity works. Section A: Boiler-house plant—three 30ft. by 8ft. Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser, electric motor, Messrs. R. Taylor and Sons, Marsdon, £2,924. Section B: Engine-house plant—one 300-kw. and one 150-kw. high-speed steam dynamos and accessories, motor-transformer, spare parts, etc., Messrs. Mather and Platt, Limited, Manchester, £6,386. Section D: 10-ton overhead travelling crane, Messrs. Higginbottom and Mannock, Manchester, £264. Section E: switchboard and instruments, Mr. James White, Glasgow, £1,181. Section F: Accumulators—Tudor Accumulator Company, Limited, £1,958. Section G: Underground work—trenching, cables, etc., British Insulated Wire Company, Limited, Prescot, £14,123. Section J: Meters—Ferranti and Co., Limited, Hollinwood, £500.

BUSINESS NOTES.

Bray.—The reduction of the charges for light to 4d. per unit is advocated.

Winchester.—The Guardians have decided to adopt electric lighting in the workhouse.

Worksop.—The Urban District Council are applying for a provisional electric lighting order.

Bradford.—The promotion of the Tramways and Improvements Bill has been formally agreed upon by the City Council.

Clontarf.—The Commissioners have decided to apply for a provisional order for the electric lighting of the township.

Bury St. Edmunds.—The proposal of the Town Council to borrow £16,000 for electric lighting purposes is meeting with opposition.

Darfield.—Notice has been deposited at the Board of Trade of the intention of the Urban District Council to apply for an electric lighting order.

West India and Panama Telegraph Company.—The directors have declared a dividend of 1s. 6d. per share for the first half of the current year.

Kingstown.—The Town Commissioners will oppose the application of a private firm for a provisional order, as they intend to obtain one themselves.

Long Eaton.—A committee has been appointed by the Urban District Council to investigate the cost and mode of working an electrical supply for the town.

Slough.—The Urban Council have empowered their Lighting Committee to engage a professional electrical engineer with a view to introducing the electric light.

St. Pancras.—The Vestry have entered into an arrangement with her Majesty's Office of Woods as to works at the electric lighting station in Longford-street.

Camberwell.—The General Purposes Committee of the Vestry are considering the advisability of fitting up the vestry hall and offices with an electric light installation.

Colchester.—The electric light works are to be opened in the first week in December. The number of applications received for current is stated to be eminently satisfactory.

Windsor Castle.—The Queen's private chapel has been very successfully lighted with electric incandescent lamps, the installation adding greatly to the beauty of the interior.

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Cuba Submarine Telegraph Company, Limited.—The directors have announced a dividend at the rate of 6 per cent. per annum, and a bonus of 2s. per share on the ordinary shares.

Southall-Norwood.—The Light Railway Commissioners have submitted the London United Tramways, Limited (Light Railway Extension) order to the Board of Trade for confirmation.

Hastings.—The Corporation have resolved to take steps to apply to Parliament next session for power to construct and work on lease the tramlines from the central part of the town to outlying districts.

Walsall.—The total number of consumers supplied on Oct. 31 last was 120. The committee intend to apply to the Local Government Board for their sanction to a further loan for extension of mains.

Salford.—The Bill to be introduced into Parliament during the ensuing session by the Borough Council, contains a clause to empower the Corporation to borrow money for tramways and tramway purposes.

Perth.—The Perth and District Tramway Company have applied to the Police Commissioners for consent to convert the tramways from horse to electric traction. The application has been remitted for further consideration.

Ramsey.—The Ramsey Town Commissioners have decided to ask the Isle of Man Tramways Company and the Ramsey Gas Company to tender for the better lighting of the promenades, the former to tender for the electric light.

Keighley.—Official notification has been given by the Corporation of their intention to apply to the Board of Trade, under the Electric Lighting Acts, for a provisional order to empower them to produce, store, and supply electricity.

Mexborough.—Official notification has been given by the Urban District Council of their intention to apply to the Board of Trade, under the Electric Lighting Acts, for a provisional order to empower them to produce, store, and supply electricity.

Mirfield.—Official notification has been given by the Urban District Council of their intention to apply to the Board of Trade, under the Electric Lighting Acts, for a provisional order to empower them to produce, store, and supply electricity.

Castleford.—Official notification has been given by the Urban District Council of their intention to apply to the Board of Trade, under the Electric Lighting Acts, for a provisional order to empower them to produce, store, and supply electricity.

Acton.—The District Council are taking steps to acquire land for dust destructor and electric lighting works. The Metropolitan Electric Supply Company, who have new works at Willesden, are also seeking powers to supply the Acton district with electricity.

Wednesbury.—The compulsory area and the list of streets not repairable by the local authority required for insertion in the statutory advertisements in connection with the proposed application for a provisional order under the Electric Lighting Acts has been decided upon.

Kingston (Surrey). — The Guardians are applying to the Kingston Corporation for the supply of electric current as and when required. On Dec. 5 the Ratepayers' Association will consider the advisability of appointing a sub-committee to consider the question of free wiring.

Merthyr.—The Urban District Council will support the application of the British Electric Traction Company for a provisional order to light the district by electricity, provided that the scheme should embrace the whole of the parish, and that the charge should not exceed 4d. per unit.

Bedford.—The Town Council on Wednesday resolved that, in view of the expression of opinion in the report of the Select Committee on telephones that "immediate and effective competition is necessary," application be again made to the Postmaster-General, to grant a license to the borough of Bedford.

Appointments Vacant.—The Vestry of St. Mary, Newington, require the services of a resident electrical engineer. Particulars of this and numerous other vacancies—such as electrical engineers, meter inspectors, travellers, switchboard assistants, engineer's draughtsman, etc.—will be found in another column.

Manchester.—At Wednesday's meeting the Town Council, after a long discussion, confirmed the recommendation of the Electricity Committee to adopt the overhead wire system for working the municipal tramways. It was also agreed to abolish the charge for the hire of electricity meters as from March 25 next.

Audenshaw.—Statutory notices have been published by the Urban District Council of an application to construct tramways in the urban district of Audenshaw, in the county of Lancaster; power to Urban District Council to work tramways; to let them on lease or otherwise; to use steam or other mechanical power, or electricity, or cable haulage, etc.

Musselburgh.—The Town Council have decided to take action to oppose the application of a London syndicate for powers to establish an electric light supply station in the burgh. A special committee has been formed to consider, with the assistance of an electrical expert, whether or not a municipal electric scheme would be a profitable venture.

Croydon.—Mr. W. O. E. Meade-King, M.I.C.E., Local Government Board inspector, has held an enquiry into the application of the Corporation to borrow £5,000 for the provision of fire stations, £2,250 for the purchase of part of the undertaking of the Crystal Palace Electric Light Company, and £850 for electric lighting purposes (Norwood sub-station).

Poplar.—At the last meeting of the District Board a letter was received from the Board of Trade calling attention to the fact that the time had arrived for them to consider whether the electric lighting order obtained by the Board should be revoked, and asking the Board's intention in the matter. The letter was referred to the Electric Light Committee.

Weston-super-Mare.—The Weston-super-Mare and District Electric Light and Power Syndicate have written again to the Urban District Council reporting that it is their intention to apply to the Board of Trade, on or before Dec. 21, 1898, for a provisional order under the Electric Lighting Acts and for a revocation of the Weston-super-Mare Electric Lighting Order, 1891.

Newark.—At the last meeting of the Urban District Council it was decided that the Council would not consent to the Electrical Power Distribution Company's application for a provisional order, as the Corporation were going to apply themselves. It was explained that the Warsop General Power Distributing Company had arranged to supply the necessary power in bulk.

Heckmondwike.—The District Council will not pledge themselves to any scheme of electric lighting or electric traction before giving the ratepayers full information. They have replied to a letter from the Board of Trade calling attention to the expiration of the Council's provisional order (1891) *re* electric lighting, that they are making effort to obtain an installation themselves.

Barking.—At a meeting of the Electricity Committee, held at the Public Offices on Monday evening last, Mr. E. E. Hoadley, chief assistant engineer to the Worcester Corporation, was elected, out of some 70 applicants, for the post of electrical engineer to the Urban District Council. Mr. Hoadley had previously held appointments in the electric lighting stations at Islington, Eastbourne, and Chatham.

Newington.—The Vestry have resolved to take up at once from the London County Council the first instalment—£10,000—of the electric lighting loan of £50,000. The Electric Lighting Committee have reported that they have deferred the question of appointing a resident engineer, and instructed Messrs. Kincaid, Waller, and Manville to engage a clerk of the works, at a salary of £4. 4s. a week. This action has been approved.

Basingstoke.—The Town Council have decided to apply for a provisional order themselves. Applications for the consent of the Council to their obtaining provisional orders to enable them to supply the town with electricity had been received from the following companies: the Electrical and General Engineering Company, the United Electric Light and Traction Company, and the Steam Carriage and Wagon Company.

Camborne.—An application having been made by Messrs. Pressland and Chadwin as engineers for a light railway scheme between Camborne and Redruth, traversing the main road, to be worked by overhead electrical trolley, the District Council have resolved to support the construction and opening for traffic of such railway, subject to the approval by the District Council and the County Council of the necessary working plans.

Islington.—At the Vestry meeting to day a resolution will be proposed to the effect that it be an instruction to the Electric Lighting Committee to report to the Vestry the cost of providing the electric light from Highbury-corner along Canonbury-road and the New North-road, in order that the Islington installation may meet the electric lighting system being at present carried out by the Vestry of Shoreditch as far as the boundary of that parish.

Gorleston.—The question of bringing the electric light across the river to Gorleston is being considered by the Electric Lighting Committee. The surveyor has reported that to carry the cables under the bed of the river would cost £2,000, while an overhead system would not exceed £900. The Council have adopted the latter method, and the surveyor is to obtain the advice of Mr. Preece, and the assent of the Port and Haven Commission and Board of Trade.

Liverpool.—The Tramways Committee have instructed the electrical engineer and the city engineer to carry out the recommendations contained in Major Cardew's report to the Board of Trade, and have authorised them to provide foot sand-boxes for the German motorcars and air-brakes for the American cars, and to order the same from the respective contractors for the cars. The manager is also to make arrangements for stopping-places in accordance with the report.

Japan.—It is reported that the American Siemens-Halske Electric Company is carrying on negotiations with the Japanese Government, which has asked that firm to take over the establishment and working of trolley trams, electric lighting, as well as the supply of the power for industrial purposes, in the Japanese Empire, especially at Tokio, Yokohama, Nagasaki, and Osaka. A limited company which has secured already the monopoly of the trolley trams is about to be promoted at New York.

St. Helens.—With regard to the arrangement between the Corporation and the company referred to in our last issue, and under which we learn that the Corporation will generate and supply the electric power while the company will provide the vehicles and working staff, the Corporation undertake to lay down rails of the most approved type, to equip the lines on the trolley system, and to supply electric energy at a fixed charge—viz., 2d. per unit for the first 400,000 units, and reducible to 1d. per unit when the full quantity of power is consumed.

Western and Brazilian Telegraph Company, Limited.—At the half-yearly ordinary general meeting of the Western and Brazilian Telegraph Company, Limited, Mr. W. S. Andrews

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presiding, the report, already noted by us, was adopted. Referring to the arrangement with the Brazilian Submarine Telegraph Company the Chairman said the agreement between the companies had become operative, but he pointed out that there was no amalgamation, but the agreement was confined to what promised to be a very successful effort to unify the interests of both companies.

Leith.—The cable system for the Leith Walk section was rejected by the Tramways Committee and the following resolution passed on Tuesday last: "That the committee remit to the electrical engineer, Mr. Bryson, to report, in the event of electric traction being adopted for the Leith tramways, and Edinburgh continuing with the cable system, what mechanical arrangements are practicable to admit of the interchange of traffic from the mutual boundary at Pilrig, so as not to cause through passengers to change carriages there, and also to report on the method of crossing the harbour by the new swingbridge."

Bristol.—The Sanitary Committee have decided that in streets not less than 45ft. wide between the kerbs centre posts should be used for the tramways, while in thoroughfares of less than that width side posts with brackets should be adopted. The company has been also asked to consider whether they would share with the Corporation the expense of putting down a subway in Bath-street and Philip-street (the street which extends from Bath-street towards the bridge), for the purpose of carrying the cables of the city electrical works and those of the tramways company, whose power station will be close at hand.

Stoke Newington.—The Vestry have received a letter from the North Hackney Tradesmen's Association, stating that some members of that association are desirous of having electric light in their shops, and asking the Vestry to request the Hackney Vestry when laying their main in the High-street to carry it over to the west side for the convenience of Stoke Newington ratepayers. The London County Council is enquiring whether the Vestry has appointed inspectors or taken any, and if so what, action under the powers of the London Overhead Wires Act, 1891, or has taken steps to enforce the by-laws made under the Act by the Council.

Kensington.—The Vestry have received notices and plans from the undermentioned electric lighting companies relative to extensions of their mains in the parish—viz.: Kensington and Knightsbridge Electric Lighting Company, Alexander-square; Notting Hill Electric Lighting Company, Silver-street; and House-to-House Electric Light Supply Company, Clyde-street and Cathcart-road. The Vestry intend to obtain five arc lamps and five incandescent lamps for lighting the Vestry's depôt at Wood-lane at an estimated cost of £100. The Electric Traction Company adjoining the depôt have agreed to supply the Vestry with electricity at the rate of 6d. per unit.

Personal.—Mr. F. G. Holden has been appointed resident engineer to the Scarborough Electric Supply Company, Limited. There were 51 applicants. Mr. Holden served his time with Messrs. C. A. Parsons and Co., of Heaton Works, Newcastle-upon-Tyne, thence going to the Cambridge Electric Supply Company as improver. After a year at Cambridge he was appointed assistant general manager to that company—a position which he has held for the last three years, and which he vacates at the end of the month to take up his duties at Scarborough. Mr. Holden is a B A. (Cantab) and A.M.I.C.E. Mr. E P. Harvey, B A. (Cantab), has been appointed to the vacancy on the Cambridge staff.

Removals.—Mr. John S. Raworth informs us that his address for professional purposes is now 2, Queen Anne's-gate, Westminster, S.W., and that his telephone numbers are 678 Westminster and 16 Streatham.—Mr. James Swinburne, consulting engineer, has removed from 66, Victoria-street to 82, Victoria-street (Grosvenor-mansions), London, S.W. Telephone No. 292 Westminster.—We are informed by the Blackman Ventilating Company, Limited, of 63, Fore street, London, E.C., that, in consequence of increasing business in the Midlands and the West, they have opened new showrooms and offices at 1, Colonnade-passage, Birmingham, to which address all future enquiries should be sent.

Brierley Hill.—The Electricity Committee's report, adopted by the Urban District Council last week, states that they had fully considered the application of the Dudley and Stourbridge and District Electric Traction Company, Limited, for the Council's consent to the granting to them by the Board of Trade of a provisional order authorising them to supply electricity in the district, and recommended that the required consent be not given. The committee further recommended that Messrs. Kincaid, Waller, and Manville, consulting electrical engineers, of Westminster, be engaged, subject to their fee being satisfactory, to advise the Council as to the advisability of applying for a provisional order to supply electricity in the district themselves.

Diary for 1899.—We have received from the proprietors of the *Indian and Eastern Engineer* their useful diary for 1899. The diary is particularly valuable for the information it gives concerning India and other Eastern countries. For instance, it gives the English equivalents of many little known weights and measures used in various countries, especially the Indian States. A great deal of postal and telegraph information as to India and Ceylon, China, and Japan is given, and also the various customs tariffs in these countries. Much useful data for the use of smiths, plumbers, slaters, and others, and also an abstract of rules against fire risks in electric lighting, is also given. The information ends with a description of all the railways in India, Japan, and the Malay States.

Hammersmith.—Reporting on the subject of generating stations and supply, at the last meeting of the Vestry, the Law and Parliamentary Committee stated that the local authority within the area of supply should have the power of deciding the route the mains are to be laid. as well as the power of themselves breaking up and reinstating the streets. They advised the Vestry to use every endeavour to retain its power of veto, both in regard to wires for the purpose of traction and applications for provisional orders. They further recommended the Vestry to communicate with the other local authorities in the Metropolis with a view to their supporting these views and co-operating with the Vestry in the matter. The report was carried. It was agreed to order another engine from Messrs. Robey, of Lincoln, for £2,305; and also to accept the tender of Messrs. Ferranti at the sum of £1,900.

Edinburgh.—A circular has been issued appealing to consumers to help the Electric Lighting Committee in the present unfortunate crisis in the electric lighting undertaking of Edinburgh. The circular explains that, relying on promises of plant delivery, which were not fulfilled, new consumers were connected up in large numbers during the summer and autumn, and the committee are now unable to deliver current at the standard pressure during the hours of heaviest load, from 4 to 7 p.m. The consumers could help the committee in this difficulty by arranging to light only two-thirds of the lamps usually required during the above hours. If this were done, more light would be got from the remaining lamps than if they were all on, as the full pressure could be maintained. If the switches did not suit, the necessary lamps could be unshipped. The City Council have decided to apply for a telephone licence and for Parliamentary powers to instal and work the telephone.

Tobermory.—At a meeting on the 10th inst., Mr. Yorke, electrical engineer, Glasgow, referred to the advantages of electric light—the greater brilliancy, its convenience, and safety. Mr. Yorke roughly estimated the cost of the plant which would be required at Tobermory at about £2,000. In the event of the scheme being proceeded with, the people of Tobermory would receive the water rights free of cost as a gift from the Laird of Aros. He reckoned that if the number of lamps taken amounted to 1,200 the cost per lamp would not exceed 6s. per annum. No town that he knew of had superior advantages to Tobermory in this respect, and the saving of labour would be very great. The locality pre-eminently favoured the storage of electric power. After discussion it was resolved to lay the matter before the Commissioners on the following Monday with a view to an enquiry being made by them as to the feasibility of introducing electric light into the burgh.

Ayr.—At the meeting of the Town Council on Monday a letter was read from Mr. J. E. Winslow with reference to the proposed electric tramways between Ayr and Prestwick, and reporting on the feasibility of the scheme. Mr. Winslow recommended a line from St. Leonard's Church, a mile to the south of Ayr, to Prestwick, the whole extent being four miles. It was recommended that at some of the narrow points in High-street the line should be single, but that it should be double for the rest of the way. The total cost, including the electrical equipment, was estimated at £44,460. To carry the line on to Burns monument from St. Leonard's Church would cost an additional £13,350, but this part of the scheme was not recommended, while an extension by way of Miller-road, Charlotte-street, and the Esplanade, at a cost of £6,500, was recommended. The Council agreed to incorporate the scheme in their Bill in Parliament. The salary of the electrical engineer has been increased by £50 per annum.

Stretford.—The District Council on Tuesday resolved that a notice under the Tramways Act and the Council's seal should be served upon the Manchester Carriage and Tramway Company requiring them to sell to the Council the tramway works and undertaking within the district, including lands, buildings, plant, etc. A further resolution to the effect that negotiations be entered into with the carriage company to continue the working of the tramways until the lease expires in 1901 was referred back for further consideration. After considerable discussion the following resolutions were then passed: "That Mr. R. P. Wilson, of Victoria-street, Westminster, be engaged, at a remuneration not exceeding 40 guineas, to advise the Council on the various schemes relating to the supply of electricity to the township; that the report above referred to be printed and circulated throughout the township; and that a circular be sent to each occupier of premises in the compulsory area set forth in the Electric Lighting Order, 1897, asking if it is their intention to use the electric light."

Southgate.—At the last meeting of the Urban District Council the Chairman said that the sub-committee appointed to consider the question of electric lighting had fully done so, and had arrived at the decision to recommend the Council to apply next year for a provisional order on their own behalf. With that idea it was resolved to recommend that the companies now seeking powers be accorded no support from the Council. It was also agreed that any ratepayer making application could obtain a copy of Mr. Skelton's report upon the subject of electric lighting. The Chairman said the inhabitants of the district need not be under any apprehension that the Council would run blindly into any scheme involving the district in any cost. They had received a report of a practical nature from a member of the Council, and had discussed the practical side of the lighting question. After consultations with the parliamentary agent, it was thought advisable to apply for this suggested provisional order, as it would form a valuable asset on behalf of the district. The report of the committee and its recommendations were agreed to.

Stockport.—In his opening speech the Mayor said that, although their first installation of electric plant was a modest

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one, the works had been carefully planned with a view to economical extension and the utilisation of the site to the best advantage. He felt sure that in the course of a very short time after its introduction—which was now almost an accomplished fact—the advantages of the electric light would be understood and appreciated, and he felt confident that the extension of the works would be rapid and constant. He also predicted that a large amount of electricity would be required in the near future for tramcar propulsion. The employment of horses for drawing tramcars was rapidly becoming obsolete, and the time was not far distant when nearly all trams would be propelled by electricity. One of the growing needs of the town was a tramline to Offerton and another from Portwood to Cheadle. Nothing stimulated the growth of a town and the surrounding neighbourhoods so much as cheap and rapid transit. In his opinion it would not be long before the Corporation would be obliged to undertake the construction of these tramlines.

Aberdeen.—The special committee of the Town Council has now approved of the draft application to be made to Parliament for a provisional order authorising the extension and improvement of the Corporation tramways. Power will be asked, among other things, to double the line of the Woodside route from Powis terrace to Woodside, it being provided that the motive power will be steam, cable, electric, or any other motive or mechanical power, in addition to, or in substitution for, animal power. In connection with the extension of the electric lighting system to the west-end of the city, it will be necessary to provide a balancer at Queen's Cross. The electrical engineer (Mr. Ball) has been authorised to communicate with Prof. Kennedy, and, in the event of his approving of the arrangement, to select a site and invite tenders for the necessary apparatus, the estimated cost being £540. It has also been decided that in future consumers of electric current should be required to pay the cost of laying so much of the electric lines as may be at a greater distance than 60ft. from the distributing mains, and also that consumers should pay the cost of electric lines laid within private property.

Wandsworth.—At the last meeting of the District Board of Works a letter was read from the Board of Trade stating with reference to the appeal by the electric lighting company against the objection of the Board to the proposed position of a transformer box at Wandsworth Common, west side, that it has been ordered that such transformer box be constructed in some position to be agreed upon by the Board and the company, and in case of difference to be decided by an inspecting officer appointed for the purpose by the Board of Trade; also stating with reference to the appeal of the electric lighting company against the objection of the London County Council to the laying of certain mains in this district for the supply of electricity outside the district, that the Board of Trade have allowed the appeal subject to the company giving an undertaking if and when required by the Board of Trade, to provide a suitable and sufficient generating station within the areas of supply authorised by the Camberwell Electric Lighting Order, 1896; the St. Olave Electric Lighting Order, 1895; the Southwark Electric Lighting Order, 1892; and the St. Saviour's District Electric Lighting Order, 1896, for the supply of energy in those areas.

Marylebone.—At a recent meeting of the Vestry a special report was received from the Electric Lighting Committee, in which they stated that they had good reasons to believe that the Board of Trade would not grant them a provisional order to supply the parish with electric light, and they therefore recommended that the committee have powers given to it to obtain a private Bill in the House of Commons to enable the St. Marylebone Vestry to supply the parish with electricity. Mr. Brooke Hitchings, C.C., moved the adoption of the report, and, further, that the solicitor of the Vestry should take the necessary preliminary steps to obtain the private Act of Parliament; and this having been seconded, Mr. Edward White, L.C.C., pointed out that the Vestry could not instruct its solicitor to take preliminary steps to obtain the Act until first of all the Vestry had discussed the question and decided whether they go for the proposed Act or not. They could not decide the matter without 28 days' notice being given that such a question was to be discussed. Several members urged that action should be taken at once, or else the Vestry would have to wait another 12 months. On a vote being taken the report was adopted by 40 to 7.

Llandudno.—In reply to a letter on behalf of the Llandudno and Colwyn Bay Light Railway Company asking for a definite reply as to the intentions of the Council with regard to the supply of electrical energy for the purpose of working the proposed new line, the Electric Lighting Committee have stated that they are prepared to recommend the Council to waive the Council's right under the agreement of May between the company and the Council to supply electric energy on the understanding that the company should pay the Council £500 per annum as wayleave. The following recommendation of the Electric Lighting Committee has been adopted by the Urban District Council—viz., "That notice be given to the Board of Trade of the intention of the Council to oppose the application of the Llandudno and Colwyn Bay Light Railway Company for an order to construct a light railway in Llandudno, on the ground that no reference is made in such order to an agreement entered into by the light railway company and the Council, dated May 18, 1898. That the solicitor to the Council be instructed to take steps to carry the above resolution into effect, and to obtain the insertion of a clause in the order whereby some reference be made as to the existence of the agreement referred to, or that the clauses mentioned in the agreement in respect to heavy goods traffic and the supply of electric energy by the Council be embodied in the order, and that the order be framed so that the line may be constructed and worked as a tramway as contemplated by the agreement referred to."

Chelsea.—The Lighting Committee of the Vestry have reported that as one of the necessary steps to give effect to the Vestry's resolution to apply to the Board of Trade for a provisional order for lighting Kensal Town by electricity, they had engaged Mr. Sydney Morse, of 4, Fenchurch-street, as parliamentary agent for the order. The committee had approved a draft of the necessary advertisement, and had, *inter alia*, inserted therein, as the names of the streets in which it was proposed to lay electric lines, within a period of two years, the following; Harrow-road, Kensal-road, Wedlake-street, Wedlake-street footbridge. To comply with the rules of the Board of Trade, the committee had named as the approximate capital expenditure under the order the sum of £36,000. The report has been approved. The Vestry of Kensington have also written to the Chelsea Vestry giving notice of their intention to apply, during the ensuing session of Parliament, for a provisional order under the Electric Lighting Acts, 1882-1890, authorising that Vestry to generate, distribute, supply, and sell electricity within the parish of Kensington, and the wharves and premises now belonging to them situate in the parishes of Chelsea and Hammersmith. The Vestry are seeking, *inter alia*, power to open and break up streets in Chelsea as follows: Edith-grove, Lots-road (part of), Cheyne-walk (part of), and Kensal-road (part of), also power to take up, remove, or interfere with any sewers or drains. Consideration of the letter has been deferred until the end of the month, when the Clerk will report on the whole of the schemes.

Colwyn Bay.—At the last meeting of the Council the surveyor reported as follows: "For the last two months the electricity works have given the greatest satisfaction. From Sept. 15 to Oct. 4 the light was extinguished at 10.30 nightly, and from Oct. 5 the plant has only been running at half-load—*i.e.*, 12 lamps instead of 24 being kept alight, the same being put out at 10 o'clock. I have brought the whole of the 24 lamps into work, lighting 12 alternatively so as to keep them in proper working order. Since the lighting of half the lamps has been resorted to, the saving in the consumption of gas does not equal 50 per cent.; still, it means 150ft. of gas per hour, half-load consuming about 350ft. as compared with 500ft. for the full load. I shall be glad to learn whether to continue the lighting of the promenade any longer, but it should be pointed out that immediately the light is stopped it will be necessary to take down all the arc lamps and store them away in a suitable position so that they can be periodically cleaned, oiled, and kept in working order. Further, the gas-engine and dynamo will have to be run at intervals during the period the light is suspended; this will depend on the temperature of atmosphere in the station, and, if it gets low, the machines will have to be run oftener." It was resolved that the electric lighting on the promenade be discontinued until next season. A public meeting of the ratepayers was held yesterday to ascertain their views on the question of carrying out the electric lighting scheme in pursuance of the provisional order conferred on the Council in 1896.

Swansea.—The *South Wales Daily News* states that negotiations are in progress for the acquisition of the Swansea and Mumbles Railway by the British Electric Traction Company. The traction company has already acquired the Swansea tramways with a view of adopting electric traction. In that purchase is included the old tramway company's running power on the Mumbles Railway, and if it can only get hold of the Mumbles Railway and work it in connection with the town tramway system by electricity, it will be a grand thing for the district, for besides giving the company a continuous line between Morriston and Mumbles Pier it will have the effect of doing away with the present dangers of the Mumbles-road, which are unavoidable so long as the railway is worked by steam. We are in a position to state that there is business in the negotiations, and that an early completion resulting in a purchase is probable. Meanwhile the Mumbles Railway Company are proceeding with a Bill in Parliament for the necessary authority to abandon the section from Blackmill towards the Mumbles which runs by the side of the road, the seaside line on that section, for which parliamentary powers were obtained last year, being substituted for it. But this we learn, while affecting a portion over which the tramway company have running powers, will only improve the line as a whole and make the electric traction company a more anxious buyer. It is stated that the traction company have practically decided to carry out at an early date the extensions of the tramway service to Brynmill, to Sketty, and to the Cross at Morriston.

New Issues.—The Edison and Swan United Electric Light Company have made an issue of £150,000 4 per cent. debenture stock, at the price of 99 per cent., the amount being the balance of a total amount of £350,000 such stock authorised in consequence of the continued large expansion of the company's business. The stock is subject to redemption at £110 per cent., at the company's option, and is secured as a first floating charge on the uncalled share capital (£198,522), the properties, plant, and stock, the total assets being put at £691,090. The profits for the four years to June 30 last are given as £25,876, £23,824, £29,498, and £34 547 respectively.—The Potteries Electric Traction Company has been formed for the purpose of constructing the tramways and light railways recently authorised in the Potteries district of North Staffordshire, and also of acquiring control of the tramways already constructed (worked at present by steam, but in course of being reconstructed for electric traction) belonging to the North Staffordshire Tramways Company and the tramways in the borough of Longton, and of working all such tramways and light railways as one undertaking by the overhead system of electric

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traction. The company has a capital of £400,000, divided into 20,000 5 per cent. cumulative preference shares of £10 each, and 2,000 ordinary shares of £10 each, of which 6,666 ordinary shares will be fully paid to the British Electric Traction Company in part payment of the purchase price. The directors have power to issue £200,000 debentures. The present issue is at par of 20,000 5 per cent. cumulative preference shares and 13,334 ordinary shares of £10 each.

Whitechapel.—At the last meeting of the District Board a letter was received from the Board of Trade stating that the provisional order which was granted by that Board in April, 1892, had not been put in force, and so far as they were aware no steps had been taken to carry out the District Board's obligations. The period for which the order was available had now expired, but the Board were prepared to consider any representations in the matter the local authority might make. The communication was referred to the Special Committee. The following recommendation was brought up by the Electric Lighting Committee: "That the premises of Messrs. Ind, Coope, and Co., 27, Osborn-street, Whitechapel, containing an area of about 20,000 superficial feet, with the extensive range of offices and buildings thereon, adjoining the premises of the Board in Angel-alley, be purchased by the Board for the sum of £18,250, this sum to include the movable furniture and fixtures and plant and machinery upon such premises, and that it be referred to the solicitor of the Board to carry out such arrangement on behalf of the Board." Mr. Kearsey moved the adoption of the recommendation, and said it was well known that Mr. Turner (the clerk) some time ago obtained information that it was probable these premises might be in the market, and he at once communicated the fact to the Electric Lighting Committee, and the committee, with a view of forwarding the scheme to light the district, at once took the necessary steps to acquire the premises. They were exceedingly well situated, as they joined the Board's depôt. Mr. Snell seconded the adoption. Mr. Chillingworth said that the premises were admirably adapted for the Board, and added that the whole proceedings had been very ably conducted by the clerk and the chairman. Mr. Mattey observed that it would be difficult to find a more desirable place than the one the Board had got, and the committee could congratulate themselves upon the result of their efforts. The Chairman endorsed the observations of the previous speakers, and the recommendation was unanimously agreed to.

Paddington. — At the fortnightly meeting of the Vestry on Tuesday, Mr. Frank Dethridge, the clerk, read a letter from the secretary of the Metropolitan Electric Supply Company, Limited, asking, in reference to the conversation that the vestry clerk and Colonel Barchard (chairman of the Electric Lighting Committee) had in respect to whether the company were willing to enter into negotiations for selling to the Vestry their undertaking so far as it related to the parish of Paddington, that the Vestry should send its application in writing, and, if possible, state what amount they were prepared to offer the company. Mr. Whur wished to know by what authority the vestry clerk and Colonel Barchard had been interviewing the company's secretary on such a matter, for he had no idea that the Vestry had any idea of negotiating for the purchase of the company's undertaking. Colonel Barchard said that Mr. Whur was wrong, for power was given the Electric Lighting Committee to do what had been done. Some time ago a resolution was moved by Mr. Smith that the Vestry apply to the Board of Trade for a provisional order, but in the meantime St. Marylebone, who had obtained a provisional order, did not have that order confirmed, and then Mr. Smith altered his resolution, that the committee be empowered to ascertain from the Metropolitan Electric Supply Company on what terms they would be willing to sell their undertaking; and it was in consequence of such that the committee had considered the matter, and the secretary of the company had been asked about the matter—hence the letter received. Mr. Whur had no recollection of Mr. Smith's resolution having reference to purchasing. The Vestry Clerk read the resolution passed in July last empowering the committee to ascertain whether the company were prepared to sell. Mr. Manwicks moved that the letter be referred to the Electric Lighting Committee to consider and report upon. Colonel Blair said that he supposed that that would mean the expenditure of the paltry sum of a quarter of a million. Colonel Barchard said that in the letter it was asked that the Vestry would name what amount they were prepared to offer. The chairman, Mr. W. H. Mills, said that the committee would consider the whole question, and in its report state whether it recommended the Vestry to offer the company any sum or not. Mr. Harben, L.C.C., considered it was necessary that the question had better be taken into consideration without delay, because there was no doubt that sooner or later the authorities would have to take over the control of electric lighting. Mr. Smith wished to know whether the committee ought not to have the assistance of experts. Colonel Barchard did not think such necessary. The committee in whatever action it took would take care not to pledge the Vestry in any way. The question was then referred to the committee for consideration and report. Sir George Fardell, M.P., had a notice of motion on the agenda paper: "To draw attention to the unsatisfactory condition of the electric current supply in the borough, and, if necessary, to move a resolution by permission of the Vestry." Owing to the serious illness of his daughter, he was unable to attend, and upon asking that the motion might be allowed to stand over, Colonel Meade, by permission of the Board, took the matter up, and after discussion a resolution referring the matter to the Electric Lighting Committee was unanimously adopted.

PROVISIONAL PATENTS, 1898.

NOVEMBER 7.

23388. Improvements in and relating to electric arc lamps. John Batist Reiner, 55, Chancery-lane, London.

23397. Improvements in enclosed arc lamps. Frank Michael Lewis and the Mutual Electric Trust, Limited, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

23408. Improvements in or relating to brush-holders for dynamo-electric machines. William Brooks Sayers, 46, Lincoln's-inn-fields, London.

23411. Improvements in the manufacture of electrical cables for submarine telegraph purposes. Ludwig Lehmann Hartvigson, 53, Chancery-lane, London.

23420. Improvements in or connected with incandescence electric lamps. Louis John Steele, Sir John Blundell Maple, Bart., M.P., and John Verity, 4, South-street, Finsbury, London.

23430. Improvements in electric controller mechanism primarily adapted for railway motors. William Phillips Thompson, 6, Lord-street, Liverpool. (Thorsten von Zweigbergh, United States.) (Complete specification.)

23433. Improvements in and relating to the construction and arrangement of electric arc lamp cut-outs. Charles Vernier, 7, Southampton-buildings, Chancery-lane, London.

23436. Improved method of attaching the holders of electric incandescent lamps to their bulbs. Edouard Bilharz, 22, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 10, 1898, being date of application in France.)

NOVEMBER 8.

23462. Improvements in or connected with street electric tramways and railways. George William Bell and Ernest Richard Royston, 15, Water-street, Liverpool.

23497. Improvements in and connected with electrical tramways and in the transmission of electricity to the car or vehicle. William Heath Merriman, 77, Colmore-row, Birmingham.

23503. Improvements in devices for controlling the operation of electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Horace See, United States.) (Complete specification.)

23510 Improvements in insulators for incandescence electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Albert Haller Spencer, United States.)

23515. Improvements in or relating to antiseptic supports for telephone receivers or transmitters. Alfred Julius Boult, 111, Hatton-garden, London. (Adolphe Klotz, France.)

23529. Improvements in a method and system for generating and distributing electric energy. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Charles M. Green, United States.) (Complete specification.)

23530. Improvements in a method and system for generating and distributing electric energy. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles M. Green, United States.) (Complete specification.)

23531. Improvements in a method and system for generating and distributing electric energy. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles M. Green, United States.) (Complete specification.)

23532. Improvements in electric brakes for electric railway cars and other electrically-operated mechanisms. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

23533. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Hartham, United States.) (Complete specification.)

23534. Improvements in governors for air-compressors driven by electric or other motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Sam. H. Libby and William B. Potter, United States.) (Complete specification.)

23541. Improvements in apparatus for controlling electric motors. Henry Leitner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

23545. Process for obtaining an electrolytic deposit of metallic films on aluminium. Otto Paul Nauhardt, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25556. Improvements in submarine cable telegraphs. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Albert C. Crehore and George O. Squire, United States.)

NOVEMBER 9.

23593. Continuous to alternating electric current transformer. Harry Chapman, 128, Rushdale-road, Heeley, Sheffield.

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23597. Improvements in apparatus for the electro-deposition of metals. John Walter Smith and William Evans, 128, Colmore-row, Birmingham.

23624. Improvements in or relating to the utilisation of Hertzian and similar radiations and apparatus therefor. Louis Heathcote Walter, 111, Hatton-garden, London.

23639. Process and apparatus for the separation of slightly magnetic substances. Alexander Melville Clark, 53, Chancery-lane, London. (The Metallurgische Gesellschaft A. G., Germany.)

NOVEMBER 10.

23659. Improvements in and relating to the electrical propulsion of tramway cars, railway carriages, and the like. David Robertson, jun., 96, Buchanan-street, Glasgow.

23662. Improvements in electrical switches. John Henry Tucker, 16, Oozells-street, Birmingham.

23699. Improvements in and relating to trolleys and trolley poles used in overhead systems of electric propulsion. Robert Price Strachan, 70, Chancery-lane, London.

23706. Improvements in the manufacture of dynamo brushes. Johann Leissing and Charles L. Hiebl, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23716. Improvements in or relating to secondary or storage batteries. Reginald Haddan, 18, Buckingham-street, Strand, London. (George J. Miller, United States.) (Complete specification.)

NOVEMBER 11.

23728. Improvements in or connected with incandescent electric lamps. John James Brooke and Frederick Williams Allen, 5, John Dalton-street, Manchester.

23750. Improvements in electro-dynamic relays for use on telephone and telegraph lines. Sidney George Brown, Van Buren, Poole-road, Bournemouth.

23753. Improvements in electrical measuring instruments called potentiometers. John Ambrose Fleming, University College, Gower-street, London.

23768. Improvements in rails with cable for electric traction. Albert Plank Weight, 171, Queen Victoria-street, London.

23820. Improvements in apparatus for measuring the phase of alternating currents. Josef Tuma and Max Raphael Kaldegg, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23821. Improvements in and relating to coin-freed telephones. Alexander Edwin Gillespie and John Gillespie, 18, Southampton-buildings, Chancery-lane, London.

NOVEMBER 12.

23827. Improvements in the art of electric dyeing and shrinking and in apparatus therefor. George Dexter Burton, 46, Lincoln's-inn-fields, London. (Complete specification.)

23853. Improvements in primary galvanic batteries. Sydney Ferris Walker, Cardiff Electrical Engineering Works, Severn-road, Cardiff.

23890. Improvements in electric velocipedes or other vehicles. Albert Hänsel, 171, Queen Victoria-street, London.

23895. Electric ignition apparatus for internal-combustion engines. Alexander Melville Clark, 53, Chancery-lane, London. (La Société Anonyme des Automobiles Peugeot, France.)

SPECIFICATIONS PUBLISHED.

1897.

21178. Treatment of solutions of carbonates of soda resulting from electrolysis of chloride of sodium, and in apparatus applicable for use therein. Hargreaves.

23681. Mechanism for operating or controlling electrical motors at a distance. Martinez.

24417. Electrical and other recording instruments. Barker.

27598. Electrical fusible cut-outs. Byng.

29235. Electrical switches. Moores and Farrell.

30008. Steering wheels for mechanically-propelled road vehicles. Southey and the Electric Motive Power Company, Limited.

30622. Combined manual and automatic switch for electric circuits. Hailey.

1898.

58. Rail joints for electric railways. Barschall.

156. Method of fixing and suspending bare electric conductors. Blackburn and White.

13861. Electro-deposition of copper and other metals on rotary cathodes. Heys. (Dumoulin.)

16659. Electrolytic process for extracting metals from their halogen combinations. Hilberg.

16717. Trolleys for electric railways. The British Thomson-Houston Company, Limited. (Case.)

17588. Primary electric batteries Boult. (Bussom.)

18807. Electric sparkers for explosion engines. Winton.

19075. Electric high and low tension fuse head for blasting, mining, and the like purposes. Taylor.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Nov. 12	4,035	3,604	+ 431	—	—
Blackpool and Fleetwood Tramroad	,, 12	229	—	—	13,365	—
Bristol Tramways and Carriage Co.	,, 11	2,607	2,498	+ 109	—	—
City and South London Railway	,, 13	1,056	1,081	- 25	19,360	18,661
Dover Tramways	,, 12	161	98	+ 63	7,502	—
Dublin U.T., elec. cars	, 11	353	+274	+ 79	9,760	7,030†
Dublin S.D. Electric Tramways	,, 11	789	411	+ 378	19,262	13,123
Halifax Corporation Tramways	,, 9	233	—	—	5,174‡	—
Liverpool Overhead Railway	,, 13	1,436	1.283	+ 153	—	—
South Staffordshire Tramways	,, 11	660	598	+ 63	28,547*	28,729*

* Receipts since Jan. 1. † Horse cars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	15½-16½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10-10½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16½-17½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-14
Brush Electrical Engineering, Limited, Ordinary	2	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	100-113
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	10-10½
——	6	5¾-6¼
—— Pref. Half-Shares	1	1¼-1¾
—— " "	5	4½-5
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23½-24½
—— 90,001-100,000	10	23½-24
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	69-71
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	124-126
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	13½-15½
—— " " No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1¾-2
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	100-102
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	1-1¼
Elmore's Wire Company	2	1-2
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	23-25
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7½-8½
London Electric Supply, Ordinary	3	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-6½
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	15-16
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7½-7¾
—— £4½ Shares, New	4½	6¾-7
Oriental Telephone and Electric Company	1	1-1¼
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-108
South London Electric Supply, Ordinary	3	2½-3½
St. James's and Pall Mall, Limited, Ordinary	5	9½-10½
—— 7 per cent. Pref.	5	5-6
—— 4 per cent. Deb. Stock, Red.	100	102-106
Telegraph Construction and Maintenance	12	25-30
—— 5 per cent. Bonds	100	108-111
Waterloo and City Railway, Ordinary	100	14-16
Westminster Electric Supply, Ordinary	5	

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NOTES.

A New Professor.—The council of King's College, London, have appointed Mr. Ernest Wilson, M.I.E.E., professor of electrical engineering, in succession to the late Prof. John Hopkinson.

Combined Systems of Lighting.—An interesting display of a combined system of gas and naphtha lighting was lately given at the St. James's Park Station of the District Railway. Naphtha lamps of the costermonger order were suspended from the various gas lamps, and served to indicate the place where the passengers should look for the gas flame. The precaution was quite necessary.

The Wilde Prize.—What is known as the Wilde prize of 40,000fr. has, says the *Western Electrician*, recently been awarded by the French Academy to Mr. Charles A. Schott, of the United States Coast and Geodetic Survey, for his excellent work in territorial magnetism, and chiefly for the theoretical investigations for determining the variations of magnetic elements. This is the first time the prize has been awarded, and our contemporary is naturally pleased that it should go to an American.

Aluminium.—The returns of the Home Office on the output of British mines and quarries gives some figures as to the extraction of aluminium in the British isles. The British Aluminium Company are responsible for the return. Their alumina is prepared at works near Larne, in Ireland, and then dispatched to the Foyers works in Inverness, where the electric furnaces are situated. The quantity of alumina extracted at the Larne works last year was 850 tons, valued at £15,300, which produced 310 tons of aluminium, valued at £45,800.

Royal Institution.—The Christmas course of lectures, specially adapted to young people, at the Royal Institution, will be delivered this year by Sir Robert Stawell Ball, LL.D., F.R.S., Lowndean professor of astronomy and geometry in the University of Cambridge. The subject will be "Astronomy," and the lectures (which will be illustrated by models and the optical lantern) will deal with the sun, the moon, the inner planets, the great planets, shooting stars, and new methods. The first lecture will be delivered on Tuesday, Dec. 27, at three o'clock, and the remaining lectures on Dec. 29 and 31, 1898, and on Jan. 3, 5, and 7, 1899.

Institution of Electrical Engineers.—The annual general meeting of the students' section was held at the Institution on Wednesday, Nov. 16. It was unanimously passed: "That the hearty and sincere thanks of this meeting, as representing the students of the Institution, be accorded to Mr. S. S. Grant for the able and earnest manner in which he has fulfilled the position of secretary during the past year, and for the great interest he has taken in the students' future welfare." The following gentlemen were elected to serve on the new committee: Messrs. M. R. Gardner, F. S. Miller, L. R. Morshead, A. Pope, W. G. Royal-Dawson, and M. Solomon (hon. secretary).

Metal Conduits for Electric Wires.—In a recent number of the *Elektrotechnischer Anzeiger* an illustration of an ordinary iron gas-pipe which had been used as a conduit and had failed is shown. In a length of about 6in. three large holes had been burnt through the pipe by an electric arc from one of the conductors. Our contemporary presumes that the wires had been well insulated, and raises the question as to whether the bare iron pipes should be used for the purpose. It argues that the insulation inside a tube itself is more advisable. The error in judgment appears to us to be in allowing the electric circuit to be so inefficiently protected by fuses. If the wires in question had been properly fused, the cut-outs would have gone long before any damage could be done to the conduit or any risk of fire incurred.

Etherion.—This new gas, said to have been found by Mr. Brush in the States, was referred to in a note in our columns a few weeks ago, in which we pointed out the exceedingly slender grounds on which the presumed discovery was based. Our contemporary the *Journal of Gas Lighting* says in this respect that doubts have been cast upon the existence of this reputed constituent of the atmosphere, but the fact of Mr. Brush having read a paper describing his new find before the Chemical Society of Cleveland should silence cavillers." We see now that De Rougemont's veracity must no longer be doubted, because he read two papers before the British Association. Our contemporary has the audacity to head this notice, "The Presumed New Gas, Etherion." We trust that the Chemical Society of Cleveland will take up the matter.

Languages.—The need an electrical engineer has for a good knowledge of French and German, and perhaps of other foreign languages as well, is becoming every hour more pressing. A vast amount of good technical information is contained in the technological literature of Germany, and this is not taken advantage of by, we are afraid, the majority of our electrical engineers. How different the matter is in Germany is well known to anyone who has friends among the German profession. It is there found that every electrical journal from other countries is closely studied and new information made use of. The facilities for acquiring foreign languages in London are many, but we wish particularly to draw attention to the Central School of Foreign Tongues. Mr. Howard Swan is the principal of this undertaking, and uses the Gouin system. The fact that Mr. Swan has had large experience in electrical matters makes the school of especial value to electrical engineers.

Injunctions.—The laws governing the interference of one company with its rival in the same line, in America, are, to say the least, incomprehensible to an Englishman. A case in point is described in the current number of the *Western Electrician*. It seems that the Electric Railway Company of Chicago had powers granted them by that city to lay down tramways in Plymouth-court and Custom House-court. The company tried to rush the work through between midnight on Saturday and Monday, in order that a certain railway company should not be able to obtain an injunction to stop the work. The railway company was not to be done, and succeeded in obtaining what is called a Sunday injunction. The next obstruction consisted of the railway company upsetting two lines of coal-trucks across the proposed route, and in doing so they seriously damaged a warehouse in the route which the loaded trucks took before being upset. As a result the new tramway could not be constructed, and ordinary traffic was interrupted. We manage these things better in England.

Glasgow Electric Tramways.—Mr. John Young, manager, last week submitted a report to the Tramways Committee of the Glasgow Corporation on the working of the previous fortnight of the electric tramways between Mitchell-street and Springburn. It showed that the cost of the electric traction was 6½d. per car mile run, while the earnings were 1s. 4½d. per car mile—a profit of 10d. per car mile. The departments had not yet the full use of the engine power. He also reported as to the probable cost of the conduit system as compared with the overhead system. He estimated that the introduction of the con-

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duit system would cost £347,000 more than the overhead system for the 28 miles of tramways which had not yet been converted to electricity. With the exception of nine miles, which would not require to be relaid, these had all the old style of shallow rails. But even with the cost of altering these the adoption of electricity would result in a considerable saving as compared with horse traction. He estimated that the conduit system would cost about 5½d. per car mile, as against 5d. by the overhead system.

Falcon Works Engineering Society.—Mr. Percy Sellon delivered the presidential address to the above society at the inaugural meeting of the present session on the 17th inst., when there was a large attendance. After referring to current and prospective developments in the electrical industry, Mr. Sellon passed on to consider the position of the British manufacturer of electrical produce in the face of competition from the Continent and America, and contrasted the conditions as regards labour, materials, and supervision of the respective systems in present operation in Great Britain, Germany, and Switzerland, and the United States. Mr. Sellon concluded by referring to the changes and extensions which have been, and are now being, introduced at the Falcon Works with a view to assuring for the Brush Company's manufactures the benefits of latest thought and experience on labour conditions and productive organisation, including the introduction of the single-break day, the growth of the piece-work system, the company's profit-sharing scheme, etc. A cordial vote of thanks to the president concluded the meeting.

Scottish Society of Arts.—The opening meeting of the session of the Royal Scottish Society of Arts was held last week in Edinburgh, when the president, Mr. Andrew Beatson Bell, delivered an address dealing with the question of "Illuminants." He said that the rivalry between gas and electricity had resulted in people learning, as they never learned before, what illumination really means. They had learned from electricity that gas might be still further improved and cheapened both in manufacture and consumption. He also referred to the large scheme for the production of electricity at the top of Loch Leven, near Ballachulish, where it is proposed to divert the waters of Loch Ericht, which at present have their outflow through Loch Rannoch, and thence as an effluent of the Tay into the German Ocean, by conveying them across the watershed of Scotland, and discharging them into the head of Loch Leven, forming there an extensive system of water power for the generation of electricity. Now that the application of water power to the generation of electricity had been successfully introduced in the Highlands, he thought it highly probable that within the next few years the great tidal currents at the mouths of the salt-water lochs of the West Highlands might be utilised, in addition to the fresh waterfalls at present alone employed.

Incandescent Lamps in Gasworks.—A regular correspondent, Mr. J. Gilham, has forwarded us some particulars of the fatal explosion which recently occurred at Saltley Gasworks, and makes suggestions which we consider to be very valuable as to the prevention of such accidents in the future. It seems that the engine tender, who died from injuries caused by the explosion, was minding an engine directly coupled to a large pump and used to draw the gas from the retorts. It was his custom to block the engine in a position in which it could be easily restarted by means of a wooden prop. The accident arose from this prop breaking the cover of the gas-cylinder. There was at once an outrush of gas, and before it could be prevented the explosion occurred which fatally injured the deceased. The explosive mixture was ignited by the gas jet in the engine-room. Our correspondent points out that had incandescent lamps been used no explosion would have occurred, and the great damage to property and loss of life would have been avoided. The necessary electric installation in gasworks could be conveniently driven from gas-engines, and would be specially valuable to the gas engineer in other ways. He would have then a good opportunity of ascertaining the actual cost of electric lighting, and would not be dependent on paper figures for his information, as so many gas engineers are.

Electric Motorcars.—Our contemporary the *Journal of Gas Lighting* deigns to notice the recent meet of the Motorcar Club in Whitehall, because "the progress of the road motor, such as it is, is a decided set-back to the overweening pretensions of the electricians to have 'the future' in their keeping." The editor says, "Mr. Shaw Lefevre twaddled very amiably in the evening about the ultimate solution of the problem of mechanical road traction being reserved for electric power. 'Electricity' means as much in the mouths of such speakers as did 'Mesopotamia' to the old lady of blessed memory. The fact remains that petroleum was far and away the most common source of power represented at last week's meet. A few of the now familiar yellow electric cabs that buzz along the streets of London with their carefully-limited loads were present; but otherwise electricity was not in evidence. This is a poor showing for the 'motive power of the future,' for that which has no beginning rarely comes to any good." Our contemporary is evidently much vexed at the repetition of the formula that "electricity is the light of the future," but we believe that the soreness is much aggravated by the knowledge that electricity at present is a heavy opponent of its interests. Still, we should hardly have expected the vexation to have reached such a pitch as to cause the string of words which conclude the above notice to be put forward as either sense or logic. We shall be told next week, we presume, that "that which has a beginning never commences."

Calcium Carbide.—At a recent meeting of the Polytechnical Society at Berlin, Mr. Nicolai, a director of the German Electric Company, read a paper on the manufacture of calcium carbide, from which we abstract the following highly interesting data: In discussing the raw material best suited for the production of a standard grade of calcium carbide, Mr. Nicolai stated that the best proportion of mixture was 100 parts by weight of lime to 70 of coke. Lime averaging 99 per cent. of calcium, and coke low in ash, will produce an almost pure carbide. The coke should not run higher in ash than 5 per cent. Charcoal proved unsuitable for the furnace process, but in the smelting machine invented by Nicolai it can be used, for in this case the material to be smelted is compressed on an electrical conductor to a suitable height, and the arc touches the compressed mass only at the moment of smelting. A burning of the carbon or the carrying off of fine carbon or lime particles is impossible in this case, for the hot gas developed escapes directly into the open air without having come in contact with the charge that is being fed in. In the manufacture of calcium carbide care should be taken that the raw material be not burned by hot gas, as is often the case in the electric furnace, that the loss of electrical power be reduced to a minimum, and that the raw material should be exposed to the electric arc only so long as is necessary for its conversion to carbide. We are indebted to *Kuhlow's Review* for the above extract.

Water Power in Ontario.—Mr. T. W. Gibson, in the *Canadian Engineer*, makes some most useful extracts from the report of the Ontario Bureau of Mines for 1898.

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These deal with the districts in which large water powers from rivers and lakes are still unused. The conclusion arrived at is that the presence of so many available water powers in the Lake of the Woods, Seine River, Wahnapitae, and other mining districts of Ontario is a fortunate circumstance, and cannot but have a very favourable effect upon their development. Cheap power means economy in working, and will permit of ore bodies being profitably utilised which would otherwise not pay for treatment. The immense deposits of low-grade ore which are found north of Lake Superior and on the Upper Seine are in many cases situated in proximity to waterfalls capable of yielding hundreds and thousands of horse-power at comparatively little expense. The importance of preserving these water powers as far as possible for the general benefit and preventing their being locked up in the hands of speculative individuals who would not use them themselves, but who would demand heavy toll for their use by others, has led to the adoption of new regulations under the Act respecting Water Powers (61 Vict., chap. 8), passed at the last session of the Legislature. The principal features of these regulations are those which provide for the leasing of such powers by the Crown, instead of patenting them outright, and for the furnishing of surplus power by the lessee to others on terms to be fixed in case of disagreement by the Lieutenant-Governor-in-Council.

The Metropolitan Railways.—The experiment with electric traction on the Metropolitan and District Railways is to be carried out on the loop line between arl's Court and Kensington High-street. This section of the line has been chosen for two special reasons—first, because the ordinary service thereon is not so frequent as that on other sections, and, in the second place, because it contains some steep gradients—as sharp as 1 in 40—which will enable the new electrical system to be tested under the severest conditions that would be experienced in regular working. The experiments will be carried on, without any interruption of the present steam locomotive traffic, to demonstrate the practicability of the principle thereafter to be introduced generally on the lines of the Metropolitan and the Metropolitan District Railways. The contract for the experimental work has been placed with one of our largest electrical firms, but as the details are not finally settled, we refrain from mentioning names. The generating plant will be of a temporary nature, but the equipment of the trains will be more permanent. It is proposed at present to have the motors distributed on the different carriages of the train, some four gearless motors being used for each train. These, with a series-parallel controller, it is thought, will give better results than an electric locomotive. The conductors will be placed between the lines, both lead and return being insulated, and the present experiments are chiefly required to ascertain the best arrangements of these to prevent interference with steam traffic, either during construction or afterwards. The experiments are to be carried out in July next.

The Toronto Magnetic Observatory. — The magnetic observatory which for years had done such good work in Toronto, having been rendered useless by the electric tramway service of the town, the question of the best site for the establishment of a new observatory in the neighbourhood had to be considered. The director of the observatory was accordingly authorised by the Government to choose and purchase a suitable site for a new magnetic observatory, and after making careful examination as to the distance that the electric currents might affect the magnets, it was decided to erect the new building near the village of Agincourt, a point about 10 miles distant from the present observatory. The site is easily accessible by railway, and yet is very unlikely to be invaded by the trolley system. The new observatory was, says the *Canadian Engineer*, commenced in June and finished during the early days of September. It consists of two parts—first, a circular stone cellar 19ft. in diameter, the walls 2ft. in thickness, the floor concrete, and the roof covered with felt and gravel. In this chamber, on stone piers sunk in concrete to a depth of 6ft. below the floor, are placed the self-recording photographic instruments. These comprise the declinometer for recording changes in the direction of the magnetic needle, and the bifilar and vertical force instruments for registering respectively changes in the horizontal and vertical components on the earth's magnetism. Above ground and connected with the cellar by a flight of steps is an erection which is divided into two portions, in the larger of which absolute magnetic determinations will be made, piers being provided on which to place the necessary instruments, and an adjustable opening on the roof for transit work. The smaller room is used as an office which will be heated by a copper stove. Observations were first made in the new building on Sept. 16, and it was hoped that by October all the instruments will have been adjusted in their new position and everything running smoothly. Results already obtained have shown that values will differ but slightly from those obtained at the old observatory, and it is proposed to make a very careful comparison before dismounting the old eye-reading instruments in Toronto. Very great care has been taken in selecting material for the building; every stone used was tested for magnetic effect, and none but copper or zinc nails and fastenings have been used. There appears to be every prospect that the new observatory will be admirably suited for the purpose for which it has been designed, and there is strong reason to think that the series of observations at Agincourt will be practically a continuation of the old and valuable series of observations in Toronto.

Rontgen Society.—The president of the Röntgen Society and Mrs. Mansell Moullin and the council entertained a large number of scientific gentlemen and their friends at a conversazione at the St. Martin's Town Hall on Monday night. While a most enjoyable programme by the London Concert Orchestra, with a couple of songs by Mr. Fitzroy Sheridan, and an excellent buffet supplied the wants of the inner man, those who wished that "this too solid flesh could melt" had no difficulty in gratifying their desire. In the main hall, which was filled with exhibits, Dr. Hedley presided over the London Hospital outfit, supplied by Isenthal, Potzler, and Co. A small portable dark-room was set up, and this cupboard was well patronised by those who wished to examine their friends skeletons or part of their own. Similar exhibitions were given in a large darkened room by Dr. Pepperdene, and Messrs. Webster, Watson Baker, Coldwell, Cox, and Dean. A number of patients in charge of nurses were similarly examined, under the supervision of Dr. Walsh, assisted by Mr. Fenton and Mr. Isenthal, a case of congenital clavicular malformation being especially easy to discern. Another patient lay on a stretcher in the main hall, and his bones could be distinctly seen by means of the fluoroscope, which consists of a fluorescent screen fitted with bellows like a camera, ending in an eyepiece bound in fur. This permits the exclusion of all extraneous light, and these appliances are very useful in simple cases, as the room need not be darkened during the examination of the patient. The phenomena of the Geissler tubes by Messrs. Corser, Gerard Smith, and Vesey, and the "white magic" by Prof. Silvanus P. Thompson, F.R.S., who demonstrated the

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action of the Tesla oscillator upon vacuum tubes destitute of electrodes, drew such a large audience that it was almost impossible to get near. Mr. Harry W. Cox showed a large induction coil with his new type of contact-breaker. The coil required about six amperes and twelve volts when giving a 19in. spark. Mr. Isenthal had an apparatus fitted with double bulbs. These tubes consist of a very large bulb, about double the size hitherto used. The tube is continued vertically, then another bulb, about a quarter of the size, and a small sideward branch with another anode in it, is added. The advantage claimed for this arrangement is that a continuous supply of X-rays is produced without the necessity of heating the bulb every now and then, and that the current required is very low. A large selection of X-ray photographs lined the room, and we should suggest that another time the tablets should bear more definite inscriptions. It is rather puzzling at first to come across a female skeleton, and to read: "Mr. A—— B——," this being presumably the name of the exhibitor, and not of the exhibit.

Teslaic Transmissions.—The best criticism we have seen of the enormous potentialities claimed by the daily Press, both here and in the States, for Tesla's latest development in electric works, is contained in the *Electrical World*. Our contemporary, in a leader headed "Boundless Space a 'Bus Bar," states that at least one of the American electrical journals has taken Mr. Nikola Tesla's patents more seriously than the inventor intended them. The idea proposed comprises nothing more nor less than a high-tension step-up transformer feeding into a vertical conductor with a terminal at such an elevation above the earth as to reach a strata of rarefied atmosphere which has a comparatively low electrical resistance, a similar step-down transformer to be connected at any desired point with the same conducting strata by means of any suitable device, such as that used by the illustrious Benjamin Franklin, or, preferably, as stated in the patent, by means of a balloon, the earth being utilised as a ground return. The fact is set forth that the atmosphere at 15lb. to the square inch, or other pressures common near the surface of this mundane sphere, is a good insulator, while at lower pressures, as is well known by manufacturers of 200-volt lamps, it becomes quite a fair conductor. By a rigid suppression of the reasoning faculties, and a little freedom of the imagination, fancy pictures a conductor poked up through the insulating sheath at Niagara, establishing an alternating difference of potential between the superincumbent ether and this ball of solid matter below protected by an atmospheric dielectric, which difference of potential can be tapped, so to speak, at any desired location, such as the large cities, or by express trains with electric locomotive towing balloon trolleys, making contact with an overhead conductor, from which they cannot readily slip off. The use of several great sources of natural power will, of course, necessitate generators of the same frequency running in synchronism with each other, as they are all, so to speak, connected across the same 'bus bars, and lacking the third 'bus bar, multiphase systems will go out of fashion. The system might, however, give other results more valuable than those of power transmission. With transmitting and receiving stations at Niagara Falls and New York City respectively, the State of New York would possibly be illuminated by a gigantic Geissler tube overhead that would turn night into day, put to shame the aurora borealis, and make the advocates of diffused illumination shout for joy. (The writer reserves all rights to the use of interplanetary space as a vacuum tube for lighting purposes.) Mr. Tesla should certainly be enjoined from putting his polished ball terminals too high, or a Crookes tube effect might be obtained, emitting a profusion of X-rays which would disclose altogether too much to anyone with fluorescent spectacles, and might make it necessary for mortals to carry leaden umbrellas to prevent the skin being burned from the tops of their heads.

Cadmium Standard Cells.—Mr. S. N. Taylor gives an account of some valuable experiments on cadmium cells, considered as standards of E.M.F., in the *Physical Review* for September-October, 1898. The disadvantage of a Clark cell when used as a standard of E.M.F. lies in the fact that its voltage varies by about ·001 volt per degree centigrade, and, further, that it is a matter of some difficulty to ensure that the internal parts of a cell are at any required temperature. The cadmium cell, on the other hand, has an E.M.F. almost independent of temperature. This difference between cells which are to a great extent similar in their construction is probably due to the fact that, whereas the solubility of zinc sulphate varies somewhat rapidly with the temperature, cadmium sulphate dissolves to the same extent in moderately warm as in cold water. Mr. Taylor commenced the examination of cadmium cells with the intention (1) of determining to what extent cells set up at different times and by different persons would agree as to their E.M.F., and (2) to determine this E.M.F. in absolute units. The method employed in making the cells was as follows: Six parts by weight of mercury were mixed with one part by weight of cadmium, the whole being gently heated till fusion took place. The mixture became solid when cold. In making the H form of cell, platinum wires were sealed into the bottoms of the side tubes, and the cadmium amalgam was introduced while still pasty into one of the side tubes, so as to cover the platinum wire. This became hard and fixed when cool. Above this was placed a layer of $CdSO_4$ crystals, reaching to the cross tube. In the other tube the platinum wire was covered with mercury, which serves as the positive electrode. Above the mercury a paste of mercurous sulphate mixed with cadmium sulphate crystals was poured in, so as to reach the cross tube. The remaining space was filled with a saturated solution of cadmium sulphate, the orifices of the tubes being finally closed with corks, and sealed with a cement made from beeswax and resin. As far as the tests of these cells are concerned, they show conclusively that the E.M.F. of a cadmium cell may be depended on to within a few hundred-thousandths of a volt. The value of the E.M.F. is about 1·0180 volts. This does not vary with time, as far as experiments have proceeded at present, to any greater extent than that of the Clark cell. With regard to the absolute determination of the E.M.F., Rayleigh's method was used, the E.M.F. of the cell being compared with the difference of potential between the terminals of a coil of known resistance through which a known current is flowing. The strength of the current employed is also determined, after Rayleigh's method, by weighing, a special form of electro-dynamometer being used. Though great care seems to have been employed in the design and construction of this instrument, it is to be regretted that unsuitable dimensions were given to the coils, so that the current could not be accurately determined without greatly extending calculations which, under the most favourable circumstances, are very laborious.

Continuous Current in the Alternating Arc.—Messrs. Eichberg and Kallir's paper read before the Imperial Academy of Sciences in Vienna, is thus condensed in Mr. Carl Hering's digest in the *Electrical World*. The author's researches were made with the apparent continuous currents produced in the alternating arc between different kinds of electrodes. If an alternating arc is tablished between a metal rod and a carbon, then a

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tangent galvanometer in the arc circuit shows a continuous current in the arc from the metal to the carbon, and a voltmeter at the arc shows a continuous voltage in the direction of carbon metal. This phenomenon occurs when there is a drop of molten metal on the metallic electrode and when the arc burns quietly; cored carbons were used; iron, aluminium, copper, and nickelline were used as electrodes, but the observations were difficult with the aluminium. Measurements of all the factors were carefully made, and the results are given in tables; for all the different metals the continuous current and voltage have approximately the same values. It has been shown that in a continuous-current arc there will be a lower voltage when the current is from the metal to the carbon than when in the opposite direction, and that the voltages are different for the different metals. The current and voltage curves were also measured in the case of the alternating arc, the results being given in curves, which show that the formation of the arc from carbon to iron involves the production of a great resistance, but whether it is a true resistance or a counter E.M.F. was not apparent; this explains the almost complete interruption of the current in the direction of the carbon to the iron, which checks that current, but allows the other to pass. The phase shifting produced is quite appreciable with a machine of high self-induction. The fact that the arc from the carbon to the iron was not formed was shown photographically, the illustrations being reproduced for six phases, differing by 60deg. The curves show that continuous current and voltage values are affected by the alternating E.M.F. and the phase shifting. The almost complete interruption in the direction carbon iron produces remarkable phenomena when such arcs are connected in series or in parallel; the latter are discussed, as are also experiments with an exploring carbon introduced in the arc. An alternating arc between a metal and carbon therefore acts like a valve, allowing a current in only one direction to pass; they connected a battery of accumulators with such an arc and found that about the best efficiency of conversion of the alternating into direct current was 30 per cent. They then made tests of the arc between carbons of various kinds and positions, and found direct currents; when the upper was cored and the lower homogeneous or the reverse, or when they were horizontal, a continuous current was produced, the largest when the cored carbon was the upper; in all three cases the continuous current was from the cored to the homogeneous carbon, the latter being positive to the former; some numerical results of the observations are given. These direct currents seem to be the resultants of two continuous currents, one dependent on the position and the other on the constitution of the carbons.

An Electric Printing Establishment.—Mr. G. A. Damon read a paper, early in November, before the Chicago Electrical Association, entitled "Electrical Equipment of a Model Printing Establishment." The example taken is the establishment of the W. B. Conkey Company, at Hammond, Indiana. The location of their buildings in Chicago made it necessary before electricity was introduced to maintain two distinct plants, one for lighting and one for heating. Power was transmitted by means of belts, rope drives, and pulleys. By this system fully 45 per cent. of the power delivered to the main driving shaft was used in driving the shafting, and with light loads the loss was considerably greater. The company, considering these disadvantages, sought a new location, and secured a good site at Hammond, Ind. The new buildings are very commodious, but consist only of one floor. The engines used are of the Corliss type, and run at 125 revolutions per minute. The dynamos are compound wound, and are designed to give 100 kw. output at 225 volts when running at 125 revolutions per minute. The field frame is split, and the upper part can be removed. In case repairs are needed to the armature windings or field coils, provision has been made to slide the field magnets along the axis clear of the armature. The armature is of the iron-clad type, with a large commutator. The plant is arranged with two engines and three dynamos, and the machinery is connected on the "Arnold system" of power station construction, which enables one generator to be operated by more than one engine, which would be very useful in case of an engine breaking down, and lessens the need for reserve plant. The building is lighted by arc lamps, each set of four being controlled by a cut-out. The total number of motors employed at the present time is 95, of which 17 are used in the electrotype foundry, belted and geared to various machines, with a total of 21 h.p., and also one 10-h.p. motor direct-connected to the electroplating dynamo; 25 are used in the bindery, the total horse-power being 80·5, belted to shafting and various machines; two in the stock-room, belted to shafting and driving cutting, etc., machines; one is belted to a fan for office heating, and one in the machine-shop, and one in the composing-room. In the press-room 47 are attached to presses. The total horse-power of all the motors installed is 321. The motors throughout are of the Lundell type, and are made with one field coil, which is protected by the field casting. The motors do not spark with sudden changes of load. There are various considerations which usually determine in each case whether a motor should be belted, geared, or directly attached to a machine, or perhaps indicate that the machine should be grouped with others of its class and driven from a common shaft. For instance, there are certain classes of machinery, such as folders, stitchers, type-setting and type-distributing machines, etc., which take but a very small amount of power, which are each in operation almost continuously and which can be arranged in rows convenient to a line-shaft. Little would be gained by driving these with individual motors. The method of driving the large presses, however, presents the most problems. Here the conditions of operation leave but little doubt that individual motors should be provided. But whether to belt, gear, or direct connect the motor to the press is the problem. The belted equipment is the cheapest and most convenient, and the higher speed at which they run makes them of more value in press work. The belted motor takes up valuable room, however, and as it must be protected it usually presents an unsightly appearance. The geared motor can be installed in most cases and is an improvement over the belted type, though the increased cost of its installation makes its advantage a doubtful one. The directly connected motor takes the place occupied by the driving pulleys of a belt-driven press, and thus has the advantages of neatness and compactness. As presses are usually built the main driving shaft makes five revolutions to every impression, so that a press operating at 1,440 impressions per hour requires a direct-connected motor running at 120 turns per minute. This slow speed means a large and comparatively expensive motor. The slow speed of the armature prevents the accumulation of energy to help the press over the centres. In spite of these disadvantages, however, the improvement in the mechanical design of the equipment with direct-connected motors over the belted or geared arrangements and the longer life of the slower-running motors were thought to be sufficient to justify the extra investment, and therefore motors directly connected to the 41 presses were installed.

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ON THE RELATION BETWEEN THE HEAT EVOLVED AND THE E.M.F. GENERATED BY VOLTAIC ACTION.

BY DESMOND G. FITZ-GERALD.

The question—in its bearings on the theory of lead reversible batteries—as to the relation between volts and calories has remained for some time in a most unsatisfactory, but at the same time interesting—I might almost say sensational—stage of elucidation. On the last occasion—more than a year ago—that I met the late Mr. Latimer Clark, he referred to this matter, and said that, although he had read a good deal of what had been written on the theory of accumulators, in which he took some interest, he could not accept any of the conclusions arrived at, and thought "we were all at sea." And so we were—more or less—and so perhaps we are! Certain it is that at least one great oversight, mistake, or blunder—it will be characterised by all these terms—has been made, and that the youthful student, if not the adult investigator, is not only puzzled, but absolutely mystified by minor mistakes or careless inaccuracies.

My own position in the matter is peculiar. I am on the horns of a dilemma, one being much sharper than the other. I can escape the imputation of having participated in—well, a grave error only by being convicted of another, for which I should be solely responsible. The point at issue is not one of detail—the exact value of the second decimal figure in a number with four integers—it is far too broad to be a mathematical point at all. Having said what it is not, let me at once state—first, as concisely as possibly, and, afterwards, in fuller detail—what the point at issue really is.

It has been universally admitted in effect that—since in the case of a Daniell cell, for instance, it is certain that the number of calories generated in a voltaic reaction involving, say, dyad-gramme equivalents is about 46,000 *per volt*—therefore, since the E.M.F. of a lead accumulator is two volts nearly, the number of calories generated in this case per dyad-gramme equivalent must be about 92,000 calories (92 kilo-calories).

Now, the point at issue is whether this statement, as regards the accumulator, is approximately true or fundamentally false.

To avoid apparent paradox, let me at once point out that when we say "the E.M.F. of a Daniell battery is about one volt," and "the E.M.F. of a lead accumulator is about two volts," we are using the term E.M.F. in two different senses: first, to express a *constant*; and second, an *initial* value. *Verbum sapienti sufficit.*

The hitherto universally accepted view in regard to the lead secondary battery has been very lucidly expressed by Prof. S. P. Thompson as follows: "Why does an accumulator give an E.M.F. of about two volts? That is a purely thermo-chemical question. Why does the Daniel cell give us a little more than one volt? That is a purely thermo-chemical question, and can be shown without the slightest difficulty purely from thermo-chemical data—at any rate, to a first approximation. For example, we know that, taking an equivalent quantity of zinc, and causing it to be consumed in sulphuric acid and form zinc sulphate, the quantity of heat given out from the zinc is 85,000 calories, whereas the similar data for the equivalent of copper show 37,520 calories; and the difference between the two is 47,880; and, seeing that 46,000 calories or thereabout correspond to one volt, it follows that the E.M.F. of a zinc-copper element is a little over one volt. Now, if from the thermo-chemical properties of zinc and copper we can calculate the E.M.F. of a Daniel cell, we ought to be able to calculate precisely (if we know the chemical data) the E.M.F. of an accumulator. Conversely, if we know the E.M.F. of an accumulator to be two volts, or a little over or under, as the case may be, we ought to be able by that very fact to say which of the various thermo-chemical data corresponds to that E.M.F., and therefore say precisely what are the chemical facts.

"What are the various hypotheses that have been propounded? I think I know of five.

"Some people say that the E.M.F. of the accumulator is due to the reduction of peroxide of lead to spongy lead. It is rather a wild hypothesis, for it requires us to believe that the running down of the spongy lead to the metallic state at the anode reduces the peroxide back to the metallic state at the other end!

"The second hypothesis is that the peroxide is reduced from its condition of oxygen activity by the sulphuric acid to become lead sulphate.

"The third hypothesis is that at one end the lead goes to lead sulphate, and at the other end the peroxide is reduced to spongy lead.

"The fourth hypothesis is that both the plates go to sulphate: at one end PbO_2 gives up its oxygen and takes up SO_4, at the other end spongy lead takes up SO_4, and both become $PbSO_4$.

"And the fifth hypothesis is that at one end the peroxide goes down virtually to monoxide, and that at the other end the spongy lead goes down to litharge also.

"Of all these hypotheses, which is correct? If we know the thermo-chemical data, we can say absolutely which of these five is the proper hypothesis. It is only a question of knowing the facts. Take the first hypothesis—that peroxide of lead is reduced to spongy lead by hydrogen, by nascent hydrogen from the water in the acid—what am I to write up? I have to write, not a chemical, but a thermo-chemical calculation. We have $+ (H_2,O) - \frac{1}{2}(PbO,O) - \frac{1}{2}(Pb,O)$. According to the researches of Tscheltzow the numbers are 68,800 – 6,070 – 25,530, and the net result is 37,000. Now 46,000 go to one volt, or thereabouts, so these 37,000 only correspond to ·81 volt; so that settles that that is not the action.

"In the same way I would show you that the second hypothesis would lead to 1·17 volts. Also with the third hypothesis—which I believe is Mr. Fitz-Gerald's—that the spongy lead goes down to sulphate, and that the peroxide is reduced to a lower oxide: that would lead, according to the thermo-chemical data, to a force of less than one volt—0·96 volt.

"The accepted hypothesis is that both get sulphated. According to Tscheltzow the reaction is

$$(+Pb,O) - (H_2,O) + (PbO,SO_3,Aq) - PbO,O) + (H_2,O) + (PbO,SO_3,Aq);$$

now the numbers are

$$51{,}060 - 68{,}800 + 24{,}840 - 12{,}140 + 68{,}800 + 24{,}840 = 88{,}600,$$

which, turned into volts, $\frac{88{,}600}{46{,}000} = 1{\cdot}93$ volts, or very nearly two volts. This would show that the expression is a fair representation of what goes on. It is quite true that we get sulphate at both ends—I am perfectly sure on that point—and Mr. Fitz-Gerald will hear a further reason why he does not find it.* But, although I say that, I am very strongly of the impression that sulphating at both ends is, in one sense, no necessary part of the action of the battery; it is necessary in another sense, because the elements are chemically what they are. Suppose you have zinc and put it into a battery, that zinc dissolves in the sulphuric acid and unquestionably gives out heat—that is, if you let it only do that—but if instead you let it drive a current through a wire, then the energy is carried off through the wire and gives out heat somewhere else. But does the greater part of the heat come from the zinc going down to the state of oxide of zinc, or does it come from the oxide of zinc going down to the state of sulphate? Remember also that if you have an identical action at both sides of the battery, that action will avail you nothing, even though it gives out heat. Suppose you have zinc at each end turned thus into zinc sulphate, there is heat at both ends, but they do nothing; the heat is non-adjuvant, and does not assist the E.M.F. of the battery. Now, whatever else you have—the reduction of the oxide or the oxidation of the spongy lead—you certainly have lead sulphate: and if

* This refers to a statement in my paper "On Reversible Lead Batteries," that certain plates had been charged and discharged a great number of times without exhibiting the smallest patch of "white sulphate." I was referring to the non-conducting crusts on elements said to be "sulphated." In a less objectionable form—*i.e.*, in intimate admixture with active material—I have always found sulphate of lead present in discharged plates—both peroxide and spongy lead.—D. G. F.-G.

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you have lead sulphate at each end, the actions balance one another and become non-adjuvant.

"In the fifth hypothesis—that sulphating is a necessary accident of a non-adjuvant kind, and that the real actions are those that take place before sulphating begins—the heat values worked out give, as I make it, 103,460 calories, which is as near as possible 2·2 volts. Therefore, I am inclined to think that that is the real action of the cells."*

In Mr. Augustus Treadwell's recently published work on "The Storage Battery,"† which, whatever may be its shortcomings, is the most important treatise on the subject in the English language, the relation between volts and calories is set forth—for the benefit of investigators and learners—as follows:

"*Formula for the Calculation of the E.M.F. of Secondary Cells, given in E. J. Wade's 'Chemical Theory of Accumulators.'*‡

"In the following formula

H = the number of calories liberated by the recombination of a unit weight of one of the decomposed ions;
e = its electro-chemical equivalent;
c = its chemical equivalent;
h = the electro-chemical equivalent of hydrogen = ·00001038;
J = Joule's coefficient = 4·2;
E = the E.M.F. required:

$$E = J\,e\,H.$$

Now $e = h\,c$,

therefore $E = J\,h\,c\,H = 4{\cdot}2 \times {\cdot}00001038\,c\,H = {\cdot}0000436\,c\,H.$

Now $c\,H = \frac{\text{Heat of formation}}{\text{Valency}}$,

therefore $E = \frac{{\cdot}0000436 \times \text{heat of formation}}{\text{Valency}}$.

"Since nearly all battery equations are expressed in terms of the transfer of two atoms of hydrogen, or their equivalent (that is, they are bivalent), and since

$$\frac{{\cdot}0000436 \times 46{,}000}{\text{Valency}} = 1 \text{ volt},$$

we have $E = \frac{\text{Heat of formation, in calories}}{46{,}000}$."

For giving this extract, without comment or explanation, Mr. Treadwell deserves to be prosecuted by the Anglo-American Society for the Prevention of Cruelty to Students—supposing such a beneficent institution to exist. The unfortunate learner who has not a professor at hand is simply mystified; and the professor could only tell him that the equations are correct numerically, since they are the expression of Thomson's law, with one little blunder rectified by another.§ But, to begin with, the formula is given as applicable to "the calculation of the E.M.F. of secondary cells"—*quod est disputandum*—and this naturally suggests to the learner that it may be inapplicable to primary batteries, in which direction only it has received verification. Then, what is the learner to understand by "a unit weight"? What is meant, of course, is "a unit mass," the weight of which is immaterial. But what unit mass? If the indefinite article had been omitted, the enquiring learner might be snubbed by telling him that he ought to know that the C.G.S. absolute system of measurement is all but universally adopted in science, and that unit mass in 1 grm. But "a unit mass"—surely the student might be excused, indeed, justified, in thinking that this may mean *any* unit mass. But since the term "calorie," in the final formula, undoubtedly signifies the gramme-centigrade calorie of Dulong, the gramme is the only unit mass that satisfies the conditions; and "a unit weight" should have been "1 grm."

Then, what is "E = the E.M.F. required"? Is it the *initial* E.M.F. of the charged accumulator, which may be as high as 2·2 volts? In this case no one would maintain that the formula is applicable. It certainly is not the *final* E.M.F. of the discharged accumulator. Is it the *mean* "useful" E.M.F., between 2 and 1·8 volts? In this case, again, I think no one would hold that the formula is applicable. Is it the *mean E.M.F. acting throughout the whole period of a discharge*, from 2·2 to zero volts? In this case, I think, no one but myself would say that the formula is applicable.

If this admission on my part implies the making of a blunder, this is the less excusable for being made in the teeth of a general consensus, that "the E.M.F. required" is, not the initial, nor the final, nor the mean useful, nor the mean total E.M.F., but *two volts*. But according to my view, the calories generated by completely discharging a fully-charged lead secondary cell correspond to a mean E.M.F. of about 1·35 volts. "And I may further say that if, in any case where E.M.F. is not constant, but falls from a maximum to zero, the thermal values deduced from an electro-chemical equation were equivalent to the *initial* E.M.F., or to the final E.M.F. (which would be nil), then I should know that the electro-chemical equation, or the application to it of the thermal data, was wrong."* When the E.M.F. falls from 2 to 1·85 volts, then my calculated value for the mean E.M.F. acting over the whole period of *this* discharge is 1·87 volts, which is somewhat lower than the mean value obtained by experiment.†

I have to appeal, *inter aliis*, to the learner, for whom few writers in these days show much consideration—almost justifying the schoolboy's conclusion that "it was put that way to make it more difficult for us." On his behalf—for he has just got hold of Mr. Treadwell's book—I must make a short digression.

Thomson's law—which Mr. Jeames de la Pluche, F.R.S., prefers now to term Lord Kelvin's law—will become quite clear to you if you will bear in mind first that, since watts = volts × amperes, the E.M.F. at any period will be $E = \frac{\text{watts}}{\text{amperes}}$. It will be quite evident also that, consequently, $E = \frac{\text{watt-hours}}{\text{ampere-hours}}$.

Now, the calorific value of one watt-hour has been shown both by experiment and theory to be about 857‡ of the gramme-centigrade calories of Dulong. Substituting calories for watt-hours, we must divide the former by 857 to preserve the ratio constant. Thus

$$E = \frac{\text{calories}}{\text{ampere-hours} \times 857}.$$

Taking the monad-gramme equivalent as the unit of electro-chemical action, then, since this yields us 26·833 ampere-hours§, our equation becomes:

$$E = \frac{\text{calories}}{26{\cdot}833 \times 857} = \frac{\text{calories}}{23{,}000},$$

which is the expression of Thomson's law.

Now, what I venture to maintain, in opposition to a general consensus, is that, in the case of a cell where the E.M.F. is not constant, but falls from a maximum to a minimum, this formula (with certain corrections dependent upon conditions of experiment) will give the *mean E.M.F. acting throughout the discharge*, and *not* the maximum or the minimum E.M.F. The lead reversible battery—the ordinary accumulator—belongs to this category, and if we take the calories corresponding to a complete electro-chemical reaction (such as the conversion of Pb into $PbSO_4$ by the aid of the additional atom of oxygen in PbO_2, which latter also becomes converted into $PbSO_4$ in presence of H_2SO_4 in excess), these calories and this reaction correspond to a complete discharge of the cell down to zero E.M.F., and their voltage equivalent will be the mean E.M.F. in action during the total discharge. Conversely, should the assumed

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* *Journal* of the Society of Telegraph Engineers and Electricians, vol. xvi., No. 66, p. 200.

† "The Storage Battery: A Practical Treatise on the Construction, Theory, and Use of Secondary Batteries," by Augustus Treadwell, jun., E.E., A.M.Amer.I.E.E. London: Whittaker and Co. New York: Macmillan Company. 1898.

‡ London *Electrician*, vol. 33, p. 657.

§ c being the chemical equivalent—not the atomic weight—"heat of formation" = c H (not c H × valency), and

$$E = \frac{\text{heat of formation in calories}}{23{,}000}.$$

* "Notes on Accumulator Construction," Section XLI., *Electrical Engineer*, Dec. 17, 1897.

† *Loc. cit.*, Section LXIII., Jan. 28, 1898.

‡ *Loc. cit.*, Section XXXII., where, however, this value is by a misprint given as 867.

§ *Loc. cit.*, Section LIX.

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calories give the maximum E.M.F. of the cell, or any E.M.F. other than the mean, we know that the calorific values must be wrong, that the reactions corresponding to them do not take place, and that the assumed electrochemical equation, or the thermal values corresponding to it, or both, must be inapplicable. So that, in the case of the accumulator, instead of the quotient two volts being a clear proof that certain assumed reactions and their calorific values are really correct, it is an absolute proof that they are incorrect or inapplicable.

The question at issue may perhaps be rendered clearer by an example. Let us take the case of a Daniell cell in which a monad-gramme equivalent of zinc (32·45 grm.) is to be consumed, but which is supplied with only half an equivalent of sulphate of copper—viz, 42 grm. of $CuSO_4,5H_2O$. Let there be excess of sulphuric acid with the copper solution to allow of the passage of the current after the latter has become exhausted by the deposition of its copper. Take a discharge of 26·8 ampere-hours, this being the monad-gramme equivalent of electrical quantity. The E.M.F. will not be constant throughout the discharge, but will fall considerably during the latter half, in which H instead of Cu is liberated at the cathode within the cell.

Let us consider the quantities of heat respectively generated in the two portions of the discharge taking place under the different conditions—each portion consisting of 13·4 ampere-hours. Since only half a gramme equivalent is involved in each partial discharge, the number of calories corresponding to the gramme calorific equivalent* must be halved, and the divisor in the formula for E corresponding to this equivalent must be halved also.

The calorific equivalent for the substitution of zinc for copper in combination with the acid radical SO_4 is—subject to future determinations—

$$Zn \mid SO_4,Aq - Cu \mid SO_4,Aq = 27{,}400 \text{ calories.}$$

And according to this, neglecting certain corrections, the number of calories evolved during the first half of the discharge would be 13,700, and the E.M.F. would be that of the (theoretical) Daniell cell—viz.,

$$E = \frac{13{,}700}{11{,}500} = 1{\cdot}19 \text{ volts.}$$

The monad-gramme calorific equivalent for the substitution of zinc for hydrogen, applicable to the second portion of the discharge, is

$$Zn \mid SO_4,Aq - H_2 \mid SO_4Aq = 18{,}800 \text{ calories.}$$

Halving this as before, the number of calories evolved during the second half of the discharge will be 9,400, and the E.M.F. during this second half should be

$$e = \frac{9{,}400}{11{,}500} = 0{\cdot}818.$$

Taking the calories for the whole discharge, we have:

$$E = \frac{23{,}100 \text{ calories}}{23{,}000} = 1{\cdot}004 \text{ volts;}$$

which is not the maximum (initial) E.M.F., but the mean E.M.F. acting throughout the whole period of the discharge.

TRAMWAY TRACTION COSTS.

By the courtesy of the editor of the *Street Railway Journal* of New York we received an advance proof of an interesting article on tramway costs. Mr. J. Allen Baker also sent us a copy of the article with some comments of his own, which we give below:

DEAR SIR,—Reverting to my recent report on tramway traction (published by the London County Council) and the recommendation contained therein in favour of the electric conduit system (for London) as in use in New York and Washington, I have much pleasure in handing you copy of a most important article and report which appears in the current issue of the *Street Railway Journal* of New York City, and which may be said to mark an epoch in the history of tramway traction. It will be evident from the following remarkable figures that the recommendations contained in my report are amply confirmed. It is now proved beyond all controversy that the electric conduit system, besides its admitted advantages compared with the trolley, is not only electrically and mechanically satisfactory, but has now shown results in economical working that have not been equalled by any other system. If the Metropolitan Traction Company of New York, whose lines cost much more to construct than would be the case in London, and which pays to its employés nearly double the amount of wages paid in London, is able to operate its conduit lines for 5d. per car mile, I believe that the same satisfactory result is possible in London. The present average cost of operating on the London lines is about 10d. per car mile and the gross earnings 12d. per car mile. The balance of 2d. per car mile by present horse traction yielding about £250,000 per annum on all the London lines, at the operating cost of 5d. per car mile, the profit under like conditions would equal 7d. (instead of 2d.) per car mile, or 3½ times the present profit, say £875,000, on the present mileage in London. Taking the percentage of operating expenses to earnings, it will be seen that the hitherto unreached figure of 37·9 per cent. is shown by the electric conduit in New York, and when the balance of the cable lines are converted, and the motive power centralised, this figure will no doubt be further reduced. The present cost of operating in London is about 80 per cent. of earnings, leaving a margin in favour of the conduit that bears out the figures I have previously given. I earnestly recommend the careful study of the following to all who have perused or commented on my report, or who may be interested in tramway traction.—J. ALLEN BAKER.

London, Nov. 12, 1898.

From the "Street Railway Journal," New York, November, 1898.

COMPARATIVE COSTS AND PROFITS OF CABLE, ELECTRIC CONDUIT, AND HORSE TRAMWAY OPERATION IN NEW YORK CITY.

Through the generous kindness of H. H. Vreeland, president of the Metropolitan Street Railway Company, of New York City, we are enabled to give to the street-railway world a transcript of the private cost sheets and other records of this great company, by means of which, for the first time in the history of street railroading, a true comparison of the relative cost of operation of cable, electric, and horse railways in a single city and under substantially the same conditions can become generally known. We need not point out how important will be these comparisons to railways, particularly in foreign countries, whose managers are contemplating a change of motive power, and who are anxiously seeking all the light possible on the question of the best one to select. In the honesty of these figures and the accuracy of their distribution among the several branches of the service we have entire confidence, based on a somewhat intimate knowledge of the careful methods of administration and of book-keeping pursued by this company in the management of the local transportation of over 25,000,000 passengers per annum.

Disregarding details for the moment, we may say on broad lines that the company's experience points unmistakably to the great superiority of electricity over both horses and cable, not only in traffic-handling capacity, but in economy. This will come as a surprise to many who have believed that the cable system, certainly in its own peculiar sphere of great traffic density, is the cheapest and best motive power extant. The rapid disappearance of the cable system in America has been attributed by most foreign engineers and not a few Americans to a desire for unification of motive power or to the greater popularity and traffic-earning capacity of electric cars in competition with cable lines. Few have ventured to assert, in the absence of definite figures, that electric cars replacing cable over heavy traffic routes could be operated at a less cost per car mile, but the figures here given show conclusively that from economical considerations alone there is no place for the cable in modern street railroading.

Before considering these figures in detail, the present

* *Vide* Section LIX. of "Notes on Accumulator Construction."

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condition of surface railway transportation in New York City should be clearly understood. On Jan. 1, 1893, the entire street railway system of New York City was operated by horses. In the spring of that year the Broadway cable line from Fifty-ninth-street to the Battery, 10·2 (track) miles in length, was put in operation. In 1895, 15 (track) miles additional on Columbus, Ninth, and Lexington avenues were opened through streets, most of which had previously had no horse railway service except for a short time preceding the actual starting of the cable lines. Cable construction then stopped and electric began. The company had several times attempted to instal the overhead electric system in the city, but owing to extreme popular prejudice against all overhead wires, due largely to an unusual and indefensible abuse of their privileges by a number of electric light corporations, which had, in previous years, stretched their wires in New York City to such an extent as to be a positive menace to its safety as well as an intolerable eyesore, permission to adopt this system was refused. The importance of doing away with horse traction, in the interests of both the city and the company, became so great, however, that it was at last determined to try the underground conduit electric system, which had previously been a failure in this country wherever installed, owing partly to climatic conditions* and partly to an attempt to use too shallow and cheap a conduit. The experiment was first made on the Lenox-avenue line in the northern part of the city, and a conduit was constructed which in point of size and cost was practically equal to that necessary for a cable system, the intention being, should electricity prove a failure, to change to the cable. After some experimenting with insulators this line proved to be an entire success, and has been steadily and regularly operating ever since, with a rapidly increasing traffic and a quite remarkable economy. Encouraged by this experiment, the company's engineers devised a form of conduit which, while considerably cheaper to build, possessed, it was believed, all the necessary qualifications for success on a large scale, and during the last 15 months nearly 35 miles of double track have been converted from horse to underground electric traction on Second, Madison, Sixth, Eight, and Amsterdam avenues—all great through north and south routes paralleling the Broadway cable line, and intended to relieve it to a large extent of its enormously congested traffic—and on Fifty-ninth-street.

Now, construction work of this kind means, of course, great interruption to traffic and a temporary diminution of receipts during the construction period, together with an increase in the operating expenses over what would be required were the roads in their final condition. Moreover, in this particular case, power for the new electric lines has been obtained from temporary power stations, and, although these have been fairly large and the production has been reasonably economical, it is certain that the new 70,000-h.p. station now being constructed on Ninety-sixth-street for the service of the entire city through high-tension primary lines and low-tension secondary circuits will greatly reduce the cost of power.

During the 15 months covered by the annual and quarterly statements presented herewith the company's cable lines have not been interfered with in any way, and their receipts and expenses are normal. On June 30, 1898, there were about 60 (track) miles of electric railway actually running, but nearly all of this had gone into operation during the year. . . It is evident that the company's total earnings for the year and quarter, though considerably larger than the last year and quarter respectively, should be greatly exceeded in 1898-9, when the conditions on the lines at present converted are more settled, and that not until the conversion of the system is completed will the full earning power of the property be anywhere near in sight, both because of the increases due to the introduction of new motive power, and because of the doing away with the loss of traffic coming with reconstruction.

We will now take up the figures of the accompanying annual and quarterly reports. It will be seen that during the 12 months' period the company operated 34·2 per cent. of its car mileage by the cable system, 20·2 per cent. by the electric system, and 45·6 per cent. by horses. During the last quarter, however, the proportions were greatly changed, the cable mileage being only 27·4 per cent. of the total, the horse 33·7 per cent., while the electric had risen to 39·1 per cent.

The relative traffic densities measured by the receipts per mile of track and per car mile as shown in the quarter's report are as follows: cable, 39,000dol. per mile of track and ·333dol. per mile; electric, 17,000dol. per mile of track and ·260dol. per car mile; and horse, 8,000dol. per mile of track and ·288dol. per car mile. The average earning power of the entire system was about 14,000dol. per mile of track and ·29dol. per car mile. These figures per track mile are for the quarter only—annual figures would be somewhat more than four times as large. Henceforth the cable and horse lines will undoubtedly show a decreasing traffic density, owing to the competition of the electric roads parallel to them, the electric lines will show an increasing density, while the earnings per mile of track for the entire system will increase with a growing disposition of the public to ride upon clean and rapidly moving cars and by diversion of traffic from the elevated lines in competition. For a time the earnings per car mile of the entire system may not increase rapidly as new electric lines are put in operation, for the public will not respond immediately to the improved service. Eventually, however, the earnings per car mile will be much greater than at present as population increases.

Another gauge of traffic density is found in the statement that the 11 per cent. of the company's entire mileage which is operated by the cable system is earning 28 per cent. of the total passenger receipts; the 28 per cent. which is operated by the electric system is earning 32 per cent. of the total passenger receipts; and the 61 per cent. which is operated by horses is earning but 30 per cent. of the total passenger receipts.

For the year, the operating expenses of the cable lines were 16·42 cents per car mile, of the horse lines 17·87 cents, and of the electric lines 10·23. For the three months' period, which is more favourable to electric operation for reasons already stated, the cable lines cost 17·55 cents, the horse 17·89 cents, and the electric 10·06 cents.

The electric lines during the 12 months' period earned 16·76 cents net per car mile, or but 1·25 cents less than the cable system, in spite of the fact that the latter has 7·43 cents per car mile greater receipts, while for the three months' period the net earnings of the electric lines per car mile were actually greater than the cable lines by ·25 cent, and greater than those of the horse lines by 5·04 cents.

How have these surprising results been achieved, and are they a true measure of the permanent relative earning powers of the different systems?

From a careful study of these figures, we believe that were all the lines in New York City to be equipped with a single motive power, electricity would have a permanent advantage over the cable of at least 3·5 cents per car mile in maintenance of way, a slight disadvantage in maintenance of equipment, and an advantage of at least 1·25 cents in power, of 1·5 cents in transportation, and of ·5 cent in general expenses—a total of nearly 6·75 cents per car mile. In comparison with horse traction, electricity would be at a disadvantage of perhaps ·5 cent per car mile in maintenance of way, and ·5 cent in maintenance of equipment; while it would have an advantage of at least 6 cents in motive power, 1·5 cents in transportation, and ·5 cent in general expenses; a net difference of 7 cents. Besides this, electric cars would earn more than either horse or cable cars with equivalent mileage.

The Broadway cable line has now been in operation for five years, and the Lexington and Columbus-avenue lines for nearly three or four years respectively. In that time the track has, of course, deteriorated and repairs have been necessary. We find that 58,715dol., or ·59 cent per car mile, have been spent on track repairs during the year. The electric lines, which are, of course, almost entirely new, have cost for repairs only 10,278dol., or ·14 cent per car mile. The horse railway track has cost 89,053dol., or

* Mr. Pearson, a well-known American expert, in his report to the Liverpool Corporation, and in reference to the New York and Washington conduit installations, declares that "English conditions are much more favourable to conduit construction and operation.—J. A. B.

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RECEIPTS AND EXPENSES OF THE METROPOLITAN STREET RAILWAY COMPANY, OF NEW YORK, FOR THE YEAR ENDING JUNE 30, 1898, SHOWING THE RELATIVE COSTS AND PROFITS OF CABLE, ELECTRIC, AND HORSE RAILWAY OPERATION.

Items.	Cable.		Electric.		Horse.		Total.	
	Amount.	Per car mile.	Amount.	Per car mile.	Amount.	Per car mile.	Amount.	Per car mile.
GENERAL EXHIBIT.	Dols.	Cents.	Dols.	Cents.	Dols.	Cents.	Dols.	Cents.
Total passenger receipts	4,130,225	34·42	1,918,873	26·99	4,375,597	27·35	10,424,695	29·70
Operating expenses	1,970,486	16·42	727,406	10·23	2,858,235	17·87	5,556,127	15·83
Earnings from operation	2,159,739	18·00	1,191,467	16·76	1,517,362	9·48	4,868,568	13·87
OPERATING EXPENSES IN DETAIL.								
Maintenance of way:								
1. Repairs roadbed—track, labour	41,447	·35	6,153	·09	72,928	·46	120,528	·34
2. ,, ,, material	6,673	·06	*105	—	7,549	·05	14,117	·04
3. ,, ,, steel rails	200	—	954	·01	705	—	1,859	—
4. ,, ,, switches, castgs., spikes, etc.	10,108	·08	3,128	·04	5,567	·03	18,804	·05
5. ,, ,, ties and timber	287	—	148	—	2,304	·01	2,739	—
6. Repairs overhead and underground construction	80,787	·67	5,779	·08	165	—	86,731	·25
7. ,, and renewals of cable	189 391	1·58	—	—	—	—	189,391	·54
8. ,, tube cleaners	11,758	·10	4,230	·06	—	—	15,988	·05
9. ,, oilers	40,708	·34	12	—	—	—	40,720	·12
10. ,, gearsmen and splicers	21.240	·18	—	—	—	—	21,240	·06
11. Repairs of buildings	4,099	03	821	·01	17,262	·10	22 182	·06
12. Removal of snow and ice, and street-cleaning	15,328	·13	2,731	·04	9,666	·06	27,725	·08
Total	422,027	3·54	23,851	·33	116,145	·72	562,024	1·60
Maintenance of equipment:								
13. Repairs of cars and vehicles	68,768	·57	28,687	·40	61,449	·38	158,904	·45
14. ,, ,, electrical or cable equipment of cars	42,287	·35	29,952	·42	8	—	72,247	·21
17. ,, ,, tools and machinery	1,714	·01	152	—	328	—	2,195	—
Total	112,770	·94	58,792	·83	61,784	·39	233,345	·66
Power:						—		
15. Repairs of steam plant	15,147	·13	2,042	·03	9	—	17,197	·05
16. ,, ,, electrical or cable plant	12,395	·10	824	·01	3	—	13,221	·04
18. ,, ,, harness	458	—	584	—	15,361	·10	16,404	·05
19. Stable equipment supplies, etc.	174	—	424	—	12,206	·08	12,805	·04
20. Renewals of horses	550	—	3,030	·04	62,440	·39	66,020	·19
21. Horseshoeing	571	—	2,477	·03	80,933	·51	83,981	·24
22. Cost of provender	3,432	·03	14,010	·20	445,183	2·78	462,624	1·32
23. ,, ,, feedmen—wages	92	—	1,687	·02	40,419	·25	42,198	·12
24. ,, ,, removing manure	60	—	85*	—	7,109	·04	7,084	·02
27. Ostlers, hitchers, and stable help	2,485	·02	12,795	·18	347,855	2·18	363,134	1·07
28. Engineers, firemen, and power service	65,262	·54	20·662	·29	240	—	86,163	·25
32. Fuel, power-houses	104,912	·88	51,015	·72	455	—	156.381	·45
33. Light and other supplies at power-house	15,471	·13	5,370	·08	59	—	20,900	·06
34. Water tax	21.775	·18	5,842	·08	11,138	·07	38,754	·11
Total	242,784	2·02	120,675	1·70	1,023,408	6·40	1,386,867	3·95
Transportation:								
25. Conductors, drivers, gripmen, and motormen	711,630	5·93	353,127	4·97	1,156,395	7·23	2,221,151	6·33
26. Inspectors, starters, switchmen, etc.	143,512	1·20	50,292	·71	119,400	·74	313,204	·89
29. Car-house expenses, watchmen, car cleaners, oilers, etc.	36.820	·31	27,392	·39	63,245	·40	127,457	·36
30. Car service—car lighting	39,227	·33	1,142	·02	11,690	·07	52,059	·14
31. ,, ,, oil, waste, etc.	12,932	·11	5,158	·07	7,191	·04	25,281	·07
Total	944,120	7 87	437,111	6·15	1,357,921	8·49	2,739,153	7·81
General expenses:								
35. Salaries of officers and clerks	30,359	·25	11,051	·16	41,938	·26	83,348	·24
36-40. Injuries and damage	150 325	1 25	43 829	·61	79,076	·49	273,229	·78
41-48. Other general expenses	68,099	·57	32,100	·45	177,962	1·11	278,162	·79
Total	248,784	2·07	86,978	1 22	298,976	1·87	634,738	1·81
Total operating expenses	1,970,486	16 42	727,406	10·23	2,858,235	17·87	5,556,127	15·83
Car mileage	11,991,404		7,110,090		15,994,912		35,096,406	

* Surplus account.

PASSENGER RECEIPTS AND EXPENSES FOR THREE MONTHS ENDING SEPT. 30, 1898.

—	Cable		Electric.		Horse.		Total.	
GENERAL EXHIBIT.								
Total passenger receipts	944,985	33 27	1,056,866	26·03	1,009,100	28·82	3,010,951	28 95
Operating expenses	498 318	17·55	408,250	10·06	626,521	17·89	1,533,089	14·74
Earnings from operation	446,667	15·72	648,616	15 97	382,579	10·93	1,477,862	14·21
OPERATING EXPENSES BY DIVISIONS.								
Maintenance of way	136,704	4·81	13 553	·34	24,036	·69	174,294	1·68
,, ,, equipment	36.689	1 29	38,420	95	14,280	·40	89.389	·86
Power	58,085	2·04	56,203	1·38	241,686	6·90	355,974	3·42
Transportation	226,225	7·98	262,889	6·47	288,701	8·25	777,816	7·48
General expenses	40,614	1·44	37,184	·91	57,818	1·65	135,616	1·30
Total	498,318	17·55	408,250	10·06	626,521	17·89	1,533,089	14·74
Car mileage	2,840,383		4,059,756		3,501,088		10,401,227	

·56 cent per car mile. Now, the cost of maintenance of electric track in this current year is obviously far too small, while that of the cable and horse railway track is probably smaller than average renewal and repairs for a

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SIX YEARS' STATEMENT, SHOWING INCREASE OF EARNINGS OF THE METROPOLITAN STREET RAILWAY COMPANY, DUE TO BOTH CONSOLIDATIONS AND TRAFFIC INCREASES.

Totals.	1893.	1894.	1895.	1896.	1897.	*1898.
	Dols.	Dols.	Dols	Dols.	Dols.	Dols.
Gross receipts	4,022,723	5,398 466	6,432,933	8 173 332	9,706,598	10,779,087
Operating expenses	2,696,326	3,223 956	3,389,814	4,189,145	5 090,016	5 489,104
Earnings from operation	1,326 396	2 174,510	3,043,119	3.984 186	4,616,581	5,289,982
Fixed charges	1,208,602	1,859 971	2,070 958	2 517.339	3,226,592	‡3,502,331
Net earnings	117,794	314,539	972,161	1,466,848	1,389,990	1,787,651
Dividends paid	None.	328,000	405,000	1,252,500	1,200,000	1,500,000
To surplus	117,794	†13,461	567,161	214,348	189,990	287,651
Per mile track operated.						
Gross receipts	32,753	41,229	46,032	47 555	50,692	56,294
Earnings from operation	10,784	16 599	24,213	23,163	24,171	27.696
Fixed charges	9,826	14,198	14,793	14,636	16,893	‡18,337
Net earnings	958	2,401	6,944	8,528	7,277	9,359

* Excluding Second-avenue earnings, which form part of system for three months only in the year. † Deficit. ‡ These fixed charges, which are principally rentals of lines leased from other companies, would probably be nearly double the charges in London for repayment of capital outlay.—J. A. B.

long period of time, since there has been practically no renewal so far of the cable track, and horse railway track repairs have naturally been reduced to a minimum in the expectation that the railway would be converted to electricity. Electric traction will be harder on rails than cable traction, and far harder than horse traction, the reason being, of course, that electric cars do not, as in the last two systems, simply roll over the track, but actually grind it out in exerting tractive effort, while the electric motorcars are, moreover, heavier than either horse or cable cars, and deliver a more severe hammerblow to the joints. An expenditure of ·75 cent per car mile for 40,000,000 car miles would be equal to 300,000dol. per annum, or 1,400dol. per mile of track per annum for the complete system, and this should be an ample figure for repairs and renewal of track were the whole system electric. The electric figures on the accompanying statement are therefore too small by perhaps ·6 cent.

Repairs of underground and overhead construction show a great difference in favour of electric traction over cable, and this is quite reasonable, since the amount of moving mechanism in the cable conduits is enormous, while the electric has none. Nevertheless, ·08 cent for this account in the electric column is possibly too small, and may be slightly raised as the system grows older.

Accounts numbered 7, 9, and 10, for renewals of cable, wages of oilers, gearsmen, and splicers, amount in the aggregate to 2·10 cents per car mile, and are found only in the cable system, with no corresponding charge in the electric. This is a very important saving indeed. The renewals of cables alone cost much more per car mile than will be the entire cost of electric power under final conditions!

Cleaning the tubes will cost slightly less for the electric system than for the cable, but repairs of buildings, removal of snow and ice, and street cleaning should be, under normal conditions, approximately the same.

The repairs of cable cars, exclusive of equipment, will probably be greater per car mile than the repairs of electric cars, owing not only to the greater speeds possible with electric cars, which increases the service divisor, but also because of the greater jerking which the cable gives to its cars than is the case in electric traction. The repairs of the electric car equipment should be, on the contrary, greater, as there is much more mechanism in the electric equipment than in cable. The expenditure of ·42 cent per car mile for this item in the electric column, though very large for a new road because of inexperienced motormen rapidly put into service during the last year, is probably smaller than the permanent average, but the latter should not exceed ·60 to ·75 cent.

It certainly overturns all our established ideas to find that two temporary electric power stations can actually produce power for heavy electric cars, 22ft. to 28ft. in length, at a cost less by 30 per cent. (in the quarterly statement) than can be done in two cable power stations which operate cables so heavily loaded as to make the proportion of live to dead weight greater probably than that of any cable railway system in the country, with the possible exception of the State street line of the Chicago City Railway Company. The new electric power station will do much better than this, and it is obvious, on examination of the different items in power account, that while repairs of plant will undoubtedly be greater per car mile on an average in the electric stations than they have been this year, when equipment is new, there are other items temporary in character in the electric account which will disappear in the final plant, so that the total cost of motive power will be reduced, perhaps, even to ·75 cent per car mile.

The large expenditures for provender and care of horses in the electric column are not properly chargeable to electricity at all, being due to a short horse line feeding the Madison-avenue electric line.

But 1·38 cents per car mile looks small in comparison with the 6·90 cents charged to motive power on the horse system (in the quarterly statement), and those of our foreign friends who still cling to horse power may well examine these figures with interest to see wherein lies the enormous saving in electricity over horses, upon the claims for which they have looked for so many years with suspicion.

In the transportation expenses we find again that electric traction is the cheapest of the three motive powers, and the reason for this is found chiefly in the greater speeds of car possible with electric traction, which, as above stated, increases the service divisor. The part which this speed element cuts in transportation expenses is indicated by the difference between the cost per car mile of conductors, drivers, gripmen, and motormen in the electric system against the corresponding charges for the horse system, these differences amounting to 2·26 cents per car mile in spite of the fact that motormen are paid 25 cents more per day than horse-car drivers.

In the department of general expenses everything possible has been charged directly to the different motive powers affected, but salaries of general officers and other similar charges impossible to handle directly have been pro rated on the basis of passenger earnings. The only item here which has special interest is that of injuries and damages, which can be, of course, directly charged to the motive powers which cause them. We find that, as is natural, horse traction has cost the company the least for injuries, while the cable appears to have cost more than twice as much as electric traction. It is probable that the charge of 1·25 cents per car mile on the cable system, amounting as it does to 3·6 per cent. of the passenger receipts, is a fair average for a carefully operated line in Broadway, and, considering the greater safety of the electric car through its better means of control in emergencies, the average cost for injuries and damages on the electric lines will certainly be much less than with the cable system. In the quarterly statement it will be seen that, in every grand division of operating expenses, electricity has a decided advantage over the cable system, and in every division except maintenance of equipment it has an advantage over the horse system.

During the 12 months' period the cable lines operated at 47·7 per cent. of their passenger receipts, the electric lines

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at 37·9 per cent., the horse lines at 65·3 per cent., and the entire system at 53·3 per cent. During the three months' period the cable operated at 52·7 per cent. of their passenger receipts, the electric lines at 38·6 per cent., the horse lines at 62·1 per cent., and the entire system at 50 9 per cent.

The Metropolitan Street Railway Company in 1893 controlled directly and through lease 122 82 miles of track. In each of the five succeeding years additions have been made to this system by the lease of other lines and by extensions, and the management has sometimes been criticised in financial circles for the large rentals which have been guaranteed in order to secure operating control of these properties, the fear having been expressed that the company was assuming too heavy burdens. The accompanying table has been prepared to show the influence upon the gross and net earnings *in toto* and per mile of road operated of these successive acquisitions. It will be seen that the gross receipts have increased from 4,022,723dol. to 10,779,087dol. (excluding Second-avenue); the earnings from operation have increased from 1,326,396dol. to 5,289,982dol.; and while the fixed charges have shown a large increase, the earnings over charges applicable to dividends on the Metropolitan Street Railway Company's stock have increased from 117,794dol. to 1,787,651dol., a figure in 1898 more than 15 times as great as in 1893. Moreover, the gross receipts per mile of road, which is a good test of the wisdom of these purchases, has shown a regular and successive increase from 32,753dol. to 56,294dol.; the earnings from operation per mile of track have fluctuated somewhat, owing in part without doubt to loss of traffic through reconstruction, but are now between two and three times the earnings per mile in 1893, while the net earnings per mile over charges have increased from 958dol. to 9,359dol.

THE LONG-SCHATTNER PREPAYMENT METER.

Messrs. Schattner and Co., of Norwich, have sent us some details of the prepayment meters which they are just about to put on the market after a prolonged test on the system of the Norwich Electricity Company. The meter has several novel points, but we are afraid that the accuracy obtained will not be anything to boast of. The general construction and principle of the meters is shown by the accompanying illustrations, Figs. 1 and 2, while Fig. 3 was prepared from a photograph of an actual meter.

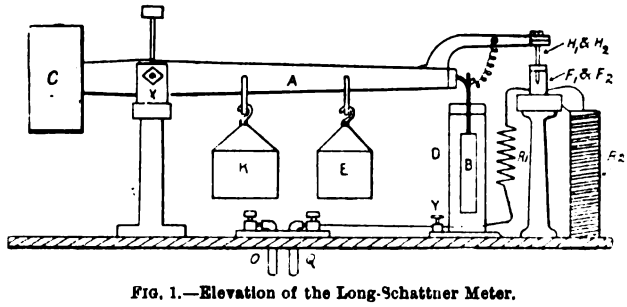

FIG. 1.—Elevation of the Long-Schattner Meter.

In Fig. 1, A is a lever pivoted at X, to the far end of which a copper plate, B, which is immersed in a solution of copper sulphate, is suspended. The box, D, is also of copper, and forms the negative plate, or cathode. C is a weight used to balance the lever, and K and E are cups to hold respectively the coins and standard weights. These weights the collector uses to replace the coins when he is examining the meter. F_1 and F_2 are mercury-cups used to complete the main circuit. F_1, the front one, is filled with mercury; F_2, the back one, is only half filled with mercury and filled up with creosote oil. H_1 and H_2 are contact pieces forming a bridge across the mercury-cups, which bridge is fixed on the lever. R_1 is a main resistance, across which the voltameter is connected as a shunt, and R_2 is a large resistance going from one mercury-cup to the other.

A plan of the connections of the meter is shown in Fig. 2. From this it will be seen that the contact in the cup F_1 is never broken. When the lever is fully up, the contact H_2 leaves the mercury-cup F_2, and the resistance R_2 is interposed in the main circuit.

From the above the complete action of the meter can be understood. The lever is in the up position to start with, and a dim light only can be obtained. On a coin being inserted the lever drops again, short-circuiting the two mercury-cups. It keeps in this position until the amount of electricity equivalent to that coin has been used—that is, until the copper plate, B, is lightened enough to cause the lever to overbalance, breaking the direct circuit, and forcing the current to pass through R_2. In this way the circuit is never actually broken, and the lamps continue to burn quite dimly, forcing the consumer to insert another coin to get any appreciable light at all. He has also

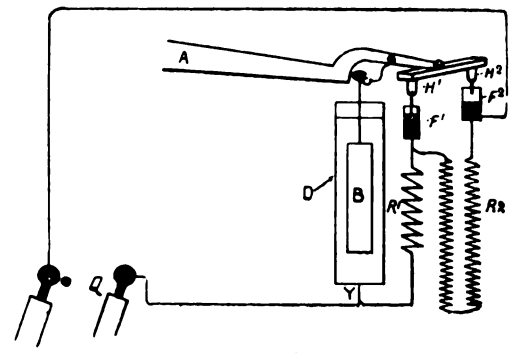

FIG. 2.—Diagram of Connections.

to pay for the light he burns dimly, as the current for that too goes, as before, through the voltameter. The next coin he inserts really pays for the current which passes through the lamps when the resistance R_2 is in circuit. This resistance is considerable. Thus with 20 16-c.p. lamps a drop of about 70 volts is obtained; with 10 16-c.p. lamps, 35 volts drop; with 5 lamps, 17 volts drop; and with 2 lamps, about 7 volts drop. It has been found that the creosote in the mercury-cup F_2 is very effective. It is said to cause a sparkless "break" and "make," even at full load on a 220-volt circuit, and it also keeps the contact-maker H_2 perfectly clean. The makers make a great point of never completely cutting off the light. The consumer need not fear the annoyance of suddenly being put in darkness, whilst the company, on the other hand, is being paid for all the power which is used.

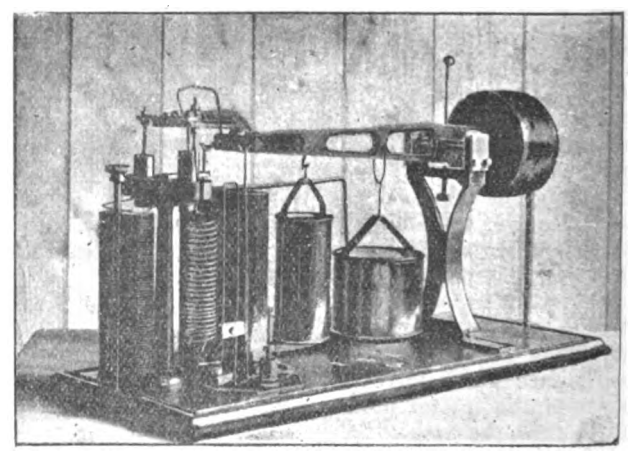

FIG. 3.—General View of the Meter.

As regards the copper voltameter, a copper box and plate will last while 700 units are being used, after which they require replacing. A thin layer of machine oil is put on the top of the copper solution to prevent evaporation. As regards the coins to be used, the meter is standardised for silver only. Coppers, if placed in, will give a supply equivalent to their weight, but the collector will demand the charges when he calls. The feature of the meter which seems to us to be the most open to objection is that it violates the prepayment system and gives credit. Thus a hard-up user may prefer to burn two lamps at seven volts below their normal voltage, and in such a case he could go on credit till the inspector called. Then the question of the accuracy of the in-

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spector's demand for back payment would arise, and the simplicity of the cash-with-order principle is lost. Naturally, the meter, having provision for given credit, makes the man pay standard rates for current which only gives a poor light if the necessary coins are not forthcoming.

As to the accuracy of the meter otherwise we have no details before us, and the method by which consumers are prevented from tampering with the apparatus is not clear from the illustrations to hand.

INSTITUTION OF ELECTRICAL ENGINEERS.

Rotatory Converters.

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S., VICE-PRESIDENT.

(*Continued from page 629.*)

The problem of changing into convenient simple ratios the awkward percentage numbers which subsist between the voltages at the two sides of a converter has engaged the attention of several engineers. Mr. Heldt has described

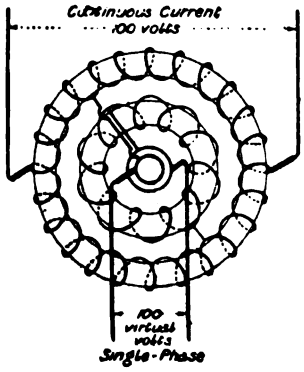

FIG. 9.

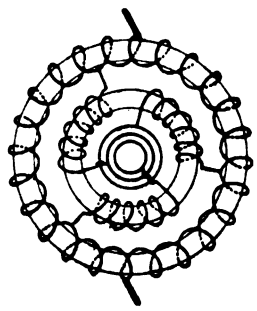

FIG. 10.

an ingenious method of obtaining any desired ratio by the device of including on the alternating-current side additional windings between the slip-rings and the points where these rings are connected up to the armature winding proper. Fig. 9 illustrates the case of a single-phase converter. Here auxiliary windings (in two parallel circuits) are joined in so as to bring up the 70·7 volts on the alternating side to 100 volts, so as to make the voltages alike at both sides of the machine. To adapt this suggestion to the case of a three-phase converter, three sets of auxiliary windings must be intercalated between the three slip-rings and the points of connection to the ring winding; these auxiliary windings being chosen, as to number and position, so as to add the desired supplementary voltage. It will be seen that this is equivalent to using a mixed star and delta winding, the delta part being that which alone constitutes the true converter winding. It is uniformly distributed around the core, and is symmetrically connected to the commutator.

Another solution of the problem, of more limited application, lies in so altering the distribution or concentration of the magnetic field at the poles as to change the irregular ratios into more regular ones. It was pointed out above that any concentration of the field will alter the conversion ratio. For example, the ratio in the case of the three-phase converter with sine distribution being 61·23 per cent., if the poles are narrowed a little, this may be raised to 66·6 per cent.; so that a machine which is a 300-volt machine on the continuous-current side will be a 200-volt machine on the three-phase side. An example of this is afforded by a four-pole 55-kw. converter constructed by the Oerlikon Company, the description of which has been kindly furnished by Dr. Behn-Eschenburg. Drawings of this machine are given in Figs. 11 and 12. It was designed to receive continuous current at 300 volts, and to run at 600 revolutions per minute. Its armature is a two-circuit multipolar drum 522mm. in diameter, 360mm. long, having 117 slots, and two conductors per slot. It has four sets of carbon brushes, set at zero lead. It runs quite sparklessly at all loads. As originally constructed the poles were furnished with pole-pieces (as shown) each of about 72deg. span, therefore having a breadth about 80 per cent. of the pole-pitch, the chord across the tips being 335mm. So shaped, the coefficient of conversion was found to be 57·7 per cent., as against the 61·23 per cent. if sine distribution had been present. When supplied at 300 volts on the continuous-current side, its open-circuit three-phase voltage was only 173 volts. The pole-tips were then cut away (as shown in Fig. 12), so that the arc of pole-span was reduced to a little under 50deg.; the chord across the tips being now 228mm., and the pole-breadth being 54 per cent. of the pole-pitch. This had the effect desired of bringing the conversion ratio up to 66·6, the open-circuit three-phase voltage being now 200. The ratio of conversion was constant within 2 per cent. at all loads. Fig. 13 gives a plot of the performance of of the machine under different excitations. It will be seen that the ratio of the ordinates is approximately that of 3 : 2. Two other points plotted show the demagnetising reaction due to wattless currents. They affect, of course, the speed and heating of the machine, but practically have no influence upon its ratio of conversion when the excitation of the field magnets is normal. In its original shape, when operated as continuous-current motor at 300 volts, with an excitation of 2·1 amperes, without load on the three-phase side, it ran at about 470 revolutions per minute. When loaded so as to give out 153 amperes per phase on an inductionless circuit the speed fell,

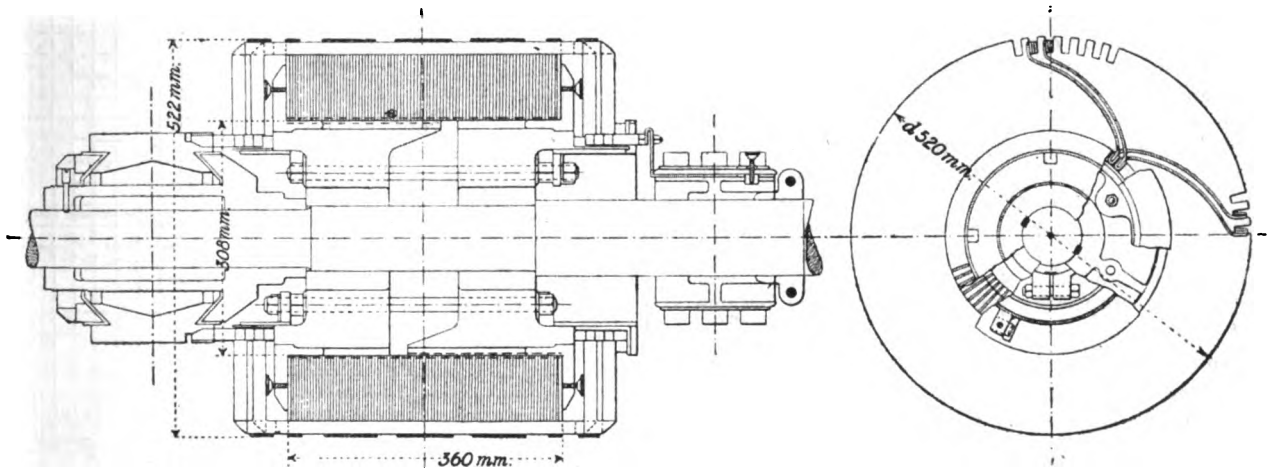

FIG 11.—Armature of 75-h.p. Rotatory Converter (by Oerlikon Company).

Rotatory Converter. Type Δ, IX., A. Continuous-current side as motor for 300 volts, taking about 190 amperes. Three-phase side as generator at 200 volts, yielding 3 × 159 amperes, with frequency 20 periods. Core-discs 117 slots, with two conductors per slot. Conductors 234, net section 2·2 × 1·6 mm. Diameter of core-discs 520 mm. Commutator 117 bars. Brush-holders, four sets, with five carbon brushes per set. Revolutions per minute, 600.

in consequence of reactions, to 440 revolutions per minute. At this speed the measurements were: continuous-current side, 295 volts, 153 amperes; on the three-phase side, 165 volts, 3 × 153 amperes. Then the output was changed to one of 235 amperes per phase of lagging current on a load of induction motors running light. The speed went up to 640 revolutions per minute (showing a

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weakening of the field), and the instruments measured: continuous-current side, 298 volts, 32 amperes; on the three-phase side, 157 volts, 3 × 235 amperes. To keep the speed, and, therefore, the frequency, constant under such conditions, the (shunt) excitation would need to be adjusted in accordance with the load and its lag.

The pole-cores and yoke of this machine are of cast steel, each pole being wound with 3,200 turns of a copper wire of two square millimetres section; the total resistance of the shunt winding being 80 ohms. The armature resistance from brush to brush is 0·028 ohm. The machine runs sparklessly with zero lead of the brushes. It will also run as a synchronous motor delivering continuous current sparklessly, with or without excitation of the field magnet, and with brushes set at zero, or set with either a large forward or a large backward lead. With a large backward lead, running synchronously, without excitation, at 627 revolutions per minute, giving out 46 amperes at 100 volts, it took in three currents of 155 virtual amperes (largely wattless) at about 100 virtual volts at the three-phase side. The reactions in this curious case are exceedingly complicated.

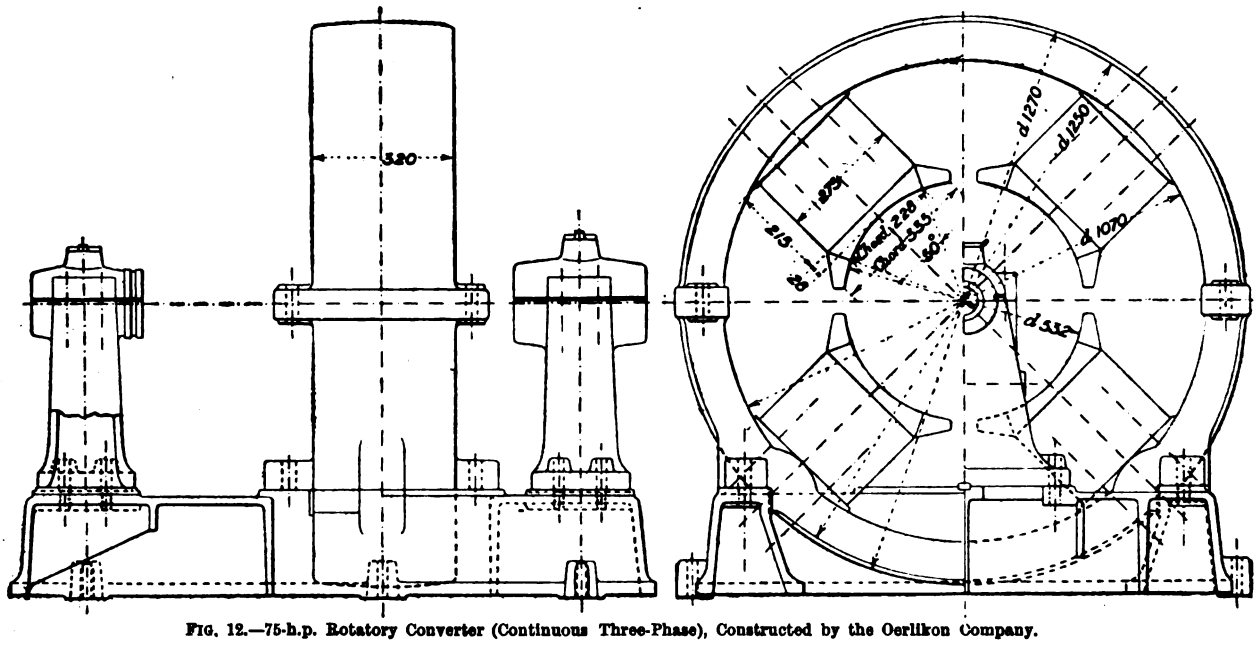

FIG. 12.—75-h.p. Rotatory Converter (Continuous Three-Phase), Constructed by the Oerlikon Company.

Quite recently Mr. Gisbert Kapp has re-examined the question of the influence on the conversion ratio, and on the efficiency, of changes in the distribution of the flux. With the theoretical case of a sine-law distribution he compares analytically other cases, equally unreal in fact—namely, those of a distribution of supposed uniform density over a limited arc of polar span. From his calculations it may be deduced that the conversion ratio will be the same as for the sine-law distribution if the poles are such that the breadth of their faces is about 70 per cent. of the pole-pitch. If the faces are broader, the voltage ratio for a single-phase machine will be lower than 70·7 per cent., and the ampere ratio higher than 141·4 per cent. If the pole-breadth is reduced to $\frac{2}{3}$ of the pole-pitch, or to $\frac{1}{2}$ the pole-pitch, the respective voltage percentages become as follows:

Voltage for	Sine law.	Pole ratio, $\frac{2}{3}$.	Pole ratio, $\frac{1}{2}$.
Continuous-current	100	100	100
Single-phase	70·7	75	82
Two-phase	70·7	75	82
Three-phase	61·2	65	71
Four-phase	50·0	53	58
Six-phase	35·35	37	42

M. Routin has made another study of the effect of varying the pole-breadth in a mathematical paper, in which also he assumes the uniformity of the field beneath the poles.

In the Oerlikon converter (above described), the pole-breadth was only 55 per cent. of the pitch, yet the voltage ratio was 66·6; showing that the field does not distribute itself uniformly, but is less concentrated, with fringing at the pole-tips.

Mr. Kapp has further treated the question of the limit of output for equal heating, for different pole-breadths, and for different angles of phase displacement in the currents. When the phase displacement is zero, the limiting output of a single-phase converter armature was (see above) 85 per cent. of that when used as a continuous-current armature simply, if the sine law is assumed. For pole-breadths of $\frac{2}{3}$ and $\frac{1}{2}$ respectively, Kapp finds this increased to 88 to 95 per cent. This is equivalent to saying that if by concentration of field one makes the midway coils relatively more active, there will be for equal output less heating of the coils next to the connectors, and a less total heating. If there is a phase displacement such that cos $\phi = 0·8$ ($\phi = 35$deg.), the percentage output for sine-law distribution is 69, but with pole-breadths $\frac{2}{3}$ and $\frac{1}{2}$ respectively, this is raised to 73 and 80 per cent. But in practice the fringing of the field will reduce these latter values. For the more favourable cases of two-phase and three-phase converters, these percentages of output for equal heating of the armature are greatly raised. The three-phase converter, assuming sine distribution and no phase displacement, has a limiting output 134 per cent. of that of the simple continuous-current armature. With pole-breadths of $\frac{2}{3}$ and $\frac{1}{2}$, the output rises to 138 and 144 per cent. respectively; and if there is a phase dislocation such that cos $\phi = 0·8$, to 117 and 126 respectively. For a two-phase converter the limiting output of 164 per cent., for the case of sine distribution and cos $\phi = 1$, becomes 167 and 170 per cent. respectively for pole-breadths of $\frac{2}{3}$ and $\frac{1}{2}$; whilst, when cos $\phi = 0·8$, these numbers fall to 144 and 153 per cent. respectively.

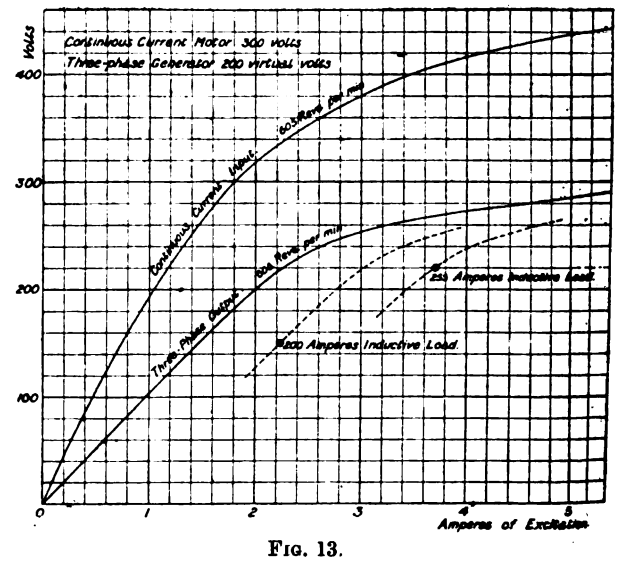

FIG. 13.

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A four-pole 30-kw. two-phase converter, constructed by Messrs. Brown, Boveri, and Co., has been described to me by Mr. M. B. Field, who designed it for that firm. The armature is wound according to the scheme shown in Fig. 14. It has four poles (two wound, two unwound), and runs at 1,200 revolutions per minute giving a frequency of 40 periods per second. Its efficiency is about 90 per cent. The input being two currents, of 415 working amperes each, in quadrature at 40 volts, the output is 500 amperes at 60 volts. The armature is a cylindrical drum-wound, in 56 slots, with two conductors per slot, as a singly re-entrant double winding, being cross-connected

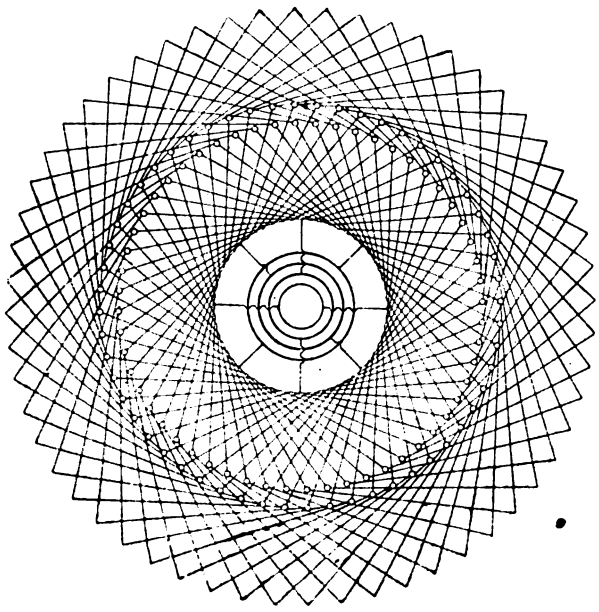

FIG. 14.

at the slip-rings to give four parallel circuits. At normal load, the excitation is such as to give a flux-density in armature core body of 7,800 lines per square centimetre, and in the teeth of 10,700 to 14,900. It runs (as exciter for some two-phase alternators) in parallel with some turbine-driven exciters and with a two-phase to continuous motor-generator. The ratio of conversion when running as two-phase motor did not alter greatly with the excitation, as the following figures show:

Exciting current.	Virtual volts between slip-rings.	Volts at commutator.	Ratio of conversion percentage.
2	18·5	30·0	60·8
3	27·0	43·0	62·7
4	34·0	53·0	64·2
5	41·0	62·0	65·1
6	46·5	68·5	67·8
8	53·0	77·0	68·5
10	56·5	82·0	68·8
12	59·0	86·0	68·6
14	62·0	88·5	71·0

It is, however, in America that the converter has found its application on the larger scale, for the purpose of supplying continuous currents for tramway circuits, electric lighting systems, and electrolytic processes from distant power stations, whence the transmission is accomplished by polyphase currents at high voltage. These high-voltage currents, when they reach the receiving end, are first passed through transformers to reduce the pressure to a suitable lower voltage, and are then passed through the converters.

(To be continued.)

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Foreign Member.—A. Schaar, 12 Millionnaya, St. Petersburg.

Members.—B. Balaji, Baroda, India; J. R. Cowell, the Town Council Lighting Works, Johannesburg, S.A.R.; W. E. J. Heenan, Northampton Electric Light and Power Company, Northampton; C. G. Marconi (Officer de la Couronne d'Italie), 28, Mark-lane, E.C.

Associates.—R. W. Alcock, Altair, Sutherland-road, Ealing; W. A. Amesbury, 13, Waldegrave-road, Upper Norwood, S.W.; D. Banerji, M.A., Indian Government Telegraph Department; J. D. Bell, Clifton Hall, Ratho, N.B.; H. Bentham, Hollycroft Shirebrook, Mansfield; A. Bentley, Municipal Electric Lighting Department, Johannesburg, S.A.R.; A. H. Blagden, Electric Light Works, Great Western Railway, Paddington; F. Bourne, Electrical Department, South-Eastern Railway, London district; C. Buckton, Hipperholme, Halifax, Yorks.; Cecil Burman Callow, Vril Launches, Limited, St. Helens, Isle of Wight; J. McIlvaine Cater, Southdown, Wimbledon, S.W.; E. G. Clark, A.I.C.E., Luz Electrica, La Plata, Argentine Republic; G. D. Collins, 131, Churchill-road, Willesden Green, N.W.; C. B. Davies, 93, Church-lane, Charlton, S.E.; A. H. Dowson, Widcombe House, Brislington, Bristol; J. S. Enright, 202, Holland-road, W.; T. W. Foinette, 11, Alvanley-place, Birkenhead; R. J. N. Franki, care of Messrs. The Fairfield Shipbuilding Company, Limited, Fairfield Works, Glasgow; J. Harrington, Edison and Swan Electric Light Company, Ponder's End, N.; W. Jamieson, Orangefield, Greenock; T. H. Kingscote, 2, Stanley-road, Patricroft, Manchester; V. Lindop. Casilla, No. 75, Tucuman, Argentine Republic; P. Mallik, B.A., Indian Government Telegraph Department; C. T. Mitchell, 43, Highbury Park, N.; E. Moorhouse, Messrs. The Edison and Swan Company, 127, Albion-street, Leeds; F. E. Nosworthy, care of ss. "Viking," Amazon Telegraph Company, Para, Brazil; S. L. Pearce, Hampden Club, Phœnix-street, N.W.; W. M. Rolph, 28, Holland-road, West Kensington, W.; Tom Rowe, Corporation Lighting Works, Box 1,179, Johannesburg, S.A.R.; W. H. Smith, St. James' Gate Brewery, Dublin; H. Stansfield, B.Sc., A.R.C.S., Municipal Technical School, Blackburn; E. A. Uttley, 68, Kirkmanshulme-lane, Longsight, Manchester; H. R. Wickins, Box 1,413, Johannesburg, S.A.R.; R. S. Williams, 20, Gracechurch-street, E.C.; N. Woodhouse, National Electric Free Wiring Company, 82, King street, Egremont, Wallasey; E. H. Wright, Corporation Electricity Department, Bradford.

Students.—E. A. Adey, 87, Elliscombe-road, Charlton, S.E.; W. R. C. Barrington, 10, Whitehall-parade, Highgate, N.; H. G. Beeton, 23, West-hill, Sydenham, S.E.; F. T. Bersey, 16, Gore-road, South Hackney, N.E.; Arthur Buckney, 51, Highbury Park, N.; F. Horton Clough, 63, Charlton-lane, Charlton, Kent; H. H. Dadson, Faraday House, Charing Cross-road, W.C.; H. F. Dell, Nicholsky Pereyulok, No. 6, App. 5, St Petersburg; L. B. Draper, 82, Shooter's Hill road, Blackheath, S.E.; P. F. Endemacker, 177, Waller-road, New Cross, S.E.; P. J. C. Eve, Claremont, Cavendish-road, Sutton, Surrey; P. A. Fisher, Ashbourne Villa, Tyrrell-road, East Dulwich, S.E.; B. D Fox, B.A. (Cantab), 5, Wellington-road, Charlton, S.E.; M. Hickman, Winchester House, Alleyn Park, West Dulwich, S.E.; G. Hicks, 22, Alderney-road, Mile End, E.; J. W. Holliday, 24, Meadow-road, South Lambeth, S.E.; S. R. Inch, Homewood, Mount Pleasant-road, South Tottenham, N.; H. Johnson, 49, Charlton-lane, Charlton, S.E.; H. Joseph, Mason College, Birmingham; W. J. Linford, Hamilton Lodge, Barnsbury-square, N.; L. R. Morshead, Finsbury Technical College, Finsbury, E.C.; S. Ransom, Holker House, St. Mary's-grove, Chiswick, S.W.; Emile Rasecki-Morton, 115, Queen's-road, Finsbury Park, N.; Augustus Reckenzaun, 34, Hemberton-road, Clapham, S.W.; L. Redmayne, 6, Portsea-place, Connaught square, W.; C. G. Seeley, 17, Carlton-road, Stroud Green, N.; J. C. Smail, 13, Cornwall-street, Edinburgh; F. Stacey, 41, Mill Hill-road, Acton, W.; G. A. Tatchell, 58, Lordship-park, Stoke Newington, N.; S. J. Temple, 62, Bramfield-road, New Wandsworth, S.W.; E. D. Tiddeman, 52, Kenninghall-road, Clapton, N.E.; R. N. Torpy, Sunnycroft, Gordon-road, South Woodford; L. C. B. Trimnell, Faraday House, Charing Cross-road, W.C.; W. T. Trussler, Windmill Hill, Enfield, Middlesex; J. H. West, 26, Redcliffe-square, S.W.; C. W. Wood, Faraday House, Charing Cross-road, W.C.; P. J. Woodward, 112, Northumberland-park, Tottenham; E. V. Young, 24, Russell-road, Kensington, W.

FORTHCOMING EVENTS.

FRIDAY, NOV. 25.

Physical Society.—At Burlington House, at 5 p.m. "On the Properties of Liquid Mixtures," by R. A. Lehfeldt; and "On certain Diffraction Fringes as applied to Micrometric Observations," by L. N. G. Filon.

Electro-Harmonic Society.—At St. James's Hall at 8 p.m. (Ladies' night).

MONDAY, NOV. 28.

Society of Arts.—At 8 p.m., Cantor Lecture by Prof. Vivian B. Lewes on Acetylene. Second of four lectures.

TUESDAY, NOV. 29.

Institution of Civil Engineers.—At 8 p.m., "The Effect of Subsidence due to Coal-Workings upon Bridges and other Structures," by Stanley Robert Kay, Assoc.M.Inst. C.E.

WEDNESDAY, NOV. 30.

Society of Arts.—At 8 p.m., "Photographic Developers and Development," by C. H. Bothamley, F.R.S.

Liverpool Engineering Society.—At the Royal Institution, Liverpool, at 8 p.m., "The Basis of Propeller Design," by Mr. J. Denholm Young, Wh.Sc.

FRIDAY, DEC. 2.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Sunlight Gold-bearing Reef, Lydenburg, Transvaal," by Charles Benjamin Saner, Stud.Inst.C.E.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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IN GOVERNMENT EMPLOY.

Memory is treacherous, and as years roll on it is easy to realise the correctness of the dictum, *vita brevis*, for there is so much to crowd into the ever-lessening period of activity that little time remains to verify the actual words of the authors of long ago. Some faint remembrance of Lamb—genial, jovial, gentlemanly Charles Lamb—would have us attribute to him the concrete essence of a Government official's life—the going home early in order to make up for the coming late to office. Nowadays, however, according to the correspondence given elsewhere, the life of a Government servant is not the acme of happiness. His hours are too short, and so, contend the writers, is his pay. In the olden days the patriarch, or the chief, governed in a fatherly way the members of the tribe. At the present day the trades union has usurped many, if not all, the functions of the patriarch, and dictates, like the old autocrat, what is to be, and if it should happen not to be, why there is a considerable flare up. The unbiassed outsider who calmly reads the correspondence sent to us—two letters in which are marked private, though evidently attached to the remainder in order to direct opinions into one channel—will probably come to a very different conclusion to that desired by the active movers in this little drama. Examine the affair. A wireman is employed in doing some Government work. We must assume that before he entered the employ he knew the hours of work and the rate of pay. He was not compelled to accept the position. He, if he did not agree to the terms, ought to have taken his labour elsewhere. As a matter of fact, he did accept the terms, probably, however, with a mental reservation to get them altered in his favour. In all this he was perfectly justified, he was within his rights to accept or reject and to attempt to better himself. Admitting to the full his own rights, we must presume he would allow also that his employer has rights. Among the employer's rights we should contend are the offering of a wage, to be accepted or not as pleased the workmen; to dismiss the workmen, giving due notice or compensation in lieu of notice. We do not know that it is compulsory upon an employer to give reasons for dismissal; we should say the employer who gives reasons is not far separated from a fool. The employer in this instance is very much in the position of a judge, and we all know that a judge should give his verdict, but not his reasons for that verdict. The correspondence we publish clearly indicates that the man was dissatisfied with his position, that the union attempted to put pressure upon the responsible employer to retain the service of a man he did not believe merited employment. Both the dismissed man and the union practically tell the responsible electrical engineer he is a liar. We congratulate the electrical engineer for sticking to his decision; we congratulate all the Government officials who had a hand in the matter for supporting their colleague. If trades unions would restrict themselves to their legitimate objects every sensible man would support them, but they have got such swollen heads that they are con-

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tinually interfering in things with which they have no possible concern. The argument of the general secretary is the argument of a man who has no earthly conception of business matters. Because one firm pays its travellers six hundred pounds a year, that is no argument that another firm should pay at the same rate. There is another point in this correspondence to which the attention of the authorities should be called, and that is the so-called private letters. Does the secretary of a trades union deem it within the scope of his duties to write to a subordinate officer to get his opinions, when he has got the statements of the responsible or superior officer? What opinion have outside parties as to the conduct of a subordinate officer in condescending to discuss actions of a superior with third parties which have nothing to do with him. It is perfectly evident from the letters that the secretary of the union first wrote to the subordinate. We have no information except such as the correspondence itself gives, but from the letters we conclude that the whole affair has been deliberately planned, whether to force the hands of a Government department, or to damage a responsible official who was honestly endeavouring to do his duty, we cannot say. There is nothing to directly indicate the immediate object.

LONG-DISTANCE TRANSMISSION.

The paper of Prof. Forbes to the Society of Arts on Wednesday last, contains much interesting and some controversial matter. One point his critics—if, indeed, the discussion could be deemed criticism—ignored. Prof. Forbes does not directly claim, but his argument requires throughout that the transmission from the various centres mentioned must be a monopoly. The author emphasised again and again that the figures given were merely to illustrate his argument, and were not figures in a concrete form. It was assumed however, that high prices could in many cases be obtained, and that these high prices would pay both seller and buyer. In Rhodesia, New Zealand, Dongola, etc., the saving clause for commercial success is absolute monopoly. Upon another point his critics were somewhat unanimous, and yet we venture to think the author erred only in going to extremes. In discussing the financial question, he suggested the division of the money required into two parts—one, capital proper of a speculative character; the other, capital raised by mortgage upon the copper belonging to the transmission system. The amount obtainable by mortgage upon the copper asset would seldom be so large as Prof. Forbes put it, but that something of the kind suggested by him is feasible we believe. The suggestion is not new, except as applied to a particular case. Many men buy and immediately mortgage to the full extent, borrowing the money on mortgage at a lower rate than the return they get, and so benefiting by the difference in these amounts. Put this into a concrete form. A person buys a house for a thousand pounds and gets 5 per cent. upon his purchase. He mortgages the house for eight hundred pounds and pays 4 per cent. for his advance. His capital expenditure is two hundred, and he gets on this the difference between fifty and thirty-two pounds—that is, eighteen pounds—which gives him an interest of 9 per cent. upon his capital. Not a bad bargain. That process is the one suggested by Prof. Forbes, with the difference that the mortgage of three thousand tons of copper in a transmission line in Africa is hardly the same as the mortgage of a house in any town in England.

REVIEWS.

The Storage Battery. A Practical Treatise on the Construction, Theory, and Use of Secondary Batteries. By AUGUSTUS TREADWELL, jun., E.E., A.M.Amer.I.E.E. London: Whittaker and Co. New York: The Macmillan Company. 1898.

In spite of many shortcomings, Mr. Treadwell's book is a welcome and important addition to the somewhat meagre list of technical works of reference on the storage battery. And it may be said that the main defect—the general absence of anything like critical judgment in that large section of the work which is devoted to the description of no less than 120 different forms of the battery—is somewhat less prevalent than in other works of similar character but of less scope. The section to which we refer is little more than a compilation; but this is sufficiently complete and specific to render it useful to the practical investigator. A short introduction to the work is of special interest; and here the author exhibits, perhaps, a touch of humour in taking, apparently *au pied de la lettre*, the editorial statement of a contemporary that the "positive plate of a secondary battery is properly so called because it is plum-coloured and peroxidised, while the negative plate is of a neutral colour and not oxidised." But the main uses of accumulators are here concisely and forcibly set forth by the quoted opinions of various authorities; and an equally concise historical sketch of the successive discoveries from which the storage battery has become developed during the past 30 years will be useful to students. A fact that is by no means generally known is here mentioned—viz., that two years prior to the date of the first Faure patent (1881) R. L. Metzger "did away with the tedious forming process, by mechanically applying the active material."

The sixth chapter of the work sets forth with sufficient detail, yet without tediousness to the ordinary reader, the actual position of the "Theory of the Storage Battery." The views of Frankland, Streintz, Darrieus, Gladstone, Griscom, Duncan and Weigand, Crosby and Bell, Ayrton and Robertson, Elbs and Shönherr are here referred to. From what is stated, the imperfections and fallacies of the theory which has tacitly been accepted may be inferred; but they are nowhere specified or indicated. It perhaps would be unfair, whatever competence Mr. Treadwell may exhibit as an exponent, to expect much in this direction. And yet it has already become very evident to practical men, if not to theorists, that the generally received electro-chemical equation—however applicable to a cell fully charged and then run down to zero potential—is wholly inapplicable to the conditions of practice, *i.e.*, to a cell fully charged and then run down until the E.M.F. falls to 1·85 volts. And the futility—or worse—of the efforts which have been made to bring the calorific values corresponding to this equation into harmony with the suppositious value of two volts, as the normal, instead of the practical maximum, E.M.F. of the accumulator, has for a long time past been suspected, although it has only quite recently been demonstrated.*

In Chapter VII., on "Storage Battery Installations," the statements made in the introduction as to some of the main uses of accumulators are more fully developed for the instruction of the average technical reader. Illustrations, diagrams, and curves of discharge are freely distributed throughout the work; but in this portion they are much more elaborate

* See article "On the Relation Between the Heat Evolved and the E.M.F. Generated by Voltaic Action" in present issue.

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than elsewhere. The following, coming as it does from across the Atlantic, is sufficiently cogent for reproduction: "Many engineers claim (? opine) that the great trouble with storage batteries is their low efficiency. In the Boston station, however, it has been found that the watts (? watt-hours or energy) lost by the inefficiency (? low efficiency) of the battery is (are) made up more than fourfold by the better efficiency of the steam plant. In Hamburg, the loss in the accumulators is only 1·2 per cent. of the average amount of electric energy generated during the year. Manufacturers will guarantee the efficiency of a battery, when operated in parallel with a dynamo, to be greater than 75 per cent. Moreover, foreign experience has proven that the use of accumulators involves a saving of at least 15 per cent. in fuel. According to the New York *Electrical Review*, a battery plant, costing 150,000dol., when worked in connection with the trolley system, will show a net increase of 100,000dol. in earnings."

In the chapter on "Traction" much information has been brought together; and this is generally of an up-to-date character. The non-existence of an accumulator commercially adapted to the conditions of traffic is, it is here repeated, one of the most serious hindrances to electrical progress: it is one, we think, that might soon be removed if men of action and men of study could be brought together for mutual assistance. In the concluding chapter, the question as to the best method of charging accumulators is discussed, and many useful directions are given as to their management.

Metrical Tables. By Sir GUILFORD L. MOLESWORTH. Third edition, revised and enlarged. London: E. and F. N. Spon. Price, 2s.

This is a very handy little book. Although we have never been able to appreciate the transcendent merits of the metric system as put forth by its advocates, and hold that its adoption throughout so large a part of the world is due to other considerations than logical argument or merit, we are not blind to the fact that it is so adopted. Hence a series of tables giving equivalent values are valuable for reference, especially to business and scientific men, who constantly require the transposition of English measures into their metric equivalents.

The Mechanical World Pocket Diary and Year Book for 1899. Emmett and Co.

We have in previous years referred in terms of praise to this diary, and the present issue is an improvement even upon what has gone before. It contains a mass of very interesting and useful practical information. Most of the tables contain facts and figures constantly required for use, hence the little book should be in the hands of every engineer ready for constant reference.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LINE LOSSES.

SIR,—As no one appears to have taken up this matter, may I point out with regard to the answers to question 109 that three of your correspondents whose answers are printed make an assumption which is unwarrantable—viz., that of a constant current. Evidently the quantities given to work upon will be:

E_1 = volts at generating end of line, which, of course, should be as high as circumstances will permit;
W = watts it is required to transmit (a fixed quantity);
C = current (unknown);
m = miles of cable;
r = resistance per mile (unknown).

(*a*) $W = C E_1 - C^2 r m$. Now, r is a variable, W, E, and m are constant; therefore C is variable. Therefore, Thomson's law does not apply in this case.

The annual cost of cable per mile is put in the form

$$\frac{\text{Constant}}{r} + C^2 r.$$

In the case of Thomson's law this cost is a minimum, subject to the condition of C being a constant. In the power transmission scheme this expression is required to be a minimum subject to the condition of equation (*a*).—Yours, etc., R. C.

[N.B.—Our correspondent is correct in saying that the case does not come entirely within the Thomson law, but the general principles underlying the law are applicable in considering the question.—ED. *E. E.*]

RESISTANCE WIRES.

SIR,—We are looking for a high-resistance wire (about 50 times copper) with practically a zero temperature coefficient. We understand that it is made either in England or on the Continent. Perhaps some of the people whom your paper reaches know about it. Can you aid us in any way in locating this material? The temperature coefficient of "Rheostene," "Constan," "Kruppin," etc., is too high, while "Manganin" and "Eureka" are not high enough resistance.

We also want a wire of low resistance (as near as possible to copper) with a low temperature coefficient.

If you can suggest a way by which we can get either of these wires we would appreciate the favour.—Yours, etc.,

WILBUR B. DRIVER AND CO.

New York, Nov. 12, 1898.

THE GOVERNMENT AS AN EMPLOYER OF LABOUR.

SIR,—I beg to enclose copies of correspondence that has passed between us and the Office of Works with reference to the discharge of one of our members from his employment as an electrical wireman.

The two letters marked private from . . . . . show that Mr. Calipe was discharged for a reason that would be expected in a sweating contractor, but not at the hands of a Government department. I may say that Mr. —— is not a member of this union, and does not want his name mentioned if it can be avoided.

Trusting this may interest you, and that we shall have your assistance in bringing this before the public, yours, etc., F. E. SIMS, General Secretary.

Mr. Maddick. June 9, 1898.

Sir,—I beg respectfully to ask for a higher rate of pay than I am at present receiving, seeing that the rate is really below the minimum rate paid by contractors on account of the less hours worked by your department.

I also beg respectfully to call your attention to the fact that a large number of firms pay 9½d. and 10d. per hour to wiremen; charge hands 11d. and 1s. per hour.

Trusting that you will consider me worthy an advance, your obedient servant, A. CALIPE.

June 15, 1898.

Dear Sir,—In reply to your letter of the 9th inst., I have made all enquiries in reference to same, and see no reason why I should make any advance in the rate of your wages, as I think you are being fairly paid for the class of work you are now doing.—Yours faithfully,

SAML. W. MADDICK.

Mr. S. W. Maddick, Chief Electrician,
Electrical Department, Houses of Parliament. July 1, 1898.

Sir,—Having been advised by your representative that my services will not be required after Saturday, July 2, I beg respectfully to approach you with the following question: why am I discharged from your employ; and also with the query as to whether there is any truth in the statement made by your leading hand at St. Stephen's House: that the cause of my discharge being my "dissatisfaction" interpreted by you from my letter of the 9th ult.?

Trusting you will kindly grant me this request, your obedient servant, A. CALIPE.

Sir John Taylor, Principal Surveyor
to Her Majesty's Works. July 8, 1898.

Sir,—I much regret to trouble you with the enclosed

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correspondence, but not having received any reply from Mr. Maddick, chief electrician, electrical department, Houses of Parliament, to my last letter, dated July 1, 1898, I shall be pleased if you could kindly give me some reason as to my discharge.

I enclose letter of June 9, with reply, which I think has reference to the cause of my discharge.—Obedient yours,

To Sir John Taylor. A. CALIPE.

Aug. 15, 1898.

Sir,—Sir John Taylor desires me to say that he has made enquiry in reference to the matter mentioned in your letter of the 8th ult., and finds that it is one which is entirely within the jurisdiction of Mr. Maddick, the electrical engineer.—Yours truly,

Mr. A. Calipe. M. ROWAN.

S. W. Maddick, Esq., Chief Electrician,
Houses of Parliament, S.W. Sept. 6, 1898.

Sir,—I am instructed by my committee to ask you to be good enough to inform us what was the reason of the discharge of Mr. A. Calipe, who was employed as an electric light wireman at St. Stephen's House, S.W. He was discharged on Saturday, July 2, last.—Obediently yours,

F. E. SIMS, General Secretary.

F. E. Sims, Esq. Sept. 9, 1898.

Dear Sir,—In reply to your query *re* the discharge of a wireman named Calipe on July 2 last, I am directed to inform you as that we had no further need of his services he was discharged by the foreman in the usual way.—Yours faithfully, R. B. JAMES.

(*pro* S. W. Maddick.)

The Right Hon. A. Akers-Douglas, M.P.,
First Commissioner,
Her Majesty's Works and Buildings,
12, Whitehall-place, S.W.
Sept. 16, 1898.

Sir,—I am requested by my committee to bring before your notice the action of your engineer at the Houses of Parliament electrical department in dismissing one of our members (Mr. A. Calipe) who was employed as an electrical wireman at St. Stephen's House, S.W. He was discharged on July 2 last on the ground that the department had no further need for his services. We contend that he has been discharged because he ventured to ask for a higher rate of pay than the department are at present paying, and for no other reason. At the time he was discharged other men were taken on and kept on for weeks, so that slackness cannot be urged as the reason, and we are in a position to prove that Mr. Fennimore, the foreman of the department, told other men in the department's employ that the reason he was discharging Mr. Calipe was because he was dissatisfied, as he had asked for 9½d. per hour and they were only paying 9d. No fault was found or could be found with his work, and we contend that the department treated this man very unfairly in discharging him because he ventured to ask for ½d. an hour rise. The reason that this man wrote in for a higher rate of wages than the department was paying was because, to begin with, the men in the employ of the department are allowed only to work 50 hours a week, which, at 9d. per hour, amounts to £1. 17s. 6d. When we are working for electrical firms we work at least 53 or 54 hours, so that the men lose at least 2s. 3d. per week as compared with that they get in outside firms. As there are several firms who pay 9½d. per hour, Mr. Calipe thought that there would be no harm in calling the department's attention to it, and suggesting that, considering the loss involved, the department might see their way to increase his wages by ½d. per hour. There was no suggestion that he would leave or was dissatisfied; the advance was simply asked as a matter of justice, with the result that he was discharged for so doing.—Trusting that you will give this matter your attention, I have the honour to be, Sir, yours most obediently, F. E. SIMS, General Secretary.

S. W. Maddick, Esq., Chief Electrician,
Houses of Parliament, S.W. Sept. 17, 1898.

Dear Sir,—Yours of the 9th inst. has been fully considered by my committee *re* the discharge of Mr. A. Calipe on July 2 last on the ground that your department had no further need for his services. I have to say that in our opinion that is not the real reason of his discharge, as we had pretty good evidence to the contrary, which will at the proper time be produced. In the meantime, I am instructed to bring the whole matter before the First Commissioner of Public Works.—Obediently yours,

F. E. SIMS, General Secretary.

Oct. 14, 1898.

Sir,—With reference to your letter of the 16th ult., relative to the discharge of A. Calipe, an electrical wireman in the employment of this department, I am directed by the First Commissioner of her Majesty's Works, etc., to acquaint you, for the information of the Electrical Trades Union, that the man in question was dismissed because he was an unsatisfactory workman, and his discharge was in no way connected with his request for an advance of wages.—I am, Sir, your obedient servant,

REGINALD BRETT.

(*Private.*) Oct. 24, 1898.

Dear Sir,—In answer to your enquiry *re* Mr. A. Calipe, I can only say that as regards myself I do not know the real reason of his being discharged from the employment of the House of Commons electrical department whilst he was working at St. Stephen's House.

My surmise is the same as yours, that it was because he asked for the ½d. per hour extra, but I was never directly told so; and as to their reason that it was because he was an unsatisfactory workman, I can only say that whichever way you class that term it was not that he did his work in an unsatisfactory manner. As I was asked . . . . . what sort of a workman he was, both before and after he left, and replied "very good," and, furthermore, there was no one else except myself knew how well or how quick he did his work.

If there are any more particulars you wish to have more in detail I shall be pleased to give them.—Yours truly,

(*Private.*)

Mr. F. E. Sims. *Re* A. Calipe. Nov. 16, 1898.

Dear Sir,—In answer to your note of the 14th inst., I can only say that to the best of my belief I did say to Calipe that Mr. Fennimore told me that the reason of Calipe being discharged was because he had asked for more money, and he (Mr. Fennimore) thought a dissatisfied servant was better away; but I must also point out that what Mr. Fennimore told me was said in the confidential conversation . . . . and it seems to me as if it is a breach of confidence to bring that conversation in, though if the reason the department give of Calipe's leaving is detrimental to his getting another job, of course I shall only be too pleased to substantiate all that I have said, but as I have been on terms of personal friendship with Mr. Fennimore, I would certainly not like to do him any harm.

As to the general management of the electrical department of the Government, I will only be too glad to give you any help that is in my power to show it up, and would like a personal interview any Saturday night you could make convenient if you will give me three days' notice.—I am, yours very sincerely,

To the General Secretary, Electrical Trades Union.

THE LIVERPOOL MOTOR-VEHICLE TRIALS.

On Wednesday last the Liverpool centre of the Self-Propelled Traffic Association held its opening meeting of the new session in the Arts Theatre of the University College, Liverpool. The feature of the evening was the presentation of the judges' report on the recent trials of motor vehicles for heavy traffic. The prizes for the trials were announced last August, and it will be remembered that the Lancashire Steam Motor Company, of Leyland, carried off the premier honours. The judges' report is contained in a well-edited volume of about 150 pages, in which full details and illustrations of the various vehicles entered are given. The report should be on the bookshelf

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of everyone interested in road traffic. The figures given are most full, and show results as favourable as 2·1d. per net ton-mile, including fuel, wages, interest, and depreciation. The judges' conclusions are as follows·

CONCLUSIONS.

The objects, regulations, and conditions of the trials, as set forth in the "Particulars of Competition," made it clear that the chief determining factors of merit were to be economy of working, weight of freight carried, manœuvring capabilities, and general control. We have carefully considered the points specified for our particular attention, and, excluding the six-wheeled vehicle, which we regard as not being adapted to the traffic intended, we are of opinion that:

Town Haulage.—The vehicles presented for trial were suitable for a number of trade purposes, and capable of taking the place of horse haulage, in Liverpool and neighbourhood, with economy.

Distance Haulage.—The vehicles were capable of economically competing for the transport of loads up to four tons, over such distances as were embraced by the trials (30 to 40 miles), where the rates are equal to those in operation in the Liverpool district.

Volume of Traffic.—The volume of traffic between the port of Liverpool and the manufacturing districts is too large and varied to be dealt with by any isolated scheme of motor-wagon transport; there are, however, undoubted opportunities for the establishment of carrying undertakings, and for the adoption of self-propelled vehicles, by individual firms on a more limited scale with a prospect of gradual and remunerative extension.

Further Limitation.—Although the calculated costs per net ton-mile show a saving on existing railway rates, we do not consider that motor vehicles could successfully compete for traffic in opposition to reduced railway rates, except under special circumstances.

Maintenance and Efficiency.—Whilst it has been practically demonstrated under test of actual working, of great severity, that new machines may work in commercial competition with railway rates with loads up to four tons, and over distances of from 30 to 40 miles, the severity of the duties which automotor vehicles have to perform in carrying heavy loads, at useful speeds, on common roads, is so great as to involve even greater maintenance and/or depreciation charges than those which we have used in our calculations. This has a two-fold effect. First, in increasing the cost of working, and, second, in rendering the service in a measure uncertain. We cannot disguise the fact that motor vehicles, in the present stage of their development, are liable to temporary breakdowns which might cause considerable delay and annoyance.

Effect of Roads.—The imperfections of common roads are the principal causes of the heavy maintenance and depreciation charges, and of the element of uncertainty which at present attaches to any service of motor vehicles. On good macadam roads, with moderate gradients, the vehicles to which prizes were awarded would do good service with the respective loads carried during the trials, but none of them could be relied upon for a regular service on roads such as those of the routes selected for the competition. We anticipate that the consumption of fuel and water may be very considerably increased when the vehicles have to run over wet, muddy, or exceptionally heavy roads; but as these conditions will be accidental, they will probably not very materially alter the average costs per net ton-mile.

Wheels.—The form of wheels and tyres adopted by all the manufacturers, though probably perfectly efficient as carriers, were all structurally more or less inefficient as drivers.

Manœuvring. — None of the vehicles were able to manœuvre into and out of an embayment as effectively and rapidly as may be expected when time and experience have effected improvements in design, but they were capable of going anywhere that horse-drawn vehicles are ordinarily required to go.

Control.—The general control, stopping, starting, and steering of the vehicles, when working on the road and amongst traffic, was at least as good as with the best types of horse-drawn vehicles.

Hill-Climbing.—The hill-climbing powers of the vehicles were much superior to those of horse-drawn vehicles, when commercial efficiency is considered.

Gearing.—At least two speed gears, or an equivalent reserve of power, are essential to successful working on common roads with steep or even with average gradients.

Driving Operations.—Generally, too much attention was required by the various operations of regulating and driving the vehicles, and, in order that self-propelled vehicles may command a wider adoption than can yet be confidently recommended, there must be an extended use of automatic arrangements analogous to those in other fields of mechanical science. When such improvements are made, they will have a great effect in placing motor vehicles upon a more practical basis for traffic in cities, by enabling comparatively unskilled attendants to undertake their management.

Legal Restrictions.—Probably the most onerous conditions were those involved in complying with the limitations of the Locomotives on Highways Act, 1896. The limit of tare imposed by this Act seriouly tends to reduce the strengths of working parts, and practically precludes the possibility of constructing a really satisfactory motor vehicle capable of carrying five tons and upwards, except, perhaps, at such an increase of prime cost as would be commercially prohibitive. We recognise the difficulty of immediately removing all legislative limit of tare weight, but believe that an increase of that limit, from three to four tons, would be accompanied by no inconvenience whatever, whilst a tare weight of six tons might be permissible in certain localities; but any increase in the legal limit of tare weight should not be accompanied by the imposition of any restrictions on self-propelled traffic further than those already existing.

Experience.—The experiences gained during the trials will undoubtedly tend to obviate some of the chief causes of the troubles which arose on the road.

Working Light.—In any future competition trial runs should be made, and the manœuvring capabilities of the vehicles tested, both when light and when loaded.

Future Competitions.—The conditions for any further competition should be published at least eight months before the dates of the intended trials.

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE IV.

(Continued from page 655.)

First of all we have to consider the period during which the brakes are being put on. Without going further into this question now, let us assume that we can stop the car in 10 seconds in a distance of 100ft. This leaves us with 500ft. to be covered in 30 seconds. To begin with, we know what the final speed must be, for we have to cover 250ft. in 10 seconds—i.e., full speed is 25ft. per second. Since the tension of the line is 500 volts, and the drop at full speed is nine volts, we get e, the induced volts, equal to 491. Hence from equation (1) we have $\frac{M}{d} v = 5{\cdot}15$. Suppose now that $v = 4{\cdot}78$, and that $d = 33$in., we get then $M = 35{\cdot}5$. With these values of M, v, and d, the current at full speed must be 15 amperes per motor, and the resistance of each motor 0·6 ohm.

So far we know that if we construct an equipment with these values of M, v, and d, the car will move at the required speed against the given resistances to motion, and one-half the given distance will be covered in one-third the given time. In order to get up 25 feet per second in 20 seconds, the acceleration must be 1·25 feet per second per second. Inserting this in equation (2), remembering that W per motor is five tons, we obtain the accelerating current and find it to be 30 amperes, so that the total current at starting will be 45 amperes.

The acceleration curve obtained with this equipment, up to the point where the brakes are put on, is shown in Fig. 27. The acceleration is constant at 1·25 feet per second per second for 20 seconds, and during this period 250ft. are covered. The rest of the distance is covered at full speed at 17 miles an hour.

In the same diagram you see the current curve. The maximum current, 45 amperes, is constant for 20 seconds: during this period the starting rheostat is being gradually taken

* Cantor lectures, delivered before the Society of Arts.

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out; when it is all out the current rapidly diminishes to 15 amperes per motor. The area of this curve gives us the total work done, and in this case amounts to 387,000 foot-pounds of energy.

We have thus designed an equipment that will cover the given distance in the given time, but the question now arises, "Does this design comply with the specification in the most economical manner?" The answer to this is that any alteration in the values of M, v, or d that we have selected will require a larger accelerating current to cover the distance in the given

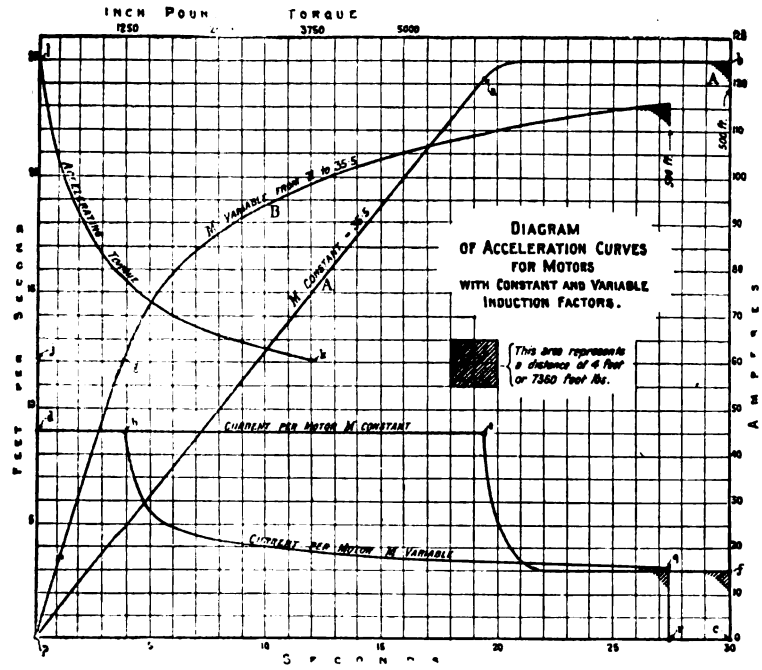

FIG. 27.

time, so long as the value of M remains constant throughout—*i.e.*, so long as we adopt what is practically a shunt-wound motor. If, however, we are at liberty to vary the induction factor by using series winding, we may be able to effect a greater economy. Let us then see what this series winding can do for us.

In Fig. 28 I have reproduced the current curve that you have already seen in Fig. 27. You know that the area of this curve

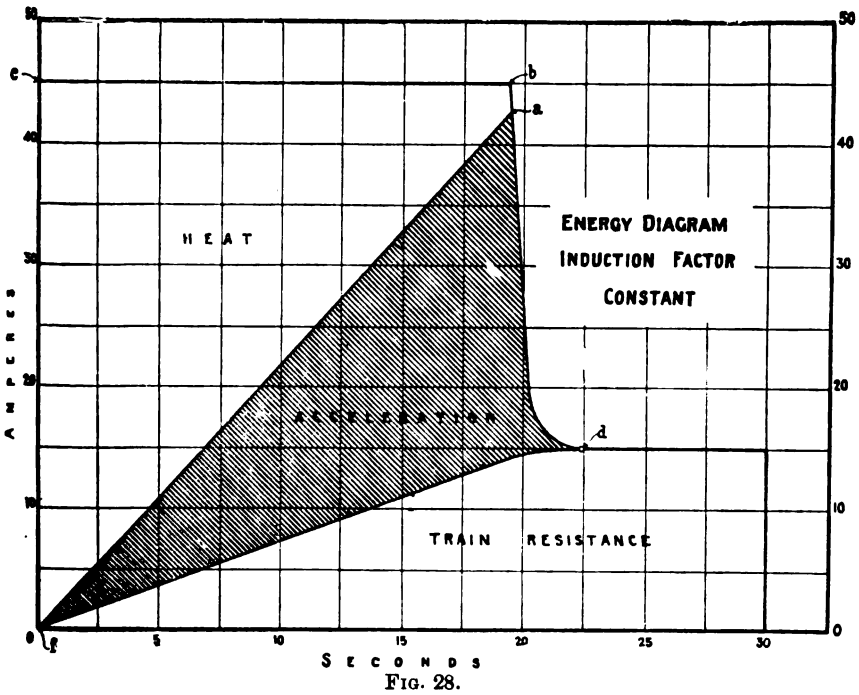

FIG. 28.

represents the expenditure of energy. Hence it should be the aim of the designer to reduce this area as much as possible.

Let us begin by analysing this area and separating the different items of energy expenditure. This I may do by drawing lines dividing the area into three parts, each representing an entirely distinct item of expenditure. I have done this by dividing the vertical ordinates of the current curve into three parts, each representing that portion of the whole current that is expended in the three different ways of heat, acceleration, and train resistance. You see that at the moment of starting the whole of the energy is being expended in the form of heat. As the speed increases less is expended thus, and some in overcoming train resistance and some in accelerating. When full speed is reached the only expenditure is for train resistance.

You will notice that the rate of energy expenditure in overcoming train resistance is not uniform, as it is sometimes supposed to be. This should be obvious when you remember that it depends upon the speed, the resistance to be overcome remaining constant, so that at the moment of starting it is nothing. I mention this because some recent calculations on motor control and energy expenditure have been based upon the assumption that the rate of energy expenditure for train resistance is uniform, so that the whole energy thus expended simply depends on the time, whereas it really depends upon the distance.

When the distance to be covered is fixed, the only way of reducing this item of expenditure is to reduce the resistance to motion. This we may do by using roller bearings or other similar devices. When, however, we have reduced it to the lowest limit the expenditure under this head may be found by multiplying the resistance to motion, expressed in terms of so many pounds of horizontal effort, by the distance that has to be covered.

We now come to the second item of expenditure—namely, acceleration. This represents the kinetic energy stored up in the moving train, and depends upon the weight to be moved and the square of the final speed. The only way of effecting a saving under this head will be to reduce the final speed, and since the expenditure varies as the square of the speed, it will be well worth doing this.

Now I have already shown you that the best speed is that which covers half the distance in one-third the time, and that if we run with a smaller final speed than this we shall have to increase the accelerating current. Since the heat expenditure varies as the square of this current, it will not be worth while adopting a lower final speed. It appears then that the saving of energy must be made, if at all, under the head of heat.

I want you to notice that the heat energy is represented very nearly by a triangle, drawn by joining the point f to the point b. The little distance $a\ b$ is, in fact, the rate of expenditure of energy due to the initial current passing through the resistance of the motor only. As the initial current rapidly diminishes this state of affairs lasts for a very short time. I shall therefore assume that the heat loss is fouud by joining f to b, and is given by the area of the triangle, $c\ b\ f$. Now, how can we reduce the area of this triangle? One way is by using the series-parallel controller. Let me explain.

The current curve that you are now looking at represents the current for one motor. If we have two motors and connect them in series at starting, and maintain the same current per motor as before, we shall have 45 amperes from the line instead of 90, and this will last until the rheostat is all out on the series step—*i.e.*, for 10 seconds—hence we shall cut a large rectangle out of the heat triangle like that shown in Fig. 33. If I have made this clear, you will see that the series-parallel controller enables us to halve the heat loss when two motors are used. This is a very important conclusion, since it shows us wherein lies the great advantage of this method of control. Whatever arrangement we adopt, however we design our equipment, if we use shunt or series wound motors, the series-parallel controller halves the heat loss.

If four motors are used, the question may arise as to whether it is worth while connecting them four in series at the start. Under these circumstances, the heat loss is not again halved. Suppose the heat loss with parallel connection to be 100, then by arranging the motors two in series at starting we reduce the heat loss to 50. By arranging them four in series at starting the heat loss becomes 37·5. This is on the assumption that we neglect the resistance of the motors themselves, and makes the saving rather larger than it actually is. It is, in general, not worth while to connect four in series, since the connections become very complicated. This arrangement might, however, be justified if it was considered necessary to be able to run at very slow speeds.

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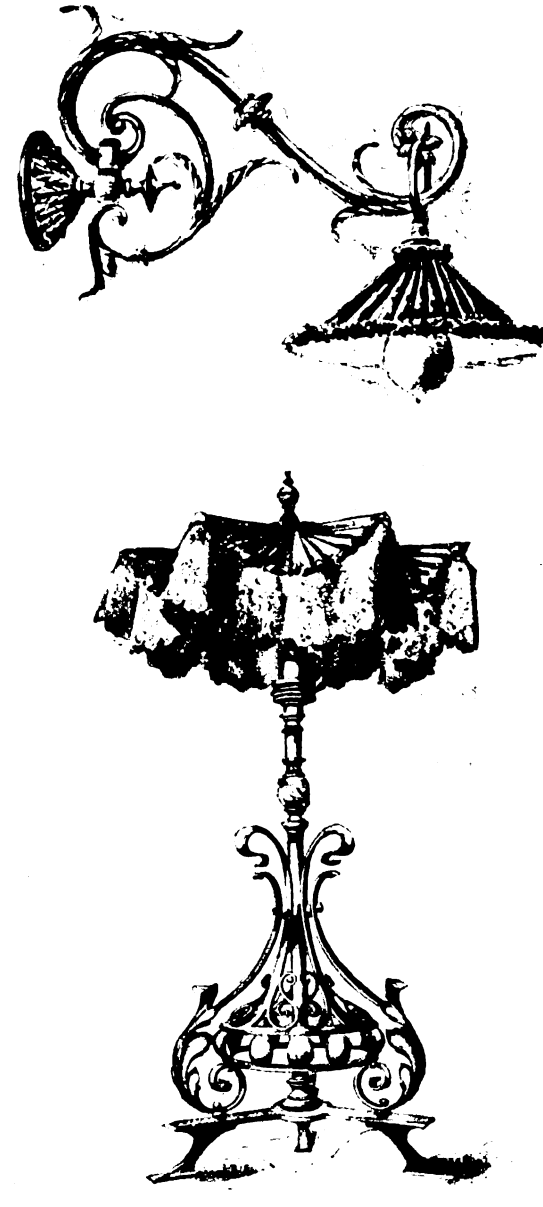
I want now to direct your attention to another very important method of reducing the heat loss. To make myself clear I must begin by asking you to imagine that you are in possession of a mechanical contrivance that at present exists only in the brain of the ardent inventor—namely, a contrivance by which you can vary at will the velocity ratio. Imagine that your car is equipped with such a contrivance, and that by simply moving a handle you can increase or diminish v without making any other alteration in your equipment. Let us see what this would enable you to do.

At the moment of starting you would make v as large as possible. Suppose, for instance, that you could double v, you would then get twice as great an acceleration as before with the same current. Now if you kept v at this value, your car would speed up to half the proper speed and you would not cover the required distance in the given time. If, however, you kept on reducing the value of v as the car increased in speed, you could bring up the speed to the same final speed as before—namely, with $v=4{\cdot}78$. There would, however, be this great difference from the case when v was constant, that the high initial current would last only so long as the initial value of v was maintained; in other words, the starting rheostat would be in circuit for a very much shorter period.

(To be continued.)

THE GENERAL ELECTRIC COMPANY'S CATALOGUE.

We have received from the General Electric Company a copy of the ninth edition of their catalogue of electrical fixtures and glassware. This is a large volume containing over 800 pages, with a very large number of illustrations. The book is a valuable and useful guide, and a standard reference for electrical engineers, contractors, etc., both in this country and abroad. It is arranged very systematically, each article being drawn to scale, and the smallest details shown, as far as is possible, in printed matter. Great attention has been bestowed on obtaining perfect insulation in all the electrical parts of the fittings manufactured by this firm. In this way the old failing, so common in the best and most artistic fittings, is avoided. We refer to the fact that in the past some of the designers have not paid sufficient attention to the electrical part of the fitting, and in consequence it has been almost impossible to make a satisfactory electric connection to the lamp. The standardisation of the screws used in these fittings, which this firm inaugurated some years ago, is a most valuable



item to all customers. In this way the ordering of the accessories which may be required is greatly simplified, much to the advantage of country customers. A large number of the designs in the new catalogue have been got out since the eighth edition was published, but in every case the illustrations represent electrical fittings which have been manufactured by the General Electric Company, and not merely paper designs. The catalogue commences with a great variety of small accessories which are required in electric installations—such as cord grips, ball hooks, insulating eyes, ceiling plates, cord ornaments, etc. The list of plain and fancy shade carriers is very complete, and we note one or two new types which are used to assist in the absurd practice of making an electric lamp represent a wax candle. On p. 562 a very useful detachable ball fitting is illustrated. This device, which is patented, allows of the lower half of the ball which carries the holders and lamps being unscrewed as a whole from the top half.

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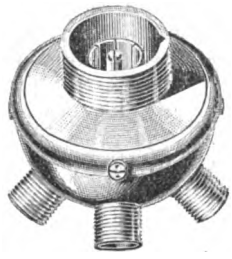
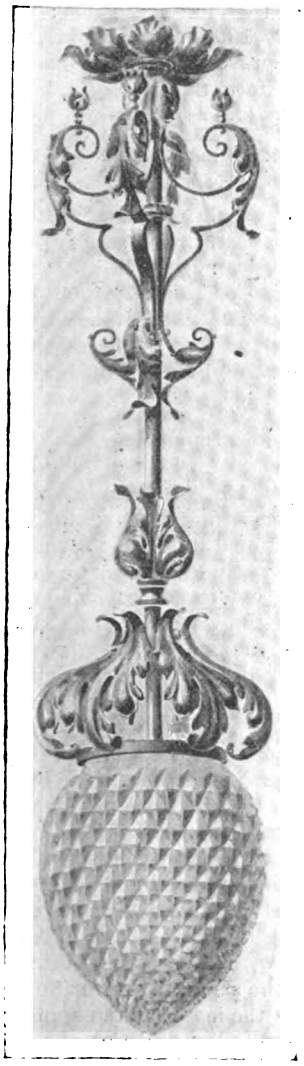
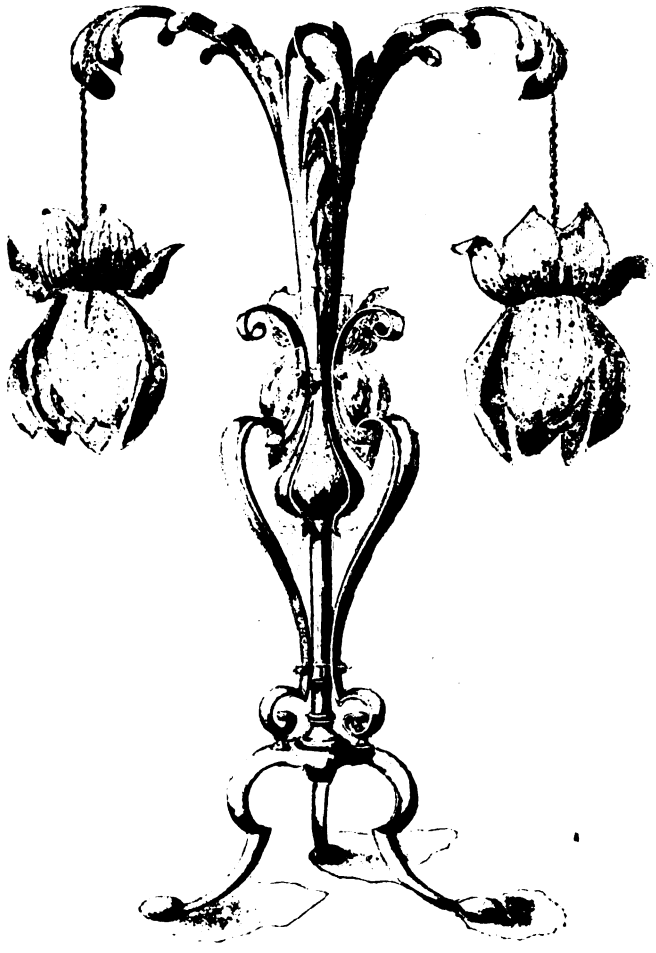
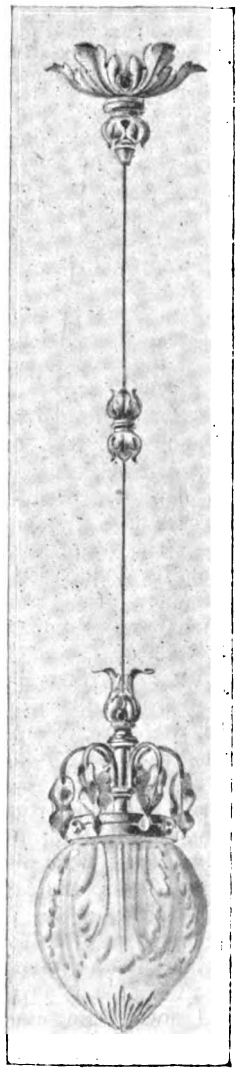
The shades used in this case are made with the standard 3¼in. openings, and can then be removed for cleaning, passing over the upper half of the ball. The arrangement is designed for both single and double circuit some openwork caps in lacquered brass, give a most pleasing effect, but if the light is required in the room they add considerably to the amount of energy taken. Window fittings, outside lanterns, and ship fittings—all have sections









workings. The following pages are devoted to the very numerous types of counterweight fittings, and then we come to those friends of the central-station engineer, bead pendants. These, which are crowned by hand- to themselves; and we are glad to see that electric light fittings for railway carriages are now so much in demand as to necessitate a special page to themselves. When one comes to the electroliers, pendants,

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and wall brackets it is exceedingly difficult to describe the various designs in detail. The best thing our readers can do, beyond getting the catalogue for reference, is to make a call at the General Electric Company's showroom at 88, Queen Victoria-street and inspect the fittings themselves. The real bronzes, which are illustrated in the last part of the catalogue, are well worthy of inspection. We give herewith illustrations of a few selected types of the more recent designs, but the limited space at our disposal prevents us from making a representative selection from the very numerous illustrations in the catalogue; the glassware shades also listed are best selected from the actual shades in the showroom.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

118. When making cable tests to earth, and especially when endeavouring to localise a fault, the positive end of the battery is invariably put to earth direct. Why is this done; could not more accurate results be obtained by putting the positive and negative ends to earth alternately and taking a mean value of the readings thus obtained? H. B. S.

119. Assuming that a 16-c.p. gas-burner consumes five cubic feet of gas per hour, and that a 16-c.p. incandescent lamp requires 60 watts, show by a diagram the relative cost of the meter bill for gas and electric lighting; the price of gas varying from 1s. to 10s. per 1,000 cubic feet, and electricity costing from 1d. to 10d. per B.O.T. unit. J. C. R.

ANSWERS.

Question No. 112.—What difference is made in the efficiency of a given alternate-current transformer by raising the frequency of the primary current from 50 to 100 complete cycles per second?

Best Answer to No. 112 (*awarded* 10*s.*).—To alter the frequency of the primary current supplied to a given transformer, as used in central-station supply, is to alter the debit or credit side of that station's accounts. To increase the frequency is to raise the efficiency, and to lower the frequency lowers the efficiency. This will be generally understood by knowing that the E.M.F. of the secondary of a transformer is made up of a product which remains constant whatever may be the frequency. $E = 4{\cdot}45\, p\, N\, t$, and E and t are always fixed, so that if we alter p (frequency) the quantity, N (lines), must alter inversely. In this case p is to be altered from 50 to 100, and, therefore, N must decrease and become $\frac{1}{2}$ N. Now, N is made up of $\beta \times a$, where a = area of iron in square centimetres, and β = density of lines per square centimetre. The quantity a remains fixed, and therefore the only alterable term is β, which varies inversely as the frequency. With our given transformer, therefore, β has altered to become $\frac{1}{2}\,\beta$ when the frequency is increased to 100. Now, at an induction of $\frac{1}{2}\,\beta$ the energy lost in reversing the lines once, say, is very much less than half of what it was when the induction was β, because the loss does not follow a proportional law. It follows a law of $\beta^{1{\cdot}6}$ power. But under these new conditions, when the lines have to be reversed 100 times to 50 under the old conditions, the total iron loss is still much less even with the higher frequency. The eddy-current loss is a constant quantity under all frequencies, and, therefore, need not be considered. The two losses are expressed mathematically thus: hysteresis, proportional to frequency and 1·6th power of induction $= (\beta\ p^{1{\cdot}6})$; eddy current, constant for all frequencies $= x\ (\beta\ p)^2$, where x is a constant depending on thickness of plate. By increasing the periodicity we have reduced the iron loss or no-load watts, making the "watts input" less in the denominator of the fraction $\frac{\text{watts output}}{\text{watts input}}$, and, therefore, we have increased the efficiency of the transformer by raising the periodicity.

As an example, consider the case of a 6-kw. transformer working at a periodicity of 50 and having a total iron loss of 180 watts, primary volts 2,000, secondary volts 100. The full load efficiency is 95 per cent. If it is put to work on a circuit of 100 periods per second the iron loss is reduced to 145 watts, and the full load efficiency rises to $95\frac{3}{4}$ per cent., the primary and secondary voltages remaining the same. Under these conditions the transformer will not get so hot, which is a consideration worth having, as it is known that the long-continued heating of the iron causes an increase in the magnetising loss. The increase in efficiency may appear small, but when it is remembered the long hours of practically no load it should be judged rather from the standpoint of "little savings make great gains."—S. J. M.

Answer to No. 112 (*awarded* 5*s.*).—The actual increase in efficiency at full load due to the higher periodicity would not amount to more than 1 per cent. in good modern transformers ranging from 1 kw. to 50 kw. output, but at light load (which is much the more important case with transformers, considering the long hours they run on practically open circuit) the increase is quite decided.

Thus, according to a first-class maker's list now before me, the increase in efficiency at one-tenth of full load for a 50-kw. transformer is 4 per cent. (89 per cent. to 93 per cent.), and for a 1-kw. one 5 per cent. (70 per cent. to 75 per cent.). The reason for the increase is this: when a given transformer is worked at 100 cycles in place of 50, the flux density in the iron core is necessarily halved, as shown by the well-known flux formula:

$$\text{Flux} = \frac{\text{volts} \times 10^8}{\text{periods} \times \text{turns} \times 4\ 44}.$$

Now, the hysteresis loss per cycle in iron is roughly proportional to the 1·6th power of the flux density, so that the relative values of the hysteresis losses per cycle in the two cases would be as 3·04 at 50 cycles : 1 at 100 cycles, or the relative losses in a given time as 1·52 : 1, about 35 per cent. more at 50 cycles than at 100. The losses in transformers at light loads (quarter load and less) consist almost entirely of hysteresis watts, the ohmic loss being almost negligible.—Q.

Question No. 113.—How can you determine the watts lost from eddy currents in the armature of a direct-current dynamo?

Best Answer to No. 113 (*awarded* 10*s.*).—The armature losses of a direct-current dynamo arise from three main causes: (*a*) hysteresis in core; (*b*) frictional losses in bearings, etc.; (*c*) eddy currents in conductors and core. The loss from the last cause may be reduced by stranding the conductors and laminating the core. The limit to this is fixed by the expense of manufacture and the amount of useful space occupied by the insulation. In order to determine to what extent this subdivision may be carried to advantage without unduly raising the price of the machine, the designer not only wants the total loss in the armature, but requires the watts lost from eddy currents to be separated from the other losses. The total loss in the armature on open circuit is obtained by running the dynamo as a motor on no load, and exciting the field from a separate source to the same strength as that obtained when the machine excites its own field at normal speed. This can be determined before disconnecting the field winding by running the machine on open circuit at normal speed with a voltmeter across the brushes, and then regulating the separate excitation so that the same volts are obtained on the meter at the same speed. Of the three losses, the hysteresis loss and also the friction loss (except at very low speeds) are proportional to the speed for the same field, while the eddy-current losses are proportional to the square of the E.M.F.'s which produce them, and therefore for the same strength of field, are proportional to the square of the speed. On open circuit the ohmic resistance losses do not exist.

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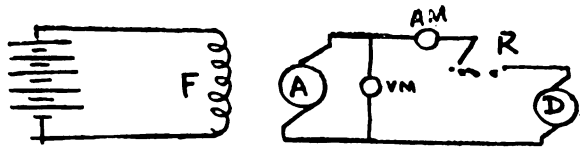
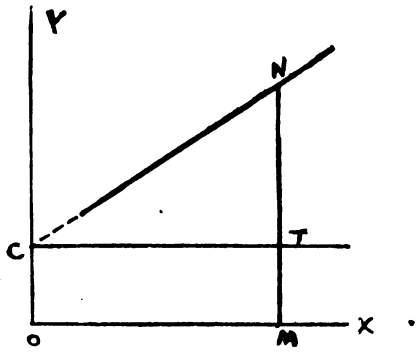
The work done in the armature of a motor is measured by taking readings of E.M.F. across the brushes and armature current, and multiplying them together. The power absorbed by the armature in watts at any particular speed will then be measured by the product. The connections for the test are as shown. F = field winding (separately excited), A = armature to be tested, V M = voltmeter, A M = ammeter, D = dynamo supplying current to armature, and R = point-to-point resistance. On varying R the amperes, volts, and speed in A are all varied. Simultaneous readings must be taken of speed (by revolution counter), current, and volts from a small speed to above the normal speed. A diagram must now be plotted having speeds as abscissæ and currents as ordinates. Since the resistance due to hysteresis and friction is independent of speed, the current



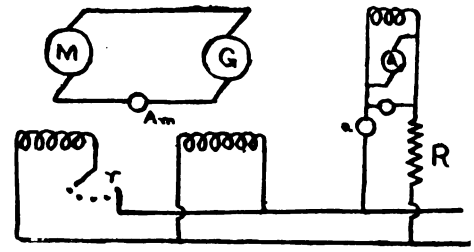
required to overcome it is the same at all speeds. The remainder of the current forming the increment as speed increases is due to eddy-current loss. The curve will take the form shown—practically a straight line at an angle with the abscissæ line. Produce it backwards to cut the ordinates line at C. Then O C represents the current that the machine would take at starting if the friction coefficient were the same at all loads. As a matter of fact, this is not the case, so that the actual starting current is greater



than O C. A point on the line drawn parallel to O X through C gives at any ordinate the amount of current used in overcoming the resistance of hysteresis and friction—*i.e.*, M T—while N T is the current required to produce the torque overcoming the eddy-current resistance. Hence the watts lost at that speed is the value N T, multiplied by the volts in (V M) at that speed, when the dynamo is running on open circuit.

The loss due to eddy currents in the armature is greater on load than on open circuit. Several methods based on Dr. Hopkinson's method of determining the commercial efficiency are used. A useful modification is the following: Two dynamos of the same size and type are required. Their shafts are rigidly connected, and their field leads disconnected. In series with one field is put a small point-to-point resistance, *r*, and the field circuits are connected in parallel, as shown, care being taken to connect them, so that when current is passed through the windings it will not reverse the polarity of either field. The armatures are then connected up in opposition, so that if both armatures were running and the two fields were equal, the E.M.F. in one machine would exactly oppose that in the other and no current would flow. An ammeter is included in the circuit. In order to obtain a current of desired strength between the two machines, the field of one is slightly weakened by inserting resistance in V. When the coupled machines are running, it will be seen that G generates a certain current, which is transmitted to M, which acts a motor, transforming electrical energy into mechanical and returning it along the shaft to G. To keep the combination running, power need only be supplied equal to that wasted by the two machines. This power may be supplied by a belt connection to an independent source of power. In this case a transmission dynamometer, such as the Hefner von Alteneck, must be used.

But a more convenient way is to supply the surplus power electrically. A small motor is either coupled direct on to the shaft or driven by belt. The difference between power given to auxiliary motor, A, and that transmitted by it to shaft—*i.e.*, that wasted in motor and belt—is too small compared to total power of large machine to be noted. A rheostat, R, varies the E.M.F. applied to terminals of motor, and hence its speed. So that the combination of the two machines under test can be run at widely varying speeds. By varying *r* slightly the main current between the armatures can be kept fairly constant



at any speed. Readings are taken of volts and amperes on auxiliary machine at every speed, and a similar curve plotted from these as before. We thus get the difference between current used in overcoming hysteresis and friction in the big machines and that taken up by eddy currents. This multiplied by the E.M.F. at any speed gives the watts lost in the two machines. Assuming the machines to be equal in their efficiencies, half this value gives the watts lost in the one armature at the current in A_m.—J. A. SEAGER.

Answer to No. 113 (*awarded* 5*s.*).—The accurate measurement of the loss in eddies of a continuous-current dynamo is a very difficult matter, and it may be said that by all methods only a close approximation can be hoped for. The total eddies in a dynamo (with a smooth core) are those in the conductors, core plates, and pole-tips, and are due to the cutting of the magnetic lines by the conductors and core discs and the magnetic fluctuation in the pole-tips, the latter arising from the disturbing effect under the tips during commutation. The eddies in the conductors are supposed to increase as the dynamo is loaded, from the reason that the magnetic field is more distorted, causing the two sides of a conductor to have large difference of magnetic density, consequently setting up increased eddies.

For all general practical purposes the "motor" method is the most accepted. Here the dynamo is converted into a motor by permitting the armature to run perfectly free, and separately exciting the field coils and supplying at different E.M.F.'s variable currents absorbed at different speeds. As the motor is running at a very light load, armature reaction and C R drop in the armature can be neglected, in which case the internal armature E.M.F. becomes equal, and the same as the terminal E.M.F., and the variation in speed directly proportional to the armature terminal E.M.F. The principle of the method is based upon the fact that the hysteresis and friction losses follow a law proportional to the speed, and the eddy loss as the square of the speed for the same strength of magnetic field. These losses following different laws permit them to be separated as below.

A numerical example will best explain the method. Suppose the machine to be tested to be shunt-wound, having a ratio output of 100 volts 600 amperes at 800 revolutions per minute. The course of procedure is to first separately excite the magnets at 100 volts to obtain the normal strength of field. From another source impress, say, 100 volts upon the armature terminals, and note the current passing into the armature. The speed may be noted also, though this is hardly necessary, as with the constant field strength the speed is directly proportional to the impressed E.M.F. Suppose in the above we obtain 15 amperes. Take another pair of readings with a lower voltage (say 80), and note the current (say 13 amperes). These readings would be sufficient if accurately taken, but for corroboration take another set (say volts), and assume corresponding current to be 10·5 amperes. During the whole time of taking these readings it is necessary that the *excitation* of the magnets be constant. If the test readings have taken a long time

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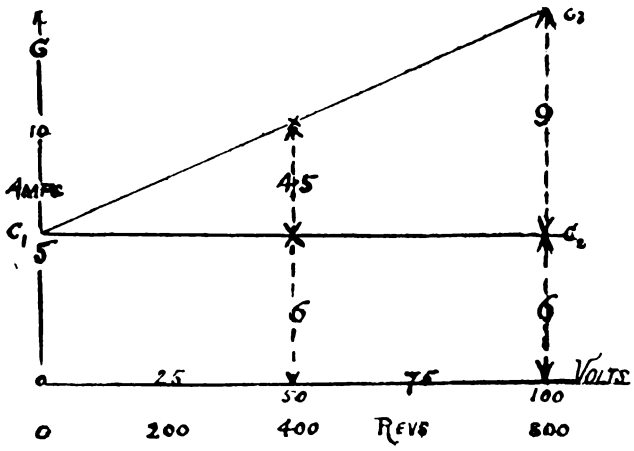
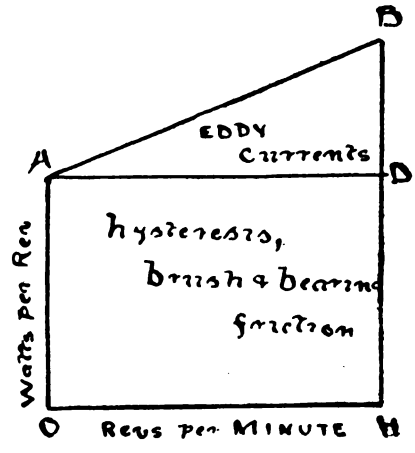
the shunt will have warmed up, thereby increasing the resistance, and reducing the exciting power and of course the field strength. Now, plotting the above results so that the ordinates represent amperes and abscissæ volts or



speed, we obtain a straight line curve, terminating in the line O C in the figure. The length of line O C_1 represents the current or torque that would be necessary to *just* turn round the armature, overcoming friction and hysteresis, and the length of line C_2 C_3 the current required to balance the eddies at full speed. The watts lost in eddies at 100 volts, or 800 revolutions per minute, will be 100 × 9 = 900, or 1·5 per cent. of full load output, and at 50 volts 400 revolutions per minute or half speed = 50 × 4·5 = 225. This would prove figuratively, as confirmed by experiment, that the watts lost in eddies vary as the square of the speed with constant field.

To obtain the eddy losses at full load it is necessary to have two machines similar in type and output, and an auxiliary small machine giving the same current. The similar machines are rigidly coupled together and are electrically connected with the small machine, so that all the armatures are in series. The fields of the similar machines are arranged so that one machine acts as motor to the other, the small machine supplying the excess power required to keep the combination running. Adjustment of the field excitation of the similar machines and the voltage of the small machine will enable one to obtain constant current over wide variations of speed and a series of readings from which can be deduced the separate value of the losses. As two similar machines are not always to hand, the general recourse is to adopt the former method, which is the easiest and readiest to perform.—EDDIES.

Answer to No. 113 *(awarded* 5*s.).*—There are several methods in use for determining this quantity, nearly all of them depending upon the fact that the losses in hysteresis and friction are proportional to the speed, while the eddy-current loss varies as the square of the speed. One method is as follows: Separately excite the magnets of the machine up to about their full strength, and then run the machine as a motor at various speeds by applying various E.M.F.'s at its terminals. Measure the E.M.F., current, and speed in each case. Then, in any case, E I = watts expended to drive the machine. Part of this loss is in heating the armature conductors, and may be found by the formula $I^2 R$. This is deducted from the total E I, and the remainder is the loss in eddy currents, hysteresis, and friction. Dividing this quantity by the number of revolutions the machine was running, thus $\frac{E I}{n}$, we get the number of watts lost per revolution, and by plotting the results of each experiment with the number of watts lost as abscissæ, and the revolutions per minute as ordinates, it will be found that the points lie in a straight line, A B, which starts somewhat above the base line, O H. Now, if the speed were exceedingly small—say one revolution per minute—the eddy-current loss would be still small, or practically zero, while the hysteresis and friction losses would be the same constant quantity as would exist at any speed, so that by drawing a horizontal line, A D, through A we are able to separate the eddy-current loss from the others. To find the total eddy-current loss of the machine under consideration, the watts lost per revolution in eddy currents at its rated speed would be found on the diagram, and this multiplied by its speed gives the total loss in eddy currents.



The separation of losses may be carried still further, but since this is not asked for it is hardly necessary.—F. E. B.

LEGAL INTELLIGENCE.

A LEEDS ELECTRICAL ENGINEER SUED FOR COMPENSATION.

At the Leeds County Court on Wednesday, the hearing of the case Pearson *v.* Hartnell was resumed by his Honour Judge Greenhow. The case had been adjourned from Oct. 21.

Mr. Warren appeared for the plaintiff, Reginald Hewitt Pearson, who sought to recover, under the Employers' Liability Act, 1880, from Mr. Wilson Hartnell, electrical engineer, Kirkstall-road, £210. 12s., compensation for injuries sustained by him whilst in defendant's employment. Mr. Shepherd (instructed by Messrs. North and Son) appeared for the defendant.

The plaintiff, a young man, entered defendant's employment as an improver in February, 1897. His wages were to be 5s. a week. In September of the same year he began to do similar work to that done by the men, and from February to April, 1898, he was at Whitby fitting up wires. When away from Leeds he was allowed the same boarding expenses as were granted to the men. On June 3 a man named Broughton asked him to assist in removing an armature—a heavy piece of machinery—from a lurry. Instead of the armature being drawn under the Goliath crane, Broughton decided to slip it off the tailboard of the lurry on to a trolley. The armature came suddenly down on the side supported by Broughton, and two of plaintiff's fingers on the right hand were so seriously crushed that an operation had to be performed. One or both fingers were permanently stiffened.

The defence was that the plaintiff was not a workman under the terms of the Act, and that Broughton was not a foreman having superintendence at the works, but only a workman.

His **Honour** gave a verdict for the defendant without costs.—*Yorkshire Post.*

COMPANIES' MEETINGS AND REPORTS.

CUBA SUBMARINE TELEGRAPH COMPANY.

The half-yearly meeting of the Cuba Submarine Telegraph Company was held on Wednesday under the presidency of Mr. Charles W. Parish.

In moving the adoption of the report, the **Chairman** said that the diversion of the cable traffic during the war had caused a considerable increase in the receipts of the Company. On the other hand, a regular cable steamer would be required to put the cut cables in order, and it was now being arranged for one to go out. He was certain the Foreign Office would do their utmost to assist them, but it would probably be some time before their claim for compensation was admitted, if at all.

The report was adopted and the dividend declared. Mr. A. G. Low was re-elected a director, and Messrs. Gane, Jackson, Jeffrey, and Wells were appointed auditors.

HAMPSTEAD ELECTRIC SUPPLY COMPANY, LIMITED.

The first ordinary general (statutory) meeting of the Hampstead Electric Supply Company, Limited, was held on Nov. 21 at the Westminster Palace Hotel, Victoria-street, S.W., under the presidency of Mr. J. Soares.

The **Chairman** said that the Company was in the strong position that it could not be interfered with by the local authorities in the way of compulsory purchase. At the date of the prospectus they

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had in operation the respectable figure of 33 miles of mains. This had now been considerably added to. The increase in the number of houses supplied since March 31 was 168, and contracts were in hand for connecting 400 more. They would shortly have in operation two additional boilers, these being necessary to cope with the rapidly-increasing output. Still further extensions would soon be required, and without in any way interfering with existing premises, land beyond the boiler-house was available, without further cost, for the erection of a range of five more boilers; in fact, the unoccupied land would suffice for an output of at least 1,000 kw. more.

A vote of thanks to the chairman closed the meeting, after which an extraordinary general meeting was held, at which Clause 65 of the articles of association of the Company was amended as follows: "The directors may whenever they think fit, and they shall upon a requisition made in writing by members holding in the aggregate one-tenth of the then issued capital, convene an extraordinary general meeting."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Middlesbrough.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of various plant. Tenders by Nov. 29.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. Tenders by Dec. 15.

Glasgow.—The Corporation invite tenders for providing and erecting switchboards and instruments at the new electricity works, Port Dundas. Tenders by Dec. 5.

Glasgow.—The Corporation invite offers for the purchase of boilers, engines, and dynamos. Further particulars appear in our advertising columns. Tenders by Dec. 6.

Shoreditch.—The Vestry invite tenders for the supply of six direct-current rotary transformers, etc. Further particulars appear in our advertising columns. Tenders by Dec. 13.

Anzin (France).—Tenders are invited for lighting the town by gas and electricity for 40 years. Particulars are to be obtained from, and addressed to, Municipal Authorities of the town by Nov. 28.

Beckenham.—The Urban District Council invite tenders for the various works in connection with their proposed electric light station, particulars of which appear in another column. Tenders by Dec. 17.

Waterloo (Lancs.).—The Urban District Council invite tenders for the supply of 16 electric arc lamp columns and carriers. Specification may be obtained on application to Mr. F. Spencer Yates, A.M.I.C.E., surveyor to the Council, Town Hall, Waterloo. Tenders to be delivered by 12 noon on 28th inst.

Bristol.—The Electrical Committee invite tenders for the supply of (a) pea nut coal (washed), (b) small coal (washed), to the electric lighting station, Temple Back, Bristol, for six or 12 months from Dec. 1. Specification to be obtained from Mr. Frank Wm. Prosser, secretary, Electricity Department, Temple Back, Bristol. Tenders by noon on 25th inst.

Barnsley.—The Corporation invite tenders for erection of a tall chimney, and engine, dynamo, and boiler house, storage rooms, and offices in Beckett-square, Barnsley. Specifications, etc., can be obtained on personal application to Mr. J. Henry Taylor, A.M.I.C.E., borough surveyor, St. Mary's-place, Barnsley. Tenders by 12 noon on Dec. 12.

Warrington.—The Cheshire Lines Committee invite tenders for the supply during 1899 of telegraph materials, instruments, wire, etc. Specifications can be obtained upon application to Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Patterns are on view to 30th inst. at the Committee's General Stores, Battersby-lane, Warrington. Tenders by Dec. 2.

Tanfield.—The Urban District Council invite tenders for the supply and erection of various electric plant throughout their district, including engines, dynamos, cables, insulators, poles, etc., to cover a distance of between one and two miles. Any other information may be obtained by appointment and personal application to Mr. Robert Heslop, surveyor, Burnopfield, R.S.O., during week ending 26th inst. Tenders by 29th inst.

Dublin.—The Dublin United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, etc., during year ending Dec. 31, 1899. Forms of tender (price 1s. each), conditions, etc., can be obtained at the Company's Offices, 9, Upper Sackville-street, Dublin, from 15th inst. to Dec. 2. Tenders by Dec. 5.

Sutton (co. Dublin).—The Great Northern Railway Company (Ireland) invite tenders for erection of buildings for an electric power station, brick chimney, etc., near to Sutton railway station, co. Dublin. Specifications may be seen at the office of the Company's Engineer-in-Chief, Amiens-street, Dublin, or at the office of the District Engineer, Belfast, from either of whom copies may be obtained on payment of £2. 2s. Tenders by 10 a.m. on Dec. 5.

Brighton.—The Town Council invite tenders for the supply of not less than 4,000 or more than 6 000 tons of hand-picked Fforchaman, Nixons, Steam Navigation, Clynmill, Merthyr, large, Cwmaman, Cwmnoel, or Aberaman, steam coal, of the very best quality (rail borne), delivered at the electricity generating station in Church-street, Brighton, in such quantities as may be ordered from time to time between Dec. 1, 1898, and March 31, 1899. Conditions may be obtained at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton. Tenders by 10 a.m. on 28th inst.

Richmond (Dublin).—Sealed tenders, accompanied by detailed estimates, addressed to the Secretary, Board of Control, Custom House, Dublin, are invited for engines, dynamos, and wiring for about 100 e.h.p. at Richmond District Lunatic Asylum, Dublin. Plans and specifications can be seen at the offices of the electrical engineer, Mr. Walter Leake, 51, Victoria-buildings, Manchester, and of Mr. W. H. Byrne, 20, Suffolk-street, Dublin. Copies of plans, etc., will be furnished to contractors by the Electrical Engineer on payment of £1. 1s., not returnable. Tenders by Dec. 5.

Barnsley.—The Corporation invite tenders for the supply and erection of (1) Lancashire boilers and Green's economiser, and setting of same; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of electricity supply works, and engine, etc., foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and service boxes, and service connections. Specifications, etc, can be obtained on application to Mr. Thos. L. Miller, M.I.E.E., 7, Tower-buildings, N., Water-street, Liverpool, on payment of £5. 5s. (or £1. 1s. per section), which will be returned on receipt of a bona fide tender. Tenders by 12 noon on December 12.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Barnsley.—The Town Council have accepted the tender of Mr. James Taylor, at £102. 10s., to provide electrical communication with the house of each fireman.

Leatherhead.—The Urban District Council intend to sell the lease of their electric lighting order for a number of years. The offer was open until Nov. 21, but we hear that no tenders were received by the Council.

Wimbledon.—The Electric Light Committee of the Urban District Council have recommended that the tender of the British Transformer Company, at £1,960. 13s. 6d., be accepted, as per schedule of prices, for transformers and boxes; and that the tender of the Brush Company, at £1,872. 15s., as per schedule of prices, be utilised as an alternative tender should it be found necessary.

Hornsey.—The District Council have received the following tenders for cast-iron telephone pipes and pit covers. Pipes (per ton): Stanton Ironworks Company, near Nottingham, £6. 18s. 6d.; Jukes, Coulson, Stokes, and Co., 11, Clement's-lane, E.C., £6. 5s. (accepted); Pontifex and Co., 22, Coleman-street, E.C., £7; H. and C. Measures, Pitlake, Croydon, £12; Hollom and Co., 17, Gracechurch-street, E.C., £6 10s.; Gibb and Co., 99, Fenchurch-street, E.C., £6. 3s. 4d.; Bird and Co., 11, Great Castle-street, W., £6. 5s. Covers (each): Stanton Ironworks Company, near Nottingham, £1. 17s. 6d.; Jukes, Coulson, Stokes, and Co., 11, Clement's-lane, E.C., £1. 3s. 9d. (accepted); Pontifex and Co., 22 Coleman-street, E.C., £1. 10s.; H. and C. Measures, Pitlake, Croydon, £1. 3s.; Hollom and Co., 17, Gracechurch-street, E.C., £1. 7s.; Gibb and Co., 99, Fenchurch-street, E.C., £1. 7s.; Newton, Chambers. and Co., Great George-street, Westminster, £1. 17s. 6d.; Bird and Co., 11, Great Castle-street, W., £1. 6s. 4d.

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BUSINESS NOTES.

Morecambe.—Lamps of 16 c.p. are to be used for the street-lighting.

Dundee.—The Home for Incurables is to be lighted by electricity.

Durham.—The estimate for the proposed electric lighting scheme is £20,000.

Hastings.—A new scheme of electric tramways has been prepared, and notices will appear in a few days.

Sunderland.—A ratepayers' meeting will be held this week to ascertain the former's views on the proposed municipalisation of the tramways.

Sheerness.—The Guardians propose shortly to consider the question of providing the necessary plant for lighting the workhouse by electricity.

Potteries Electric Traction Company, Limited.—Letters of allotment in connection with the issue of ordinary and preference shares have been posted.

Guildford.—The electric light and supply company are going to extend their mains to Ward-street, Martyr-road, Chertsey-street, and Farnham road, Guildford.

Colchester.—We hear that the new town hall will be lighted by electricity, and that electric motors will be erected to work the lifts, ventilation fans, and other appliances.

Ambleside.—The Urban District Council have decided upon retaining the full control of the electric lighting, and to ask Mr. Charles Hopkinson to report upon the same.

Fleetwood.—A sub-committee is to visit three other towns lighted by incandescent electric lamps, with a view to deciding whether new pillars are required for Fleetwood.

Electric Railway Shares.—It is stated that a syndicate has bought the interest of the London and Globe Company in the Baker-street and Waterloo Electric Railway scheme.

Grimsby.—The plans for the electric lighting scheme, for which it is proposed to borrow £40,000, have been passed by the Corporation, but the tramway proposals have been further adjourned.

Stockport.—The Corporation have passed resolutions authorising the promotion of Bills in the ensuing session of Parliament enabling them to supply electrical energy, purchase tramways, etc.

Redruth.—The Urban District Council have passed a resolution in support of the proposed light railway scheme, provided a suitable terminus be decided on and subject to the motive power being approved of.

Stretford.—A meeting of ratepayers has decided to ask the Urban District Council to get their electric light supply from Manchester. Mr. Wilson's report advocated the establishment of a station at Stretford.

Ilkeston.—The Town Council are applying to the Board of Trade for provisional orders authorising the provision of electric tramways and the supply of electricity in the borough. The estimated cost is £80,000.

Northallerton.—It is stated that the electric lighting company propose to abandon their application to the Board of Trade for the license to light the town with electricity providing they can come to an agreement with the Council.

Chester.—The mention of the fact of Chester having erected its electric lighting works at a cost of £16,000 did much to influence the Whitchurch Urban District Council to vote against purchasing their gasworks at £35,000 as proposed.

Wigan.—The Electric Lighting Committee of the Corporation have decided that an installation be put down to supply Wigan with electric light. The committee have also under consideration the running of the trams by electrical traction.

Eastern Telegraph Buildings.—We learn that the plans of Mr. John Belcher, F.R.I.B.A., have been accepted for the erection of offices in Moorgate-street for the Eastern Telegraph Company at a cost of £94,000. The building is to be of Portland stone.

Wallasey.—The voting in the poll demanded at a recent public meeting in connection with the Improvement Bill for electric trams, etc., to be promoted by the Urban District Council, has resulted as follows: for the Bill, 3,391; against, 1,563; majority for, 1,828.

Bexley.—The Urban District Council have adopted the report of the surveyor, Mr. Tom Vickers, dealing with the proposed scheme for electric lighting works in the district, and have resolved to take the necessary steps to apply for a provisional order. The surveyor has been congratulated upon his able report.

Newark.—The Urban District Council have informed the Electrical Power Distributing Company that they do not assent to their application for a provisional order with a view to the supply of electricity in Newark, and that it is the Council's intention to apply for a provisional order as early as possible.

Removals.—The Notting Hill Electric Lighting Company, Limited, have removed to new offices at 140, High-street, Notting Hill-gate, adjoining the works, owing to the rapid increase of business.—The London address of the Sheaf Ironworks, Lincoln, will be Stafford House, 27A, Cannon-street, E.C., after the 28th inst.

Greetland.—Deputations representing the Greetland, Stainland, and Northowram District Councils have waited upon the Tramways Committee of the Halifax Corporation to urge that the electric tramways should be extended to their district. The committee promised to give careful consideration to the arguments placed before them.

Colwyn Bay.—The provisional order now before the Board of Trade authorising the Llandudno and Colwyn Bay light railway contains a clause giving the company power to use other motive power than electricity, but the Urban District Council have decided to insist upon the original agreement—that none but electric motive power be used.

Shoreditch.—The Workhouse and Infirmary Visiting Committee of the Guardians reported at the last meeting that specifications had been prepared for the installation of the electric light, and considering that the expense would be so great (about £2,000), they proposed that a loan should be raised for the purpose. The report was adopted unanimously.

Millwall Boiler Works.—We are informed that Messrs. John Fraser and Son, of Millwall Boiler Works, London, E, have put down a new hydraulic plant suitable for large marine boilers, and also other additional machinery. They have also been placed on the Admiralty list of contractors who may be asked to tender for the construction of cylindrical boilers up to 14ft. in diameter.

Southampton.—At the last meeting of the Town Council the Tramways Committee read a letter from Mr. H. Wilding, of the American line, in reference to the adoption of electric traction, and it was stated that a scheme will be submitted to the Council showing all the details, including the passing of the Bargate, and that no expense will be incurred until the report of the committee has been approved.

Barnsley.—The British Electric Traction Company having notified their intention to apply for an order authorising the construction and working of light railways in the borough, the Corporation have decided to oppose the application. The Corporation have refused consent to several similar applications because they have not yet decided whether they will themselves apply for an order or consent to an application by a company.

Wheatley.—At the last meeting of the Parish Council a letter was read from the British Electric Traction Company, Limited, giving notice of their proposal to apply for powers to put down electric tramlines on some of the Council's roads. It was understood that it was the same company that had given notice to the Doncaster Corporation, who had decided, so far as the town was concerned, to take the matter into their own hands.

Arbroath.—At a recent meeting of the Arbroath Trades Council, the question of running electrical cars between Dundee and Arbroath was considered in connection with the Bill to be promoted in Parliament for powers to run electric tramway cars between Dundee and Broughty Ferry. It was agreed that the secretary should communicate with the promoters of the Bill with a view to the tramway line being extended to Arbroath.

Glasgow.—The Corporation's opposition to the application by the Kelvinside Electricity Company to the Board of Trade for a provisional order to supply Partick with electricity continues. It is stated that the company are willing to dispose of their works to the Corporation for £50,000, but that the committee was only prepared to offer £30,000. The extension of the Corporation tramways to Pollokshields was opened for traffic on Monday.

Whitechapel.—The District Board are about to apply to the London County Council for the borrowing of £25,000 for the purchase of a site as a generating station in Osborne-street, Whitechapel. This property is adjacent to the Board's destructor premises, and they hope to utilise the waste heat for the generation of the current. Among the streets to be first lighted will be the Whitechapel-road, Lemon-street, Commercial-road, and Commercial-street.

Perth.—Arrangements are being made to have an installation of electric light at Perth South, where a good deal of shunting takes place. Men are engaged at present in erecting the poles. Steam will be the motive power, and will be obtained in the locomotive shed, which is within convenient distance of the yard. It is understood that another and more extensive scheme is being considered whereby the General Station and Perth North goods station will be lighted by electricity.

Personal.—Dr. A. B. W. Kennedy, formerly professor of engineering of London University, has been appointed consulting engineer in connection with Dundee Corporation tramways. The duty of carrying out the actual works required will be entrusted to Mr. Tittensor, electrical engineer of the Commission, he acting under the advice and direction of Dr. Kennedy.—Mr. C. J. Sutherland, of Hanley, has been appointed city electrical engineer to the Worcester City Council.

Blackrock.—The Township Commissioners have passed a resolution approving of a maximum speed of 12 miles an hour for the electric cars over the lines of the Southern District Tramway Company, except on the congested parts of the road, where the speed should not exceed that which is at present provided by the Board of Trade regulations. The secretary and surveyor have been authorised to attend the Board of Trade enquiry and give evidence in favour of this speed.

Basingstoke.—The Council have decided to take the necessary steps to obtain a license from the Board of Trade to enable them to light the town with electricity themselves. Letters have been received from the following companies containing applications for the consent of the Council to their obtaining provisional orders to

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enable them to supply the town with electricity: the Electrical and General Engineering Company, the United Electric Light and Traction Company, the Steam Carriage and Wagon Company.

Paddington.—The Electric Lighting Committee are considering a letter from the Metropolitan Electric Supply Company, Limited, stating that whilst the Board were not adverse to carefully considering any suggestion which the Vestry might make *re* the purchase of the company's Paddington undertaking, the directors thought a written communication should in the first instance be made by the Vestry defining the proposal, as the matter would have to go before the shareholders and Parliament for ratification.

Price List.—We have received from the Waltham Engineering Company, of York-street, Westminster, their new revised price list of ornamental switches, etc. From the pamphlet we gather that they are fitting up hotels throughout with metal work for illuminating and decorative purposes. As instances, the Bath and Cheltenham, the Norfolk-square, the Golden Cross, Shelley's, etc., are given. Illustrations are also given of art-metal covers for switches, bell pushes, etc., as well as of electroliers and lamp brackets.

Moss Side.—At the last meeting of the Urban District Council it was resolved. "That the Council, without prejudice to their application to Parliament, allow the Manchester Corporation to include the Moss Side district as one of the places in which the Corporation may apply for power to lease, etc., all tramways." In the course of a brief discussion it was explained that this resolution would in no way interfere with the freedom of the Council in the event of their failing to come to terms with the Corporation as to the tramways.

British Columbia Electric Railway Company, Limited.—The issue is announced by this Company of 12,000 non-cumulative 5 per cent. preference shares of £10 each, forming part of a total share capital of £370,000. The remaining part of the capital is divided into 25,000 ordinary shares of £10 each, 20,000 of which have already been issued. The British Columbia Electric Railway Company is an English limited company, carrying on a business under special privileges granted by the Acts of the Parliament of British Columbia.

Lewisham.—At the last meeting of the District Board a letter was read from the Board of Trade forwarding a copy of the award which they had issued to the Crystal Palace and District Electric Lighting Company, Limited, on the subject of the appeal to the Board of Trade by the company in respect of the condition attached by the Lewisham Board to their approval of certain works proposed to be executed by the company. The award disallowed the appeal, and approved the proposed works subject to the conditions appealed against—namely, that no mains be laid under the footways except for service connections for houses.

Portsmouth.—The Town Council have decided to give 12 months' notice to the Provincial Tramways Company of their intention to purchase the local tramways, the question of price to be settled by arbitration. It is proposed, on taking over the system—*i.e.*, within 12 months after the expiration of the notice—to substitute electricity for horse traction. The system to be used has not been selected yet, as a deputation is to be sent to various towns in England and on the Continent to obtain information on the subject. The estimated cost of the purchase of tramways and their equipment and conversion for electric traction, is about £245,000.

Appointments Vacant.—The Vestry of St. Mary, Newington, require the services of a resident electrical engineer at a salary of £250 per annum. Applications to be made on forms supplied by Mr. L. J. Dunham, clerk, Vestry Hall, Walworth-road, S.E., with copies only (which will not be returned) of three testimonials of recent date, and delivered at the Vestry Hall, Walworth, by Dec. 2.—The Wimbledon Urban District Council require a resident electrical engineer at a salary of £250 per annum.—An assistant engineer and a switchboard attendant are required for Ashton-under-Lyne.—The borough of Derby require at once a capable switchboard attendant. Particulars of these and other appointments will be found in our advertisement columns.

Bradford.—The Board of Trade have given their provisional consent to the running of the Park-avenue electric tramway at Bradford. Immediately on the publication of the notices by the Leeds and Bradford Corporations that they proposed to apply for powers to enable them to extend their respective tramway systems so as to serve portions of Pudsey, Farsley, and Calverley, the Urban District Councils of these districts received communications from the Leeds and Bradford Light Railway Company, which sought powers to construct tramways in the district named a year ago. The company point out that they have not yet abandoned their scheme, and they ask for the support of the local authorities in a fresh application they are about to make for powers in the matter. The Farsley Council have already considered favourably the light railway company's request.

Crystal Electric Lamp and Rose and Bird, Limited.—At the recent statutory meeting of the Crystal Electric Lamp and Rose and Bird, Limited, the chairman congratulated the shareholders on the extremely satisfactory increase in the orders received since the amalgamation of the two companies—the Crystal Electric Lamp Company, Limited, and Rose and Bird, Limited. The factory at Bedford is working at full pressure, and in order to cope with old customers' increasing demands and the new connections, the directors have been compelled to increase the apparatus and machinery. The chairman mentioned that the Company's books exhibit a very representative and satisfactory list of customers numbering some 500, conspicuous among them being H.M. Government, the Admiralty, the War Office, the Post Office, several railway companies, the London County Council, and numerous corporations, with most of the electricity supply companies and large contractors.

Leeds.—At an extraordinary general meeting of shareholders in the Yorkshire House-to-House Electricity Company, held on Monday at the offices in Whitehall-road, Leeds, the agreement between the company and the Leeds Corporation for the purchase by the latter of the company's undertaking was ratified.—The Pudsey, Farsley, and Calverley District Councils have been asked by the Leeds and Bradford Light Railway Company to support their proposals in Parliament. The opposition of Leeds and Bradford prevented the company from passing the Bill last session, although they had agreed to provide electric light on the highway at a cost not exceeding the cost of gas-lighting, to pave and maintain the roads to a width of 17ft., and to lay down branch lines. The company now withdraws its proposal for electric lighting, but it is still thought that the local councils may favour these proposals in opposition to the application of Leeds and Bradford for powers for tramway extension.

North London Tramways.—Official enquiries will be held shortly into various applications by the Metropolitan Tramway and Omnibus Company for powers to construct nearly 30 miles of new tramways in the suburbs North of London. It is proposed to lay down a line from the London county boundary in Edgware-road to Cricklewood, Hendon, Kingsbury, Little Stanmore, and Edgware. A second line would run through Cricklewood and Child's Hill to Finchley New-road, while a third line, starting from Hampstead, would pass through Golder's Hill, Temple Fortune, and Finchley to the Great North-road near Whetstone. A fourth line would be connected at Golder's Hill with the line running to Edgware. The company further seeks powers to connect these lines with any new systems laid down by the London County Council or North Metropolitan Tramway Company up to the London county boundary. Another system proposed by the company would commence at the end of the North Metropolitan Company's system at Tottenham, making a connection with the terminus at Green lanes, and proceeding through Highgate, Finchley, Wood Green, East Barnet, Friern Barnet, Totteridge, and Whetstone. Junctions would be formed with the North Metropolitan Company's lines in this system. The company asks for powers to work the lines by horse, electric, or any other mechanical system of traction, excluding steam.

Liverpool.—The Tramways Committee will ask the Council to authorise them to carry out the construction of the lines mentioned in the city engineer's report other than the line from the Dingle to Aigburth-vale, which has already been authorised by the Council, at an estimated cost for street construction works of £118,060; and also that if the Council approve of the construction of the lines as recommended the engineer arrange to construct the lines down Smithdown-road first, provided they can be completed before July 1, 1899. As to the proposed extension of electric line from South Castle-street to Park-lane, *viâ* Lord-street and Paradise-street, the committee adopted a resolution that it be a recommendation to the Council that the Tramways Committee be authorised to carry out the extension of the electric line of tramways from South Castle-street to Park-lane, *viâ* Lord-street and Paradise-street, in accordance with the plans now submitted, at an estimated cost of £4,300. The city engineer is to be authorised to carry out, at a cost of not exceeding £710, the electric tramways triangle at junction of Aigburth-road with Ullet-road. A deputation from the Manchester Corporation has visited the new electric trams and inspected the system at work in Liverpool. They have also visited the works of Messrs. George F. Mills and Co., Limited, Birkenhead, and inspected various kinds of electric trams in the course of construction for the leading corporations, including Plymouth, Blackburn, Halifax, Sheffield, Hull, and several other places.

Watford.—Mr. Hawtayne has presented a report to the Urban District Council, in which, *inter alia*, he says: "I have carefully examined the various cut-outs of which you obtained prices, and I recommend that either those of the Reason Manufacturing Company, or of Ernest F. Moy, Limited, be accepted. The latter are slightly cheaper than those of the Reason Manufacturing Company's make, but, on the other hand, I feel that the Reason cut-outs are of more substantial design, and well worth the slight extra cost. A very large number of the cut-outs made by this firm are now employed, and I think the Council will be well advised in accepting the tender of the Reason Manufacturing Company. Of the four meters for which you obtained prices the three cheapest quotations were those of the General Electric Company, the British Thomson-Houston Company, and Venner and Co. With regard to the General Electric Company, I have carefully examined this, but I find they have only just brought this meter out, and that it is not yet for sale on a large scale, in so far as no stock is kept. I have not been able to thoroughly test these meters on that account. With reference to the British Thomson-Houston Company's meters and Venner and Co.'s, both types are of a practically similar design, those of the British Thomson-Houston Company being better known. Venner and Co.'s meters are, however, I understand, now being manufactured in large numbers, and as they are considerably cheaper than those of the British Thomson-Houston Company, and, as far as I could see from tests, equally satisfactory, I recommend that your Council accept Venner and Co.'s tender." Mr. Hawtayne's recommendation was accepted.

Wallsend.—At the last meeting of the Urban District Council a letter from the gas company, containing the following conditions,

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was accepted as a basis of agreement between the parties, with the view of avoiding the expenses connected with the opposition to the application by the company for a provisional order: (1) That the company will not at any time after the passing of this Act oppose or raise any obstacle to the Wallsend Urban District Council or their successors applying for and obtaining powers under the Electric Lighting Acts, 1882 and 1888; (2) that the company, so long as they generate electrical power, and so long as the Council do not themselves supply electricity, will supply electric lighting to the Wallsend Urban District Council and their successors, and to any company and persons within their district at as cheap a rate as is *bond fide* offered or supplied by any other corporation or public company within the area of the district under statutory authority; (3) that the capital account of the electric undertaking be kept separate from the gas undertaking; (4) that the revenue accounts giving gross profit relating to both electricity and gas be combined in our common profit and loss account (net revenue); (5) after paying statutory dividends and other statutory obligations, the surplus profits, if any, shall be applied in reduction of prices as provided by the action of the statutory sliding scale or scales; (6) these provisions are subject to the procedure and approval of Parliament. In the event of Parliament being of opinion that any of the above provisions are not proper to be inserted as clauses in the Bill, the company stated that they were prepared to enter into a formal agreement with the Council, in which these provisions can be embodied. A motion that application be made by the Council for a provisional order under the Electric Lighting Acts, in opposition to the application of the gas company, was negatived.

St. Marylebone.—A meeting of the Vestry was held last night to consider the following motions: "That application be made to the Board of Trade for the grant of a provisional order authorising the Vestry of the parish of St. Marylebone to erect and maintain electric lines and works, and to supply electricity for public and private or public or private purposes throughout the said parish; and that the Vestry's solicitor be instructed to take the necessary steps to give effect to the foregoing resolution. That the Electric Lighting Committee be instructed (1) to enquire and report (*a*) whether the Metropolitan Electric Supply Company has power to sell, and, as vendor, can make a good title to that part of its undertaking which is situated in or supplies with electricity the parish of St. Marylebone, including the benefit of any provisional orders or confirming Acts, and whether the Vestry can legally purchase; (*b*) what is comprised in the company's undertaking, so far as it is situated in or supplies, or was intended and is adapted to supply St. Marylebone, and whether that is specified or referred to in the report of the committee, is wholly separate (or capable of being wholly separated, and, generally, by what work and at what approximate expense) from that part of the company's undertaking which is not situated in or used for supplying St. Marylebone; (2) if the company has power to sell and make a good title, to what is, or can, at small expense be made, a wholly separate, independent, and exclusive undertaking for the supply of St. Marylebone with electricity, then before report, to enter into a provisional contract with the company in the name, and on behalf, but subject to the approval of the Vestry, for the purchase of the benefit of such part of the company's provisional order, works, and undertaking, including a covenant not to compete with the Vestry, and not to use any part of its purchased or added plant, or to do so, subject to such limits, and on such terms as may be agreed, at a price to be hereafter agreed on between the company and the Vestry, or in default of agreement, to be settled by submission of both parties to an arbitration under the Arbitration Act, 1889, or as may be otherwise agreed; (3) the committee to be at liberty to employ such experts or obtain the benefit of such professional advice as they may consider necessary for the purposes of this reference to the committee."

Southport.—The General Purposes Committee of the Council approved on Thursday week a new scheme for connecting Southport and Lytham by means of a tramway across the estuary. The originator of the plan is Mr. Wood, of Messrs. Wood and Brodie, of Liverpool. The scheme, which is at present only in its infancy, is from an engineering point of view one of special interest, seeing that three distinct means of locomotion will be employed at different parts of the journey across the Ribble. The tramcars, which we presume, says the *Southport Advertiser*, will be propelled by electricity, will leave the present line of rails in Albert-road at the junction of Park-road, turning thence towards the Promenade extension, and then on to the sea cop which is being formed across the Corporation land. The line of the cop will be followed on to the embankments of the Hesketh and Scarisbrick estates, all being, of course, widened and strengthened for the purpose. There will be a bend in order to get over the Crossens sluice, and then at the end of the line of embankments the ordinary tramlines will cease. The next section across the sands to the channel of the Ribble will be after the style of the Brighton and Rottingdean platform railway. That system has been in vogue for 18 months at least, and on a part of the coast where the storms are much more severe than anything prevailing in the Ribble estuary, it has answered remarkably well. Under this system two sets of rails are laid, carrying an elevated platform on to which the car or cars will be run, and then the platform will be propelled to a point near the southern training wall of the Ribble, the platform being large enough to allow of the passengers promenading outside the car. In order to cross the channel there will be a wire suspension bridge, similar to the one across the harbour of Bilbao, and along this bridge the car will be slung to the other side something after the style of the aerial flight now on the Southport shore. The height will be 90ft. above high water, so that there will be no interference whatever with the navigation. On the other side a short length will connect with the Lytham tramways, and so on to St. Annes, Blackpool, and other places along the coast. The advantages of a short cut across the estuary, not only to Southport and Lytham, but to Liverpool, Blackpool, and other places, both north and south, are self-evident, and the feasibility of the scheme is such that it is certain to secure wide approval. We understand that the promoters of the scheme intend to apply for a provisional order in the next session of Parliament.

Provisional Orders.—Advertisements have been issued *re* provisional orders by the Audenshaw Urban District Council (tramways); Aylesbury Urban District Council (electric lighting); Ashford Urban District Council (electric lighting); Belfast Corporation (tramways); Birmingham Corporation (acquisition of the electric lighting undertaking); Blackpool Corporation (tramways); Bethnal Green Vestry (electric lighting); Bournemouth (electric lighting); Bognor Urban District Council (electric lighting); Bradford Corporation (new tramways in the city of Bradford and urban districts of Thornton, North Bierley, Calverley, Farsley, and Pudsey, to be worked by animal, mechanical, and electrical power, power to supply electric energy, run over tramways of Corporation leased to Bradford Tramways and Omnibus Company, Limited, and Bradford and Shelf Tramways Company, Limited, to supply electric fittings); City and Brixton Railway (further powers); Castleford Urban District Council (electric lighting); Colchester Company (tramways); Darfield Urban District Council (electric lighting); Drake and Gorham Electric Power and Traction Company, Limited (light railways in and near Gorleston, Kessingland, and Lowestoft); Devonport Corporation (tramways); Dukinfield Urban District Council (electric lighting); Dundee Corporation (tramways); East Barnet Urban District Council (electric lighting); Edinburgh Corporation (increased access to and accommodation at central electric lighting station, construction of tramways, telephones and telephonic licenses, extension of time for acquisition of lands under the Edinburgh Improvement and Tramways Act, 1896); Electric Traction Company (to construct light railways or tramways in Dewsbury, Batley, and adjacent towns); Erith Urban District Council (electric lighting); Fenton Urban District Council (electric lighting); Glossop Corporation (electric lighting); Gorton Drban District Council (electric supply); Halesowen Urban District Council (electric lighting); Heywood Corporation (electric supply); Horsham Urban District Council (electric lighting); Ilkeston Corporation (electric supply); the Isle of Thanet Light Railways (Electric) Company, Limited (for powers to produce and supply electricity for motive power and all public and private purposes at Broadstairs and St. Peters, the whole of the contributory place of Westgate-on-Sea, in the rural district of the Isle of Thanet, and the whole of the contributory place of Birchington-on-Sea, in the rural district of the Isle of Thanet, in the county of Kent); Ipswich Tramways Company (construction of additional tramways, use of electrical power on proposed new and existing tramways, sale of undertaking to Drake and Gorham Electric Power and Traction Company, Limited); Keighley Corporation (electric supply); Kelvinside Electricity Company, Limited (to produce and supply electricity for public and private purposes within the district in the county of Lanark known as the burgh of Partick); Leicestershire and Warwickshire Electric Supply Company (for power to construct works and to produce and supply electrical energy within part of the counties of Leicester, Warwick, and Derby); Lewisham Board of Works (electric lighting); Matlock Urban District Council (tramways); Mexborough Urban District Council (electric lighting); Mirfield Urban District Council (electric lighting); Newcastle-under-Lyme (electric supply); Nottingham Corporation (tramways); Reading Corporation (tramways); Ryde Corporation (electric supply); the South Lancashire and Cheshire Electricity Company (for power to construct works and to produce and supply electrical energy within part of the counties of Lancaster and Chester); Stourbridge Urban Council and the Lye and Wollescote Urban Council (for powers to supply the electric light in the districts which they severally control, the same urban districts are included also in the application which the Midland Electric Corporation for Power Distribution, Limited, are making for a provisional order for the extension of the area of supply already authorised); Teignmouth Urban District Council (electric lighting); Twickenham and Teddington Electric Supply Company (electric lighting). Here are also applications by the Drake and Gorham Electric Power and Traction Company for an order authorising them to construct and maintain a light railway from Hounslow Barracks Station through Whitton into Twickenham to Richmond Bridge, and up to Fifth Cross-road, taking in both sides of Twickenham Green. There is another proposal to run electric trams through Twickenham by the London United Tramways, Limited, who desire to connect their Brentwood system to Hampton Court, passing through Isleworth, Twickenham, and Hampton Wick. Wath-upon-Dearne Urban District Council (electric lighting); Wednesbury Corporation (electric supply); West Kent Electric Supply Company, Limited (electric supply); Weston-super-Mare Tramways Company (tramways); Winsford Urban District Council (electric lighting); Wrexham Tramways, Limited (tramways); Eastbourne Corporation (electric supply); Power and Traction Company (electric lighting of Farnborough); Crowborough District Gas Company, Limited (electric lighting); Leeds Corporation (tramways).

Kensington.—A special meeting of the Vestry was held on Wednesday for the purpose of considering a report of the Special Electric Lighting Committee, stating "That with reference to the

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statutory notice which has been given convening a special meeting of the Vestry for the 23rd inst. to consider a recommendation by this committee in favour of an application being made by memorial to the Board of Trade for a provisional order authorising the supply of electricity by the Vestry within the parish, the committee deem it expedient to present this supplemental report upon the reference to them. The Vestry will remember that in June last notices were received from the three companies already having areas of supply in the parish, and from two outside companies, of their intention to apply for provisional orders empowering them to supply electricity throughout the parish, and on July 13, upon the recommendation of this committee, it was resolved to notify the several companies that the Vestry would withhold their consent to their applications, and would themselves in due course apply for a provisional order. Since this date the committee have given careful consideration to the present position of the Vestry in regard to this important matter, and have discussed the policies which it appeared to the committee were open to the Vestry and which may be briefly set forth as follows: (*a*) that the Vestry should avail themselves of the proviso contained in Section 1 of the Electric Lighting Act, 1888, by which it is laid down that the grant of authority to any undertakers to supply electricity within any area should not in any way hinder or restrict the granting of a provisional order to the local authority or another company, and themselves go forward for an order in competition with the existing companies; (*b*) that the Vestry should go forward with an application for a provisional order inserting provisions therein which should enable them to follow the example which has recently been set by several corporations and purchase the undertakings of the existing companies; (*c*) that the Vestry should come to such an arrangement with the existing companies as would efficiently protect the interests of the private consumers and enable the Vestry to obtain a supply of electric light for street-lighting and other public purposes on advantageous terms, should they desire such supply. The committee putting aside policy (*b*) and confining their consideration to the two remaining policies (*a*) and (*c*) thought it expedient to place themselves in communication with the three companies with a view to seeing what concessions or advantages they might be prepared to offer, and negotiations are at the present time proceeding, which, if carried to a successful issue, will, it is felt, be of mutual advantage to the Vestry, to the consumers of electric light in the parish, and to the companies themselves, and will justify the Vestry in abandoning their proposed application for a provisional order. Whilst it is hoped that the negotiations with the companies may proceed to a satisfactory issue, and that the committee will shortly be in a position to submit an agreement embodying the terms of the arrangement, which may, subject, of course, to the approval of the Vestry, have been arrived at, it is felt that at the present moment the Vestry must not neglect to take those precautionary and initial steps which, under the requirements of the Electric Lighting Acts and the rules of the Board of Trade, are necessary to enable them to proceed with their application to the Board of Trade, in the event of the negotiations with the companies for any reason falling through. Certain of the formal requirements have already been complied with, such as the giving of notices and the due insertion of advertisements in the *London Gazette* and the local papers, and those which have now to be complied with are as follows: (*a*) a copy of the advertisement, with plan, etc., has to be deposited with the Board of Trade, and with other parties, on or before Nov. 30; (*b*) the memorial and draft order have to be prepared and lodged with the Board of Trade on or before Dec. 21. Nearly two months—viz., until Jan. 14—are allowed in which objections may be lodged with the Board of Trade, and it is not until after this date that the Board proceed to deal with the application. It may be pointed out that the expenditure on the part of the Vestry in giving effect to the committee's present recommendations will be confined to the charges of the solicitors and parliamentary agents for the preparation and lodgement of the memorial and draft order, together with a fee of £50, which has to be deposited with the Board of Trade with the memorial. The committee do not consider that the time has yet arrived when they need advise the Vestry to engage the services of any expert, as they are hopeful, as already stated in this report, that if their present recommendations are adopted, and if they are allowed to go forward with the negotiations which they have entered upon with the companies, they may be in a position before long to submit a further report of such a character as shall justify the Vestry in not proceeding with their application for the provisional order. They now recommend (*a*) that an application be made by memorial to the Board of Trade for a provisional order authorising the supply of electricity by the Vestry within the district over which they exercise jurisdiction as the local authority—namely, the parish of St. Mary Abbotts, Kensington; (b) that it he referred to the solicitors and parliamentary agents to prepare the memorial to be presented to the Board of Trade in respect of the aforesaid application, and to take such other steps as may be necessary for obtaining the provisional order.—(Signed) R. A. ROBINSON, chairman." In the event of the foregoing report being adopted, the following resolutions were to be proposed: "That the Vestry do hereby formally resolve to apply to the Board of Trade, under the provisions of the Electric Lighting Acts, 1882 and 1888, for a provisional order authorising the supply of electricity by the said Vestry within the district over which they exercise jurisdiction as the local authority—viz., the parish of St. Mary Abbotts, Kensington—and that the necessary memorial embodying the application of the Vestry be forthwith prepared and presented to the Board of Trade"; and "That it be referred to the solicitors and parliamentary agents to arrange for the preparation and presentation of the memorial to the Board of Trade, and to take such other steps as may be necessary in support of the Vestry's application for the provisional order." Ultimately the Vestry unanimously resolved to apply for the provisional order, and agreed that a memorial embodying the application be forthwith prepared and presented to the Board of Trade.

PROVISIONAL PATENTS, 1898.

NOVEMBER 14.

23922. Improvements in fire-alarms or boxes from which electric signals are given in case of fire. Richard Lord and Arthur Robert Miller, 17, High-street, Swindon.

23937. Improvements in electrical dynamos and motors. James Atkinson, The Woodlands, Marple, Cheshire.

23958. Improvements in electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street London. (Elihu Thomson, United States.) (Complete specification.)

23976. Improvements in and relating to electrically-controlled taps or cocks. Paul Louis Guyenot, 45, Southampton-buildings, Chancery-lane, London.

23988. Improvements in or relating to coin-controlled telephones. William Phillips Thompson, 322, High Holborn, London. (Christen Heiberg Kahrs, Norway.) (Complete specification.)

24005. Improvements in electrical storage batteries. Alfred Julius Boult, 111, Hatton-garden, London. (Sedneff and Bratasched, Germany.)

NOVEMBER 15.

24030. Improvements in weighing apparatus and electrical weighing machinery. Henry Richardson, 166, Oxhill-road, Handsworth, Birmingham.

24037. Improvements in electrical switches. Alfred Watson, 24, Temple-row, Birmingham.

24051. Improvements in electric switch mechanism. John McLeod Murphy, 111, Hatton-garden, London. (Complete specification.)

24052. Improvements in electric railway systems. John McLeod Murphy, 111, Hatton-garden, London. (Complete specification.)

24053. Improvements in roadway structures for electric railways. John McLeod Murphy, 111, Hatton garden, London. (Complete specification.)

24055. Improved means of cooling electric machines. Robert Snow and Davy Bros., Limited, 53, Chancery-lane, London.

24104. Improvements in apparatus connected with the charge and discharge of storage cells. Ernest Wilson and John McIlvaine Cater, 64, St. John's-park, Blackheath, London.

24115. An improved electricity meter. Charles Schmidlin, 11, Southampton-buildings, Chancery-lane, London.

NOVEMBER 16.

24126. Improvements in junctions for tubes used as conduits for electric wires. Robert Gilgour Hislop, 7, Pitt-street, Edinburgh.

24133. A new or improved open or enclosed arc electric lamp. Hugo Hirst and Henry Bevis, 73, St. Stephen's-road, Upton Park, London.

24164. An improvement in electric incandescent lamp shade-holders and a device for use in connection therewith. William Henry Bradley, 22, Glasshouse-street, Regent-street, London.

24171. Improvements in voltaic cells having dry plates which may be regenerated. Hermann Schloss, 111, Hatton-garden, London. (Complete specification.)

24172. Process for obtaining a permanent electrical contact at the covers of voltaic cells. Hermann Schloss, 111, Hatton-garden, London. (Complete specification.)

24190. An improved magnetic circuit breaker. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Maxwell Scott, United States.)

24196. Electrically heating plates, dishes, and the like. Christen Heiberg Kahrs, 322, High Holborn, London. (Complete specification.)

24210. Improvements in the manufacture of electrodes for secondary batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (v. d. Poppenburg's Elemente und Akkumulatoren, Wilde und Co., Germany.)

NOVEMBER 17.

24248. The Don electric fog-alarm. Edwin Arthur Thompson, Eastwood Level Crossing, Parkgate, near Rotherham, Yorks.

24264. An improved switch for incandescence or glow electric lamps in which the filament is subjected to a preliminary heating effect apart from the lighting current. Hugo Hirst, 73, St. Stephen's-road, Upton Park, London.

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24365. Improvements in forming filaments or the like for incandescence or glow electric lamps Hugo Hirst, 73, St. Stephen's-road, Upton Park, London.

24370. Improvements in multiple wall connections for electric lighting. Andreas Peter Lundberg and Gustaf Charles Lundberg, Bradbury Electrical Works, Bradbury-street, Kingsland, London.

24377. Improvements in electrical stop motions for warps. William Phillips Thompson, 6 Lord-street, Liverpool. (Frederic Ellsworth Kip, United States.) (Complete specification.)

24387. A process for the electrolytic extraction of zinc and other metals from ores or waste containing them. John Corry Fell, 1, Queen Victoria-street, London. (Wilhelm Strzoda, Germany.) (Complete specification.)

24388. Improvements in electric batteries. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Columbus Electrizitätsgesellschaft m. b. H., Germany.)

NOVEMBER 18.

24357. Improvements in or connected with electric batteries. Arthur Thomas Ellis, 57, Chancery-lane, London.

24371. Improvements in alternating electric-current motors and distribution systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

24379. Improvements in telephones. Francis Lauder Muirhead, 323, High Holborn, London.

24382. An electric motor for tramcars. Herbert Luzerne Todd and John Dunham-Massey, 53, Elmore-street, Essex-road, Islington, London.

24404. Improvements in insulating and equalising electric currents. Louis Hackethal, 322, High Holborn, London. (Complete specification.)

24417. Improvements in induction motors. Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

24418. Improvements in alternating-current motors. Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

NOVEMBER 19

24425. Improvements in combined electric wire gauges and calculating devices. Herbert Lutz, Fairfield, Kingston-on-Thames.

24426. An improved surface-contact system for electric tramways, railways, or motorcars. Percy Coundall Day and Percy Rhodes Cobb, Foyers, Inverness-shire.

24438. Improvement in or in connection with the construction of dry voltaic cells, accumulators, and secondary batteries. Clarence Metcalfe Stead, 30, Park row, Leeds. (Complete specification.)

24447. Improvements in road conduits and appurtenances for electric traction. Thomas Walter Barber, 72, Bishopsgate-street Within, London.

24466. Improvements in connection with electric arc lamps. Willis Nelson Stewart, 55, Chancery-lane, London.

24471. An electrical resistance for use with alternating currents in the production of X-rays. Frank Holmes, 81, White Ladies-road, Clifton, Bristol.

24487. Improvements in or relating to contact-making devices for electric street railways with overhead conductors. Carl Steiner, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

17161. Means applicable for use in the electrolysis of salts. Hargreaves.

24833. Electricity meters. Routin and Brown.

25076. Electrical propulsion of barges and boats on canals and rivers. Handcock and Dykes.

26680. Electric accumulators or storage batteries. Tribelhorn.

27707. Electro-metallic depositing apparatus. Hartley and Hartley.

28823. Covers, caps, and lids of gas, sewer, telephone, and electrical supply shafts and holes, gullies, and the like. Price and Johnson.

30427. Metallic ribbon particularly adapted for battery plates, but useful also for other purposes. Howell.

30544. Electric welding of tubes and apparatus therefor. Parpart.

1898.

4878. Railway electrical signalling apparatus. Busher.

8550. Automatic magnetic circuit breakers. Scott.

11075. Electrical apparatus for producing luminous or similar effects, such as Rontgen rays from exhausted receivers. Wise. (The Moore Electrical Company.)

17692. System of reflectors for double-globe electric arc lamps. Von Mülmann.

18941. Manufacture of homogeneous mixtures for the incandescence bodies of electrical glow lamps. Abel. (Allgemeine Electricitäts Gesellschaft).

19399. Arc lamps. Mersch.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Nov. 19	3 883	3,609	+ 273	—	—
Blackpool and Fleetwood Tramroad	,, 18	211	—	—	13,566	—
Bristol Tramways and Carriage Co.	,, 18	2,667	2,553	+ 114	—	—
City and South London Railway	,, 20	1,044	1,063	- 19	20,405	19,725
Dover Tramways	,, 19	150	99	+ 51	7,652	—
Dublin U.T., elec. cars	,, 18	330	†334	— 4	10,091	7,364†
Dublin S.D. Electric Tramways	,, 18	672	378	+ 294	19,934	1,353
Halifax Corporation Tramways	,, 16	234	—	—	5,408‡	—
Liverpool Overhead Railway	,, 21	1,358	1,326	+ 32	—	—
South Staffordshire Tramways	,, 18	631	588	+ 43	29,179*	29,318*

* Receipts since Jan. 1. † Ho rse c ars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	16½-17½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10½-10¾
—— 4½ per cent. Cum. Pref.	10	10¾-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	15½-16½
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	12½-12⅝
Brush Electrical Engineering, Limited, Ordinary	2	1⅝-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	110-112
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	10-10⅛
——	6	5⅛ 6⅛
—— Pref. Half-Shares	1	1⅛-1⅜
——	5	4⅜-5
Charing Cross and Strand	5	11⅛-12½
—— 4½ per cent. Cum. Pref.	5	6 6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23½-24½
—— 90,001-100,000	10	23½-24
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	124 126
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co. Ord.	10	13½-13⅝
—— ,, ,, No. 80,000 40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1½ 2
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	135-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	99-101
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2¼-2⅜
—— 7 per cent. Cumulative Pref.	2	2⅜-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	⅛-⅜
Elmore's Wire Company	2	⅜-½
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7⅞-8½
London Electric Supply, Ordinary	3	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7⅛-7⅜
—— £4½ Shares, New	1½	6⅛-7
Oriental Telephone and Electric Company	1	⅛-⅜
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,316	5	6-6½
Royal Electrical Company of Montreal	⅛	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-105
South London Electric Supply, Ordinary	3	2⅞ 3⅛
St. James's and Pall Mall, Limited, Ordinary	5	16½ 17½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	13	37-41
—— 5 per cent. Bonds	100	104 107
Waterloo and City Railway, Ordinary	100	107-112
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

American Telephone System.—Mr. Gavey and Mr. Cooper, English Post Office officials, are making a thorough investigation of the telephone system in the United States.

Book Received. — We have received from the Macmillan Company a little book by Prof. Silas W. Holman on "Matter, Energy, Force, and Work"; price 2dol.

Institution of Civil Engineers.—Some 22 students and 35 associate members have been reported to the council as having passed the October examinations held at the institution.

Institution Annual Dinner.—The secretary has reminded us that members who wish to attend the annual dinner of the Institution of Electrical Engineers on Dec. 7 should apply for tickets before Saturday next, Dec. 3.

Chelsea Polytechnic.—Mr. E. H. Todd, a matriculated student at the South-Western Polytechnic at Chelsea, has been appointed to an open exhibition in physics and chemistry at Christ Church, Oxford, of the value of £80 per annum, tenable for four years.

Exhibition.—An international exhibition of autocars will be opened in May, 1899, in Berlin. This exhibition is organised by the Association of Autocars of Central Europe, and is open to all motors, motor-cycles, accumulator wagons, etc., and also to the literature concerning the same.

Institution of Electrical Engineers.—We understand that candidates for election to the Institution who wish to be admitted under the existing rules, should send in their applications before Monday, Dec. 5, if they seek election as members, or, if as foreign members, associates, or students, before Thursday, Dec. 8.

The St. Lawrence Power Station —This large transmission of power scheme, in which English engineers are responsible for the electric work, has been rapidly pushed forward. At present the bulk of the work in hand on the site is that concerned with the construction of the canal from the St. Lawrence River to the Grass River. As was mentioned in a recent note, Mr. J. E. Stewart, who until recently was the borough engineer of Derby, has gone to America to superintend the electrical work.

Water Power for Huddersfield.—The heads of the waterworks, electrical, surveyor's and tramways departments of the Huddersfield Corporation recently received instructions to investigate and report upon the feasibility of getting electrical energy from their waterworks in the Wissenden Valley. The idea apparently emanated from the mind of Mr. Councillor Moore, of that town, who thought that certain compensation water could be utilised. From the figures we have seen up to the present, the quantity of power available does not warrant an extensive outlay.

Graphic Representation of Static Electric Forces.—An interesting and entirely new method of graphically exhibiting electrostatic forces has just been devised by Mr. David Robertson, jun., chief assistant to Prof. Jamieson, in connection with the day laboratory electrical engineering classes at the Glasgow and West of Scotland Technical College. By the aid of a Wimshurst machine and leading wires to a glass plate, and dry sawdust or tea leaves, he has been able to electrify the dust or tea leaves, and then he so photographs the curves of force that they can be beautifully exhibited as lantern slides to a large audience.

Atmospheric Electricity.—Mr. William A. Eddy, in his recent report presented to General Greely on the results of his kite experiments near the statue of Liberty, says: "Electrical tests of the absorbing power of the statue were made on Nov. 1, 3, and 4. A Leyden jar was used on the last test, and reaffirmed the first discovery that the statue does not influence the air much beyond 100ft. in a horizontal direction from the statue, nor much more than 1,200ft. in a perpendicular direction above the torch. During the experiment four kites were driven into the water and destroyed."

Rotatory.—Prof. S. P. Thompson, at the Institution of Electrical Engineers, stated that the word *rotary* was not to be found in any standard dictionary. Perhaps Prof. Thompson really meant to say that it was found in all standard dictionaries. We have not yet seen a dictionary without it, and Webster illustrates the word by an example from the sixteenth century of a rotary pump. The extra syllable upset nearly all the speakers, as out of deference to the author of the paper most of them tried to remember the innovation. We are sure that "rotatory" will, like "dynamoes," not come into general use.

The London Electrical Cab Company.—The first annual balance sheet of this company will be found elsewhere in this issue. It will be noted that the income is altogether swamped by the expenses, and that there is an adverse balance for the year of over £6,000. Full explanations are promised at the meeting; and we trust that a better result will be obtained in the future. In starting a new venture such as the provision of electric cabs, the failures in detail, which can only be corrected after practical trials, fall heavily on the first year or so, and our readers must not rashly conclude that the first year's balance sheet is in any way a criterion of the final results obtainable.

Exportation of Electric Machinery.—It should be an encouragement to our electrical manufacturers to note, that in spite of the high import duty on electrical machinery introduced into the United States, the Swiss firm of Brown and Boveri are executing an order for three large alternators for an American gold mine. The English policy of free trade has allowed the American manufacturers to send to England a large amount of electric traction plant during the last few years. As soon, however, as our own manufacturers have standardised their plants for electric tramways, as they are rapidly doing, we are sure that they will be able to hold their own in this field as they have done in the supply of machinery for electric lighting stations.

British Association.—The second meeting of the Preliminary Local Committee appointed to draw up handbooks in view of the meeting of the British Association for the Advancement of Science at Glasgow in 1901 was held last Friday in the rooms of the Philosophical Society, Prof. Archibald Barr, D.Sc., vice-convener, in the chair. It was reported that meetings of the Sub-Committee on Industries had been held, and that appointments had been made to write the various articles in the proposed volume. A similar report was received from the Sub-Committee on Natural History and Geology. Mr. David Murray was appointed convener of the Sub-Committee on Archæology, Education, etc., and Mr. Angus M'Lean acting secretary and treasurer to the Preliminary Local Committee.

Electric Railways in the Soudan.—We notice that Prof. Forbes has stated to an interviewer from the *Dundee Advertiser* that the water-power plant he advises the Egyptian Government to put down at the Second

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Cataract would be used to work the military railway laid down by the Sirdar. The works would be situated just above Wady-Halfa, and power could be developed to any extent that is likely to be required. Its chief value here would be, however, for working the two railways—one following the course of the Nile towards Dongola for 200 miles, the other going across the desert to Abu Hamid, and thence, when completed, to Khartoum. But in order to work this last railway with the best economy, it would be necessary to make use of the Fifth and Sixth Cataracts in addition. These Prof. Forbes had not examined, and consequently did not know what their capabilities were.

Tesla's Dirigible Boat.—Several American journals have now published extracts of Tesla's patent for the construction of a vessel which can be controlled from a distance without conducting wires. We have carefully read the accounts which have appeared, and, curiously, it is a fact that in each case the real innovation or invention is not described. In fact, the details published are obvious ones which would suggest themselves to the youngest electrician. The wireless system of telegraphy is used as a means of communication to the crewless vessel, and one receiver only is provided. This receiver works four different relays for steering and stopping and starting. These relays are comparatively simple, but not a word has yet been published as to how four differentiating signals are transmitted to the one receiver. Surely this must be disclosed in the patent; but why are the technical papers so lax in their extracting?

Electrical Installation in Upper Burma.—At the works of the Burma Ruby Mines, Limited, Mogok, there has, says *Indian Engineering*, just been successfully set to work a large electrical power and light installation, which is the first of its kind to be introduced into Burma. It having been decided to utilise water power taken from a neighbouring river at some falls distant about 1½ miles from the mines, an order was placed with Messrs. Johnson and Phillips, of London, for a complete set of plant, comprising turbine, dynamo, transformers, line material, motors, pumps, arc lamps, etc., and the whole of this has now been erected, and is working with the greatest satisfaction. Mr. H. Shaw Dunn, assistant engineer, was responsible for the erection of the plant, which was finally supervised and started at work by Mr. F. M. Short, A.I.E.E., electrical engineer to Messrs. Balmer, Lawrie, and Co., of Calcutta, the agents in Burma to the Charlton firm.

Breakdown Lighting Plant.—The Government railways in Würtemberg have lately introduced an arrangement the utility of which is so obvious that it is astonishing that the same has not been generally introduced. It is a portable electric light installation, consisting of the necessary steam-engine, dynamo, water and coal tanks, cables, lamp-posts, and six arc lamps. This is fixed upon a platform provided with wheels, and the whole is kept ready in a goods van. In the case of an accident occurring on the line requiring a breakdown gang to work continuously, or when ordinary night repairs or tunnel works have to be done, the van is dispatched to the place immediately. If the light is required somewhat away from the permanent way, horses are hitched to the wheeled platform, and the whole plant can be moved along roads or over fields. In this way the urgent work can be carried out quickly, as in such matters light and speed are interdependent.

Municipal Telephones.—The policy of the Post Office officials in keeping down the applications for telephone licenses until Parliament has decided a test case is shown by the following letter. The Corporation of Bedford recently passed a resolution to apply to the Postmaster-General for a license to transact a telephonic exchange business, and the town clerk forwarded the application to the Duke of Norfolk, who, through his secretary, has replied as follows: "Sir,—I am directed by the Postmaster-General to acknowledge the receipt of your letter of 21st inst., enclosing a copy of a resolution passed by the Corporation of Bedford, applying for a license to transact telephone exchange business, and to state, in reply, that he is unable to accede to your request, as he is advised that municipalities are not empowered to work such business." This, contrasted with the letter sent to Glasgow, shows a reversal of policy which can be only accounted for on the supposition that a test case had to be raised.

Making White Lead by Electricity.—A correspondent of the *Electrical Review* of New York states that a process has been patented lately in the United States which produces a white lead of superior quality by means of electricity. A small plant is now in operation in Brooklyn by which between 5lb. and 6lb. of white lead are produced per hour. The process employs a solution of ammonium nitrate and bicarbonate, and produces 2lb. of white lead per electrical horse-power hour. The product is said to be perfectly white, and to have a body and covering capacity equal to the best quality in the market. The process is continuous, and requires no interruptions for the removal of the product. The cost of operation depends exclusively on the cost of electrical energy, the electrolyte being continuously regenerated. This process has the advantage that the ammonium salts used prevent the formation of plumbites and plumbates, which, on being reduced on the cathodes to spongy metallic lead, waste electrical energy, besides spoiling the product.

Electric Mining Plant.—The first of a course of lectures arranged for delivery during the coming winter by the Midland Branch of the National Association of Colliery Owners, in conjunction with the Nottinghamshire and Derbyshire County Councils, was delivered at the Municipal Technical College, Green-hill, on Saturday last. The lecturer was Mr. F. W. de Grave, civil and electrical engineer, of Derby, the subject of his remarks being "Electric Mining Plant." The lecturer gave a good *résumé* of the various applications of electricity to mining work. Mr. de Grave, speaking of electric coal-cutting machinery, expressed himself in favour of belts as a means of conveying the power from or to a dynamo or motor, on account of the elasticity in cases of sudden strain. The lecture, which was listened to throughout with marked interest and attention, was brought to a conclusion by a number of valuable hints on the management of dynamos and motors, together with the causes and remedies for some of the troubles encountered in the working of electrical machinery.

U.S.A. Patent Office.—In the report for 1897 issued by the Patent Department of America attention is called by the Commissioners to the need of a suitable laboratory. Questions frequently arise in reference to applications for patents relating to chemical, electrical, and metallurgical inventions which can be decided satisfactorily only by practical test and experiment. Some apparatus has been presented to the office for laboratory use, and the office has had the use of apparatus which is the personal property of examiners, but even when thus supplemented the laboratory is but meagrely equipped. It is pointed out that an inconsiderable sum would secure the necessary apparatus to equip a laboratory which would meet every requirement. Such a laboratory is not needed in our English office, as we do not require the Patent Office staff to know what is feasible and what is not in new inventions.

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As has been pointed out by Mr. Swinburne, the American system would require, to be properly carried out, that the foremost men of science in the country should devote themselves solely to the arrangement of patents and specifications.

A Heavy Electrical Tool.—An interesting example of a heavy double-angle shear, mounted on a turn-table, operated by a direct-geared electric motor, is described and illustrated in the *Iron Age*. The machine was built for the Cambria Iron Company, and is capable of shearing 8in. by 8in. by 1in. steel angles without disturbing the piece cut off. Angles can be sheared to a bevel considerably beyond 45deg., this having been especially provided for in the shape of the main frame. The sliding heads are of cast steel, each having its separate eccentric shaft, spur gear, clutch, etc., so that two gangs of men can work upon the machine at the same time. The turn-table is 10ft. in diameter, and can be revolved entirely around for convenience in handling long bars and for shearing to a bevel. The motor is mounted on a substantial bracket secured to the main frame, and drives on to the flywheel shaft through a pair of cut gears and a friction clutch. This allows the motor to be started up at full speed before throwing in the flywheel, which is quite a desirable feature, avoiding the possibility of damage from careless throwing on of the current by inexperienced operators. Another good feature of this arrangement is the fact that it makes a slipping point between the motor and the knives.

Chinese Telegraphy.—In an article in the current number of the *Engineering Magazine* on "Industrial Progress in China," by J. S. Fearon and E. P. Allen, these interesting statements are made: "The telegraph is the only institution of modern science which has obtained any considerable foothold in China. Peking is connected by wire with Tientsin and with Manchurian points up to the Russian frontier, whence connection is continued by Russian-Siberian lines to Europe. The capital is also connected with all the treaty ports and principal cities in China proper, and these again with each other. Canton has connection also through Yünnan with Burma. China learned the value of the telegraph in the war with France, and it has long since been admitted to have 'become indispensable.' The telegraph, however, is under Imperial control, and there is probably little opportunity for its extension as a private enterprise. Chinese writing being not alphabetic, but syllabic, and there being as many characters as there are words in use, the telegraphic messages are sent in a number cipher. For transcribing messages received a double-ended type is used; on one end is the character, and on the other the corresponding number. When a message is received, it is set up by the numbers, and then printed from the reverse, or character, end."

The X-Rays on the Battlefield.—Surgeon-Major Beevor, R.A.M.C., gave a lecture on Monday night at the Camera Club on "Work with the X-Rays on the Battlefield." Major Beevor obtained his experience with the subject in the recent campaign against the Afridis on the north-west frontiers of India. There was an unusual assortment of missiles used in the war, inflicting a great variety of wounds, because pebbles, cut-up bits of telegraph wire, or anything else hard and handy, was good enough for the Afridi to cram into his gun. He thought there was nothing that was such an incalculable benefit to the army surgeon as the X-rays, which enabled him to localise and define a foreign body in the human organism. Major Beevor exhibited on the screen lantern slides of a number of radiograms taken by him in the course of the campaign, and showing fractured and splintered bones of the arm, hand, leg, knee, pelvis, foot, and chest, always with the dark patches or spots which revealed the presence of a bullet, or part of a bullet—sometimes a crowd of little fragments sprinkled about the injured part. The native Afridi bullet being made of soft lead, it scatters a great deal more than a hard bullet. It appears that in some instances the wounds had been probed without success before the injured men were examined by the lecturer by means of the X-ray or the fluorescent screen.

Municipal Corporations and Electrical Supply Schemes.—A meeting of the council of the Association of Municipal Corporations was held last week, in London, to discuss the Bill of the General Power Distributing Company. This company has put forward a scheme to supply electrical energy over an area of about 125 square miles in South Yorkshire, Derbyshire, Nottinghamshire, and Lincolnshire. This Bill passed the House of Lords last session, and its progress in the Commons was suspended until the ensuing session of Parliament. Consequent upon the report of the Joint Committee on Electrical Energy, an incentive has been given to private companies to establish central stations for the supply of electrical power over large areas, and the General Power Distributing Company's Bill will not be the only one before Parliament next session. It was stated at the meeting that one of these schemes proposed to serve a large area in South-East Lancashire and Cheshire. The municipal authorities are united in their opposition to these schemes. It was agreed that a sub-committee of the council of the Municipal Corporations Association should be appointed to organise opposition to the scheme of the General Power Distributing Company and to all schemes where powers of a similar character are sought, and that to this end they should endeavour to secure the assistance of the members for the boroughs and for county divisions, including incorporated towns within the areas.

New Electric Railway Schemes.—The list of proposed new electric railways for London has been increased by a number of projects filed during the last weeks of November. In its 1899 session Parliament will be asked to sanction the following: A City and Brixton Railway, which will be really a continuation of the City and South London system. The Brompton and Piccadilly-circus scheme will be again tried, and the promoters will endeavour to get new powers to connect with the District line at South Kensington, and also powers for that company to furnish a certain amount of capital. The line would open up connections with the Baker-street and Waterloo, Charing Cross, Euston, and Hampstead Companies. Then there is to be the Strand to Wood Green line, and also the North-West London, which is a line from the Marble Arch to Cricklewood. The Baker-street and Waterloo Company will apply for further time for construction, with a deviation near Euston and subways at Paddington to connect with the Great Western Railway. A change of name is also anticipated by the Baker-street and Waterloo Company, which will further seek powers to enter into an agreement with the Waterloo and City, South Western, Great Central, North-Western, and Great Western Companies. The Charing Cross, Euston, and Hampstead line also desires power to enter into an agreement with the Baker-street and Waterloo, the North-Western, the South-Eastern, and the Midland.

"Etherion" Explodod.—It has taken the *Journal of Gas Lighting* just a week to veer through two right angles as regards the supposed new gas, etherion. In our note of last week we exposed our contemporary's futile argument, that because Mr. Brush had read a paper on the subject the gas must exist. This week we find that Sir

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William Crookes has supported our criticism of two months ago, that there was no real evidence of the existence of etherion. Our contemporary adds: "Sir William Crookes handles somewhat severely the claims of Mr. Charles F. Brush to have discovered a new atmospheric gas, which he has called 'etherion.' The discoverer has not pretended that his find possesses any chemical affinities, and admits that he only stumbled upon it by observing that in the course of some high-vacuum experiments something came off which exhibited a remarkable power of conducting heat. Sir W. Crookes was moved by this statement to look up his notes of old researches upon similar lines; and he now publishes in the *Chemical News* the evidence which tends, in his opinion, to show that Mr. Brush's etherion is nothing more than aqueous vapour. It is admitted that only an abstract of Mr. Brush's paper has yet been published, and Sir W. Crookes politely affects incredulity that so serious a matter as the existence of a new element should be proposed to be inferred from the scanty evidence yet offered. As it is, one of the strongest pieces of evidence offered by Mr. Brush—the occlusion of his new gas by broken glass—strikes his critic as one reason for regarding it as nothing but water. With regard to the conduction of heat, the rarefied aqueous vapour, somewhat misleadingly called 'water gas' by Sir W. Crookes, is a better conductor of heat than air or hydrogen at like pressures."

Free Shocks.—The reporters of the *Western Mail* have made some good copy out of a slight leakage from a 200-volt circuit to the lid of a street box. The report reads as follows: "Some curious scenes were witnessed in Wood-street, Cardiff, on Thursday last week. As soon as one of the new electric light lamps was lit a portion of the pavement near the standard became charged with electricity, and the effect on the pedestrians was startling and discomforting. The first victim was a terrier which was sniffing round. When it came in contact with the current the dog gave a wild yelp, sprang into the air, and then scampered away squealing, with its tail drawn in. Next came an old lady carrying a parcel. When opposite the lamp she screamed with fright, dropped the parcel, and hobbled off to examine her knees. A coaltrimmer of unsteady gait followed, and on receiving the shock he stood still, and, as his legs seemed to be getting on fine, he turned round in a dazed way and went for the youngsters who were standing round laughing at what had now become a game for onlookers. A man lame with rheumatism leaped high into the air, and a smartly-dressed young man knelt down to see what had happened to his foot, and as his knee received a shock he sprang up and hurried away. By this time the workmen found that something was wrong, and the current was switched off." Mr. N. Appelbee's explanation is that a committee meeting being fixed for the next day he was anxious to get the work done in order to be able to present his report. The work was performed rather hurriedly, and it was possible that there was a slight leakage, and, owing to the wet state of the pavement and the junction boxes being damp, the current was conducted to the surface, with the result that persons passing received slight shocks. The leakage was from the low-pressure system, and the full pressure (200 volts) was not sufficient to give even an unpleasant shock.

The "Mohegan" Disaster.—The enquiry into the wreck of this ship has now been completed, and the following extracts from the judgment of the Court will interest our readers: The Court found that the "Mohegan" was in good and seaworthy condition when she left the Thames on Thursday, Oct. 13. She had five compasses, not including boat compasses, in sufficiently good condition and position for the safe navigation of the ship, having been last adjusted on Oct. 5. The vessel was steered by the Standard compass—Lord Kelvin's patent. With regard to her electric lighting, she was wired on the double-wire system, and, the dynamos being 100ft. away from the compasses, the Court were of opinion that they could not have been affected by the electric current. The "Mohegan" was supplied with copper signal and other oil lamps, independently of the electric lamps, and these appeared to have been kept properly trimmed and ready for use in accessible places. The circumstances in which so few distress signals were discharged after the stranding of the ship, the Court concluded, were that within a few minutes after the ship struck she took a list of about 45deg. to port, that the rocket sockets were on the port side, and that the list made the discharge of rockets very difficult; whilst the reason no lamps were exhibited after the stranding was that the dip under water of the fore part of the vessel, where the lamp-room was, rendered that inaccessible. In answer to the question as to what caused the great loss of life, the Court laid greatest stress on the list to port and to the short interval between the time she struck and the time she went down. The Court also recommended that, when lighted with electric light, every ship should have also oil lamps in easily accessible positions ready for use in case of the failure of the electric light. This recommendation appears to have been fulfilled in the case of the "Mohegan," and it was only the exceptional circumstances which prevented their being used.

The Chief Officer of the London Tramways.—Mr. John Young, the general manager of the Glasgow Corporation tramways, has been selected by the London County Council as the chief officer of the Council's tramways, which have been acquired from the first day of the New Year. Mr. Young was called to London last week, and had a meeting with the committee, who afterwards unanimously recommended that Mr. Young be appointed to the position, and this recommendation was confirmed at Tuesday's meeting of the London County Council. At first the salary will be £1,500 a year, but the ultimate reward for the successful inauguration and carrying out of a municipal service of tramways in the Metropolis is expected to greatly exceed that sum. Mr. Young was educated at Paisley Grammar School with a view to a professional life. In 1875 he was appointed superintendent of cleansing for Glasgow, and under his energetic management a system was organised which has resulted in Glasgow being placed in a foremost place among the cities of the kingdom in the matter of cleansing. When the Corporation acquired the tramways, six years ago, Mr. Young was appointed the general manager, and his practical experience stood him in good stead in the purchase and training of the 3,000 horses required for the tramway service, the erection of stables, car-sheds, workshops, and granaries, the buying of feeding stuffs, the engaging of men, and doing the numerous other things required of him. The result was shown in the smoothness with which the Corporation tramway service was inaugurated on July 1, 1894, and the satisfactory manner in which it has been developed and worked since then. Mr. Young is a strong man, physically and mentally, cool, shrewd, courteous, and resolute. We are indebted to the *Glasgow Herald* for the above notes on Mr. Young's past training. We wish him every success in his new position, and that he will be fully supported by his committee in the arduous work of improving the tramways under his charge.

The Telephone Company's Act.—It is difficult to ascertain from the notices in the *London Gazette* exactly what the National Telephone Company asks for in the two

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proposed Bills to be presented to the next session of Parliament. When the Bills are printed we shall return to the subject and discuss it in detail. At present the following clause is enough to take anyone's breath away: "To authorise the new company or their agents, licensees, or other persons to lay down, suspend, place, erect, and maintain and renew and at all reasonable times to have access to pipes, wires, posts, pillars, insulators, conductors, and other works and apparatus connected therewith, in, through, across, along, on, under, and over highways, streets, roads, lanes, towing paths, passages, footways, and other places, whether public or private, tramways, railways, subways, canals, docks, basins, waters, rivers, estuaries, or branches of the sea, bridges, lands, houses, buildings, and other works in the United Kingdom, the Channel Islands, and the Isle of Man, and for such purposes to temporarily to break up, open, or interfere with such highways, streets, roads, lanes, and other places and properties hereinbefore enumerated, and also any sewers, drains, water or gas mains and pipes, electric, telegraphic, telephonic, pneumatic hydraulic, and other apparatus, and all other works in, on, over, or under such highways, streets, roads, lanes, or other places aforesaid respectively, and also in the event of the unreasonable refusal of the owner, lessee, or occupier of any land or building to permit a wire or wires to pass over such land or building, or to be supported thereon or attached thereto, to make such provisions in relation thereto, and also in relation to the several matters aforesaid, as may be necessary or convenient for the full and efficient establishment and maintenance of telephonic communication upon such terms and subject to such conditions, restrictions, and regulations as may be provided by the intended Act." We wonder that the company does not ask for the free use of public funds for the purpose of invading all the public and private places scheduled, and feel duly thankful for their moderation in this respect. The other clauses provide for the formation of a new company to take over all the assets and liabilities of the present concern. We hardly think that an opportune time has been chosen for the proposed innovations, and trust that the Government will prefer to buy out the present rights rather than to give further concessions and powers in order that they may be bought back later on at the country's expense.

Tramway Speeds in Dublin.—Last week Sir F. Marindin held an enquiry on behalf of the Board of Trade in reference to the application of the tramways company for permission to run their electric cars between Dublin and Dalkey, *vid* Blackrock and Kingstown, at an increased rate of speed. The evidence is so refreshingly Irish that we should liked to have reproduced many parts in full. The following extracts show what opposition had to be met, in spite of the fact that nearly all the local townships agreed to an increase to 12 miles an hour. The Dublin, Wicklow, and Wexford Railway Company were very active in their opposition, as their traffic had been decimated by the tramline. Their ordinary shares, which stood at £74 before the opening of the tramway line, are now to be had for £24 or £25. The Car Owners' and Cow-keepers' Associations were represented by counsel, and pleaded damage their members had experienced. Yet one important witness said he never saw anything like an accident on the line, as the drivers took the greatest caution in driving along. The milk-carts he considered were more dangerous on the road than the trams. A car-driver, who gave evidence respecting an accident on the Dollymount line which was caused by the electric trams, said that when he complained to the head constable at Clontarf about the matter, the head constable told witness that it was fortunate that he was not drunk or that he would lock him up for the night. Mr. Healy, M.P., was a counsel for the tramway company, and elicited many good replies from opposition witnesses. His summary of the case contained the following statements: "Close upon 5,000,000 of passengers had passed through the company's hands last year, and without scarcely an accident. If there were houses, as Mr. Wright said, all along the route, they were there because the tramway company gave people facilities for getting in and out to business in the city. In any of the morning papers they would see that houses or lodgings were to be let, and that the 'electric tram passes the door,' was added. That was not put as a warning not to approach a route which it was pretended they had desolated. It did not mean 'Don't come this way; don't show your nose down on the Rock-road.' No; it meant you will be convenienced if you live here. 'The electric tram passes the door.' In any advertisement did they ever see it boasted that the Dublin, Wicklow, and Wexford Railway passes the door?" etc. The report of Sir F. Mandarin will be presented to the Board of Trade in due course.

High-Voltage Trolley Wires.—The matter of the danger of high trolley voltages has, says the *Electrical World*, recently been brought up in Switzerland in connection with the proposal of Messrs. Brown, Boveri, and Co. to use 750 volts alternating on several three-phase trolley lines, the conditions of which are even worse in some respects than those of direct-current work, owing to the fact that there would be two trolley wires close together with a pressure of 750 volts between them. To dispel the fears of the Swiss Railway Commission, advice was obtained of three experts—Messrs. Gisbert Kapp, Silvanus P. Thompson, and H. F. Weber. The first considered that 750 volts was no more dangerous than 500, as the latter had been known to give fatal effects, and argued that on account of its apparent security it was really more dangerous than the higher voltage, which would secure greater respect. Prof. Thompson also considered that the satisfactory working of trolley pressures up to 1,500 volts was only a question of careful engineering. The third expert considered these high pressures perilous, but small compared with the other dangers of high-speed railroad running, and justified by the advantages which might be derived. The insulation is not a real difficulty. Of course, more strain insulators would be needed in the line and more care in the insulation of the motors. For long-distance work the latter, however, are generally of large size, running double-truck cars at high speeds, and the insulation is comparatively easy with the increased room. To manage large currents at these high pressures, the controllers might require further modifications, but there are ample opportunities for quick-break devices and other improvements to solve this problem. The greatest difficulty would be to obtain a system whereby the same cars could be run at high voltage in interurban and suburban work and at low voltage in the city streets. On account of the desired difference in speed, the same motors might work well at 750 or 1,000 volts on suburban lines and at 500 volts on the city streets, the only difficulty being with the electric lighting of the cars, a detail which might be worth abandoning on account of the advantages to be gained. Now that four-motor equipments are coming into considerable use for heavy long-distance service, it would be a simple matter to arrange the motors in pairs, the two of each pair to be worked in series on the 1,000-volt lines and in multiple on the 500-volt lines, by means of a single throw-over switch, the two pairs to be worked together with the ordinary series-parallel control.

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THE LANGDON-DAVIES ALTERNATE-CURRENT MOTORS.

Last week we were invited to inspect the works of the Langdon-Davies Electric Motor Company, which are situated at 101, Southwark-street, S.E., and were glad to note the fact that at last we had in London a complete factory driven wholly by single-phase induction motors. We have in previous issues described the construction of the motors designed by Mr. Langdon Davies, so that now a brief *résumé* is all that is required in this respect. The electrical designs have been perfected of late years, and great attention devoted to the improvement of the mechanical and electrical details. The motor consists of a stator of laminated iron, with two windings for the alternate currents. The one winding is only used in starting, when a difference of phase is produced by the introduction of a resistance in one circuit. The arrangement of the wires in the slots is claimed to be of a special character to ensure a uniform field. We gather, however, from Mr. Langdon Davies that the winding should be varied somewhat to suit the wave form of the alternator which will supply the motors with power. The rotor does not now take the squirrel-cage form of the earlier examples of this type. Instead of this, insulated wires are wound in the slots, and the wire filling each slot is short-circuited on itself. This gives a better result, and a more even turning moment than the squirrel-cage type. Another innovation in the rotor is the use of staggered slots instead of slots parallel to the axis. These slots are milled in the plates after they have been clamped on the spindle. The result of the angle of the slot on the rotor is also said to be a more uniform torque.

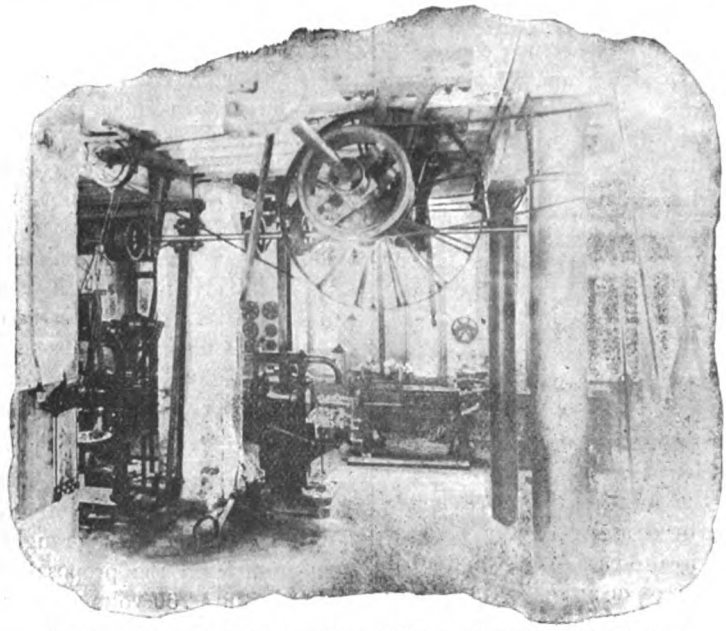

FIG. 1.—A Corner in the Machine-Shop of the Langdon-Davies Motor Factory.

The works in Southwark-street are supplied with power from the London Electric Supply Corporation, with a frequency of from 83 to 87 complete periods per second. The supply is taken at 2,000 volts through a transformer in the basement. The many floors in the building are devoted to special departments of manufacture, and we propose to commence our description with the bottom floor, and then to work upwards. Naturally, all the heavier machine tools are placed in the basement, where concrete foundations can be laid down for them. These tools

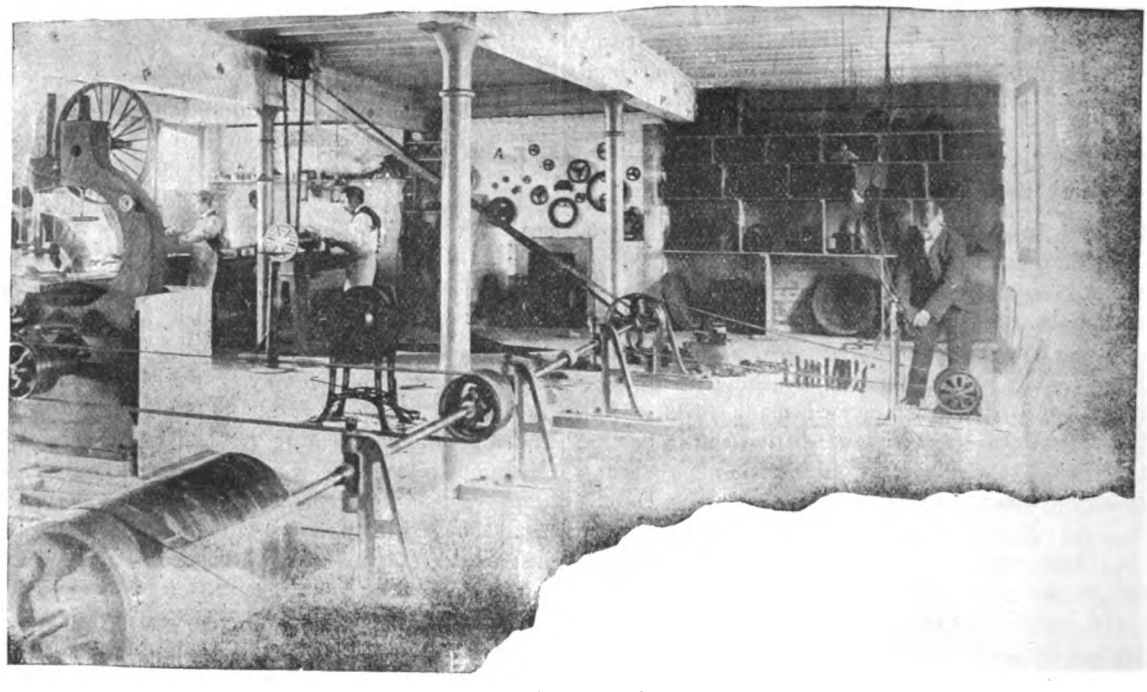

FIG. 2.—The Pattern-Shop.

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consist of planing machines, large lathes, and boring machines, and several drillers and smaller lathes. The self-acting milling machine was at work on the slots in the rotor when we were there, and was doing the work quickly and well. The driving of the tools on this floor is done by two induction motors, one of 6 h.p. and one of

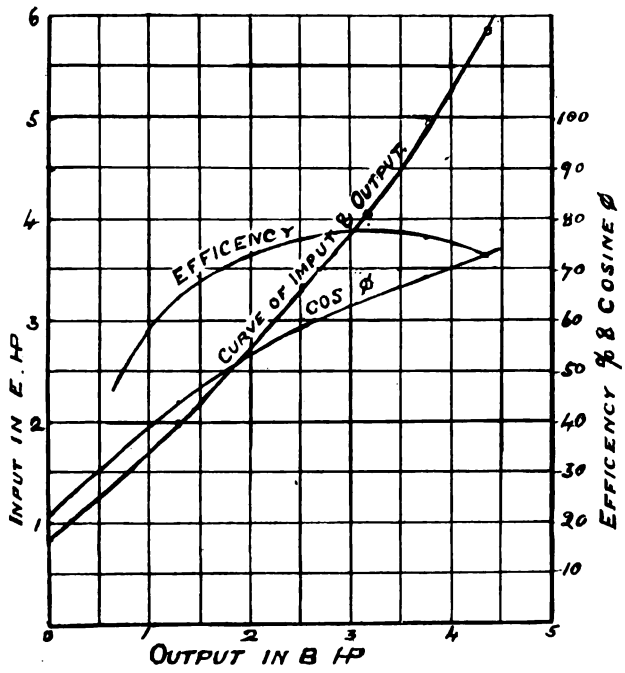

FIG. 3.—Diagram of Efficiencies and Power Factors for a 4-h.p. Langdon-Davies Motor at 87 frequency.

3 h.p. The 6-h.p. motor is placed on the floor, while the 3-h.p. motor is bolted to the ceiling, as shown in Fig. 1. This motor drives the large planer for machining the stator cases and also one large lathe.

The ground floor is used mostly for offices, but the space at the back is devoted to the storage of finished

and the operations were in full swing when we were there. All the wires are wound by hand, *in situ*, as the designs do not lend themselves to machine-formed coils. The insulating of the rotor is not a vital point, as the voltage in each short-circuited segment is never enough to cause any leakage troubles. The winding is practically the same as that required for a Paccinotti Gramme ring, except for the short-circuit. In all the sizes the same consideration applies, as in no case is any resistance introduced into the rotor coils. The stator plates are provided with holes of the elongated

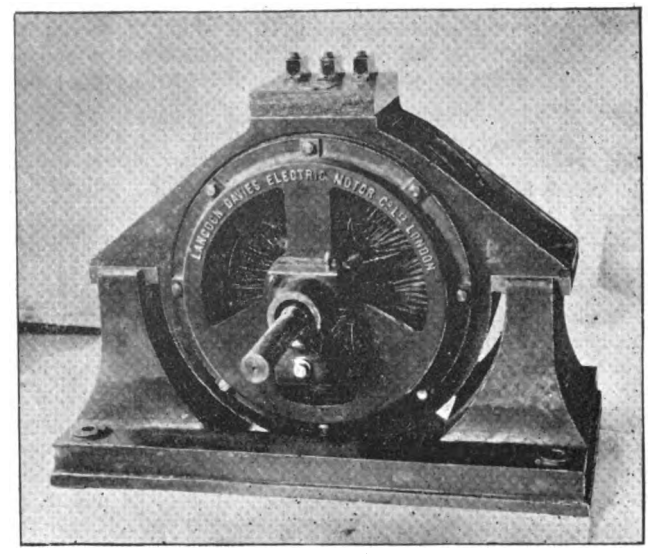

FIG. 4.—General View of a 25-h.p. Motor.

O-form. These are insulated with vulcanised fibre, and then the wires are wound in by threading the single wire through the slots until a sufficient number have been put in. Wedges are used to get the wire well disposed in the holes.

The second floor is devoted to the testing of the motors

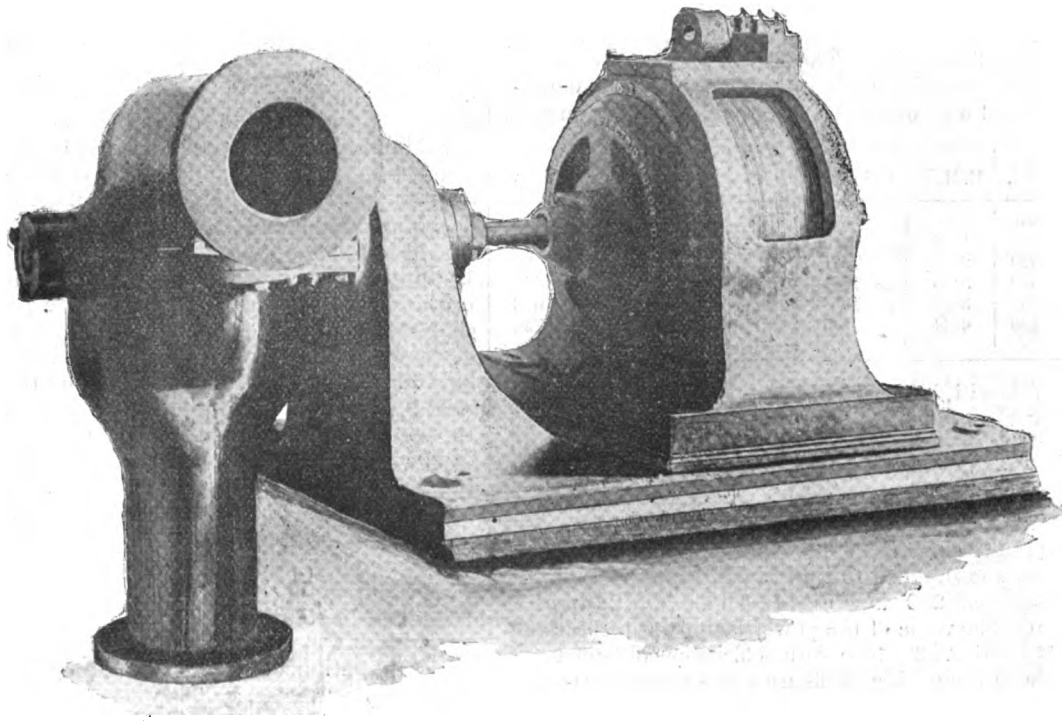

FIG. 5.—A Centrifugal Pump driven by a Single-Phase Motor.

motors. It is intended to stock all the standard sizes of motors, and a few representative machines were on view. Unfortunately for the would-be purchaser who wants a motor in half an hour, the demand is at present greater than the supply. Hence the store is not so well filled as it should be, but the firm hope to be able to supply much more largely from stock in future.

The first floor is used almost entirely as a winding shop,

when finished, and to the drawing office. The testing department is well provided with instruments for ascertaining correctly both the input and output of the motors. The brake used is the design of Mr. Soames. It is of extremely simple construction, and gives perfectly definite weighing of the torque on the pulley under test against ordinary dead-weights. It consists of a steel lever working on knife-edges, which can be raised or lowered by a hand-wheel at

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the top of the brake, which is supported on a tripod. Holes are drilled in the lever, at equal distances from the centre, corresponding to the ordinary sizes of pulley in use. The centre of the brake is placed over the centre of the pulley, and from the two holes corresponding to the diameter of the pulley under test is suspended a piece of webbing, which passes round the underside of the pulley. When the pulley is running, a weight, say, from ¼lb. to 30lb., is then suspended on the end of the arm. The whole is then raised by turning the hand-wheel, tightening the belt on the pulley until sufficient friction is put on the belt to raise the arm to a horizontal position, and keep it floating there; the speed of the pulley being taken at the same time. A constant is given with the brake which, multiplied by the speed and the weight, gives horse-power direct. The constant is $2\pi L \div 33{,}000$, L being the distance of the weight from the centre. The size of the pulley does not enter into the equation so long as the distance between the holes in the arm is equal to its diameter.

The switchboard is equipped with ammeters, voltmeters, and several wattmeters.

The third floor is the erecting shop, where the motors are put together. In this shop the few lathes and drilling machines required are driven by belts from a countershaft on the floor above. The lift motor is placed on this floor. It is an 8-h.p. motor, and drives by a countershaft a Waygood lift, capable of carrying one ton, at a rate of 60ft. per minute. The lift supplies six floors. The motor is started from the ground floor, whilst its belt is on a loose pulley on the countershaft. When the motor has run up into speed, and the resistance is cut out, the belt is put over on to the fast pulley. The motor is as a rule left running, and the motion of the lift is controlled by belt-striking gear placed on this floor. In this case the motor does not start against the load of the lift. A neat dodge for securing the laminated plates of the stator concentric with the bearing was on view on the floor. The plates are clamped up very firmly on a mandril which has projections accurately fitting the inside of the plates. The mandril is then put in the motor bearing, and holds the plates while they are being cast in by type metal.

The top floor is used as a pattern shop, and is equipped by a 4-h.p. motor, which drives the countershaft, seen in Fig. 2, for the floor below. The capabilities of the motors as at present manufactured are shown by the following figures of a 4-h.p. motor on a circuit of 87 frequency.

Watts	Speed.	B.H.P.	Efficiency	E.	C.	E C.	Cos ϕ.
630	2,660	—	—	102·5	28·5	2,921	·216
1,480	2,560	1·28	64·5	102	33	3,366	·440
2,480	2,520	2·52	75·7	101	41·5	4,191	·592
3,000	2,520	3·15	78 4	101	46	4,646	·646
3,680	2,500	3·75	76	100·5	54	5,427	·678
4,400	2,480	4·34	73·5	100	60	6,000	·734

From this it will be seen that the best efficiency is not obtained at the normal full load. This can also be seen in Fig. 3, which gives the same results in diagram form. These 4-h.p. motors pull up at an output of about 4½ b.h.p. This seems to us to be rather low, and that hence the rated outputs in the list are rather too high. When we were inspecting the test-room a 25-h p. motor (Fig. 4) was on trial. The current was supplied to it at 100 volts, as it took 210 amperes at no load, 229 amperes at 12 4 b.h.p., and 28 amperes at 21 b.h.p. The value of the power factor was respectively ·165, ·524, and 708. The best efficiency obtained was 78·5 per cent., but a higher figure was expected after the bearings had got properly heated. The firm make a great point of designing their motors so that they do not take more than one-fifth full load current in starting, and then a torque equal to about one-fifth of the full load torque is obtained. These motors are being largely used both in London and on the circuits of provincial electric lighting undertakings. Thus a pump driven by a single-phase motor, as supplied to Hanley, is shown in Fig. 5. We wish the company every success in their well-organised factory for the manufacture of reliable motors, and also note that they are selling at reasonable rates.

INSTITUTION OF ELECTRICAL ENGINEERS.

Rotatory Converters.

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S., VICE-PRESIDENT.

(*Concluded from page 687.*)

The first large converters of the General Electric Company were designed by Mr. Parshall on the lines of ordinary multipolar continuous-current generators, with powerful field magnets, and performed their functions well. Later, some designs were tried with relatively weaker field magnets, on the assumption that, in view of the lesser amount of armature reaction, commutation might be effected sufficiently well in spite of a lighter construction. But though a three-phase converter will, without any winding on the field magnets, operate by virtue of the armature reactions peculiar to the synchronous motor, the regulation in such machines leaves much to be desired, and the later designs exhibit a return toward the construction usual for multipolar continuous-current generators. By the kindness of Mr. Parshall and of Mr. Steinmetz, information as to a number of such large converters is available.

At Niagara, where the Cataract Company generates two-phase current at 5,000 volts, converters are employed to supply continuous current for certain electrolytic processes: for the manufacture of caustic soda and of aluminium. For the Pittsburg Reduction Company's aluminium works the General Electric Company constructed a number of large converters. The two-phase current is first reduced by transformers to a pressure of 115 volts. At this pressure it is led into the converters, which give out the continuous current at 160 volts, the plant having a total capacity of over 10,000 amperes, equivalent to an output of about 2,000 h.p. At Schenectady were also constructed the six three-phase converters of 200 kw. each, for use in the power-house at Brooklyn. As these machines are fairly typical of American practice, some information of their general construction is of interest. They are eight-pole 200-kw. machines, running at 375 revolutions per minute, the frequency employed being 25. The voltage on the three-phase side is 82·8; that on the continuous-current side 125, with an output of 1,600 amperes. The armature is 48in. in diameter, its core length being 7in. between heads. This gives 4·95 square inches of peripheral surface per kilowatt.* The core discs have 240 slots, with two conductors in each slot. Each lap of the drum winding is over 30 teeth. The gap measures 0·25in. from iron to iron. The commutator is 36in. in diameter, with 240 bars. The three slip-rings are each 18in. in diameter, 3½in. broad, and 1in. deep. The brushes are of carbon, eight sets of nine brushes each, and each brush with 1¼ square inches of contact surface. The brushes on the three-phase side are of copper. The flux through each pole-face is designed to be 4,380,000 lines at full load, the flux density in the cast-steel pole-cores being then 80,000 lines per square inch. In the gap the pole-face density at full load is no less than 51,300 lines per square inch. In the teeth it reaches 135,600, and in the core body 61,300. When running as a converter the brushes have no lead. When running on test as a continuous-current generator a lead equal to four bars of the commutator was necessary. The pole-breadth is 64·7 per cent. of the pole-pitch, and the voltage ratio of conversion 63·3 per cent. The $C^2 R$ loss in the converter armature at full load is 3,500 watts: it would be 6,250 if used as a continuous-current generator. The total armature loss as converter is 6,005 watts; as continuous-current generator, 9,130 watts. The temperature rise of the

* The number of square inches of peripheral surface per kilowatt of output gives a basis for estimating to what degree in the design of an armature the specific utilisation of its materials has been carried. Modern dynamos of over 100 kw. output have from four to twelve square inches per kilowatt. Old machines and small machines vary from 10 to as many as 25 square inches per kilowatt. In this estimate the working part only of the peripheral surface is counted, being the length round the periphery multiplied by the total (gross) thickness of iron parallel to the shaft. These values apply to alternators and motors as well as to continuous-current dynamos.

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armature at full load is 27deg. C. as converter; as continuous-current generator it is 47deg. C. The temperature rise of the commutator at full load is 36deg. C. as converter; as continuous-current generator, 52deg.

Another three-phase converter also constructed at the Schenectady works is a 16-pole 600-kw. machine, running at 188 revolutions per minute. In this machine the pole-breadth is 72 per cent. of the pole-pitch, yet the ratio of conversion is 71·8, the voltage at the respective sides being 115 and 160. The armature diameter is 100in., the core length 8·25in., giving 4·3 square inches of peripheral surface per kilowatt. The temperature rise after 17 hours with a conversion output of 575 kw. was 15deg. C. in the armature, 23deg. C. in the field magnets. The average flux density in the gap was 69,000 lines per square inch.

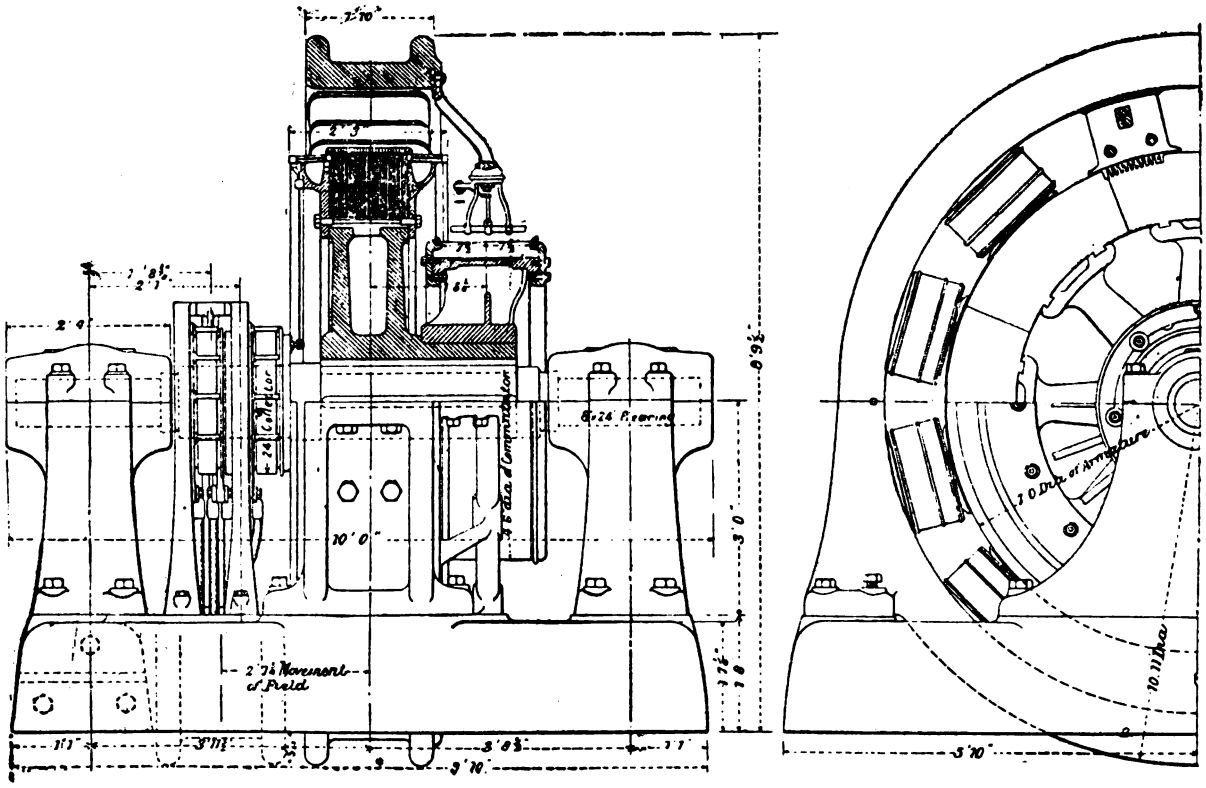

FIG. 15.—Three-Phase Converter, designed by Mr. Parshall for Central London Railway.

To the same class of machines belong the four three-phase converters recently designed by Mr. Parshall (Fig. 15*) for the Central London Railway. These are 12-pole 900-kw. machines, running at 250 revolutions per minute. Each weighs about 30 tons, and their guaranteed efficiency will be 95 per cent. at full load, 93 per cent. at half load. They are designed to take in their three alternating currents of 1,800 virtual amperes each at 310 virtual volts; the output on the continuous-current side being at 550 volts. The armature in each is a multipolar drum with 432 slots, and two conductors per slot; and, being lap-wound, has 24 circuits in parallel. It is connected down at 18 symmetrical points to the three slip-rings, there being six such connectors to each ring. Owing to the conditions imposed by the relations between voltage, speed, and size, it has been the practice in the States to design converters to operate at a frequency of 25, or at most 30, periods per second. But some of the General Electric Company's converters have been constructed for frequencies as high as 60, so as to be capable of being operated from lighting circuits. One such, a 16-pole 400-kw. two-phase converter, running at 450 revolutions per minute, has been recently described in the *Electrical World* (May, 1898).

One difficulty which has been experienced when operating converters in their application on the large scale—a difficulty which could hardly have been foreseen from the working of small isolated machines—is a tendency for them, when grouped in parallel, to set up a see-sawing interference of slow period, probably in consequence of armature reactions, similar to those which in certain types of alternators trouble their parallel running. Another puzzling defect is a similar tendency to hunt, observable when two converters are arranged in series at the two ends of a long three-phase line for the purpose of feeding continuous currents from one point to another. The cure for these troubles will probably be found in an analogous treatment to that adopted for securing good parallel running in alternators—namely, careful design so as to prevent armature reactions from unduly distorting the magnetic field. But the point demands further investigation.

Before quitting the subject of converters it is but right to refer to the existence of another class of rotating machine for effecting the same aim, and to which, for distinction, the name of permutators may be allotted. In this category are comprised those machines in which alternating currents (of one, two, or three phases) are first transmitted through a stationary part of the apparatus

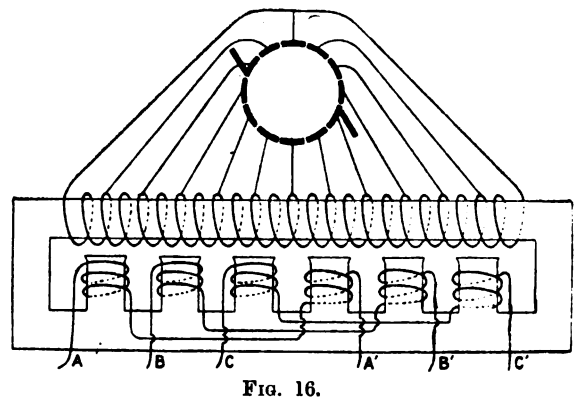

FIG. 16.

(a species of transformer), where they create in a re-entrant sectional winding a series of alternating currents which differ from one another in phase by small successive phase-angles; these currents being then led off to a commutator and commuted, section by section, into a continuous current. To fix ideas, consider Fig. 16, which is adapted from a recent article by Dr. J. Sahulka in the *Zeitschrift für Elektrotechnik*. The lower part of the diagram represents the stationary transforming apparatus, having three pairs of projecting poles, wound with three circuits,

* This cut is reproduced, by the courtesy of *Engineering*, from the description given in that journal of the Central London Railway.

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A A', B B', and C C', to which are brought the three-phase primary currents. The action of these three-phase currents is to produce travelling polarities along the row of poles, and induce E.M.F.'s in the coils wound around the portion of the core above the six pole-faces. This winding, it will be observed, is electrically the precise equivalent of a Gramme ring. In an ordinary Gramme dynamo the ring revolves between two poles. Here, instead, the two polarities travel past the re-entrant winding. Under these circumstances, seeing that the commutator stands still, it is necessary that the brushes should be rotated synchronously in order that they may collect the continuous current. An apparatus essentially upon this principle was patented by Zipernowsky and Deri in 1888, the brushes of this machine being rotated by a synchronously revolving unwound field magnet. How sparking was obviated does not appear. A further development in permutating machines was made by Messrs. Hutin and Leblanc, who turned the difficulty of the revolving brushes by the following device: Upon the shaft of the synchronous motor is fixed the commutator and a series of slip-rings equal in number to the bars of the commutator, so that, though the commutator revolves, each segment may still be in connection with its corresponding point on the stationary re-entrant winding. The brushes may then be fixed as in ordinary machines. In *L'Electricien* of April 21, 1894, a detailed account is given by M. Aliamet of the further ideas of these inventors. It appears that 18 slip-rings are necessary in practice. A further account of an installation at Epinay is given by M. Guilbert in *La Lumière Electrique* of June 16, 1894. The sole advantage of machines of this type seems to be that they can transform and convert the three-phase currents from a high voltage without requiring the interposition of any other transformer. Their disadvantage in requiring many slip-rings is obvious. It is also very doubtful whether under varying conditions of use the sparking would not be excessive. Nevertheless, this type of converting machine is well deserving of the further attention of engineers. Probably there are cases where it is to be preferred to either the motor-dynamo group or the rotatory converter proper. The motor-dynamo can transform the voltage as well as change the species of current. The converter can change the species of current, but only by adopting a fixed ratio of voltages. As it is inexpedient to operate a commutator at voltages over 1,000, the converter cannot be used in conjunction with a high-voltage polyphase transmission except by the addition of a step-down polyphase transformer. It then becomes a question whether it is cheaper (regard being had to efficiency of operation as well as to prime cost) to instal the converter with the step-down transformer, or to substitute a pair of coupled machines as motor-dynamo. Experience shows that, at any rate in cases where the frequency of the supply is already sufficiently low, the former is generally the more economic. But it is quite probable that there are cases where the economic conditions of the problem may point to the permutator as affording a solution preferable to either motor-dynamo or converter.

Discussion.

Before proceeding with the discussion on Prof. Thompson's paper, the **President** said they had received two letters, one from the American Institute of Electrical Engineers and one from the South African Society of Engineers, both letters expressing sympathy with them in the loss of their noted past-president—Dr. John Hopkinson. He also described the changes with regard to the election of associate members and students, and in the financial year, and the election of the Council, etc. The new articles would come into force on Jan. 1, 1899. Every member would receive a copy of these rules in the following week.

The discussion on Prof. S. Thompson's paper on "Rotatory Converters" was then proceeded with.

Mr. Field said that Prof. Thompson had expressed the hope that he would give a few more particulars of the 30-kw. converter he mentioned. Fig. 14 varied slightly from the actual way this machine was connected up, in that the slip rings were joined up to the opposite side of the armature. This made considerable difference, for on the assumption that the commutator and the slip rings were at opposite ends, it would be seen that the short-circuited bars did not lie exactly at 90 deg. to one another. There were 56 slots and 112 bars. The commutator was connected to the end where the pitch was 15 slots, so that the short-circuited bars lay exactly 90deg. apart. The best winding was obtained by choosing a number of conductors, which number was divisible by 16=112, being 7×16. The winding was single re-entrant double winding equivalent to the parallel winding. The connection to the slip rings equally divided the windings into eight parts. These eight parts should not only be precisely similar, but should contain an even number of conductors, so that all slip-ring connections were brought out at the same end. Hence the reason of making the number of conductors some multiple of 16. The number of commutator segments was 56. This was divisible by 4. Thus all the brushes (there being four sets) stood in an exactly similar position relatively to one another and to the segments they were short-circuiting. In this way the E.M.F. acting in all parallel circuits was expended on the continuous and two-phase side equally, so that all internal balancing currents were avoided. The figures given in the table were taken running a converter as a continuous-current motor, not as a three-phase motor. That was evidently a misprint. The field was partly excited and the commutator voltage adjusted till the speed was exactly 1,200 revolutions per minute. Taking the fourth reading they had—

Excitation.	Two-phase volts.	Cont. C. volts.	Amperes.	Ratio.
5	41	62	0	1·51

when running it as a converter transforming from two-phase into continuous, with a continuous-current load of 200 and 410 amperes. The fields of exciting section giving minimum two-phase currents were:

6·3	45	63·5	200		1·418
5·9	44	62	410		1·41

showing that the large increase in the excitation between no load and full load need not be allowed for in calculating the field winding. He had the good fortune to be in the power station one day when a short occurred in the mains. The converter was driving from the two-phase side, and was fairly heavily loaded. In parallel with it was a turbine driven exciter of capacity of 75 amperes and 60 volts, if he remembered rightly. He was interested to see what would happen, and told the machinist to let everything alone. The alternating volts sank, of course, to zero, and he judged the short lasted 15 seconds, after which it probably burnt out or a fuse went somewhere. In the generator the volts rose slightly, and nothing happened. The converter was still in step and delivering its proper share of exciting current. That was very interesting to him, as he had previously had a large amount of trouble in another central station where the excitation was furnished by two exciters directly coupled to 100-h.p. two-phase 5,000-volt motors. In the first days of this station it was not an uncommon thing for a short to occur on the 200 km. of overhead line which left the power station. The result of this was that the motors would fall behind, and if the short lasted more than a second or so, the excitation would die out, and the whole station would shut itself down automatically. He found by experiment that the short-circuit on the 5,000-volt line less than five seconds was sufficient to shut down the whole station. It was, then, very satisfactory to see that this did not occur with the 30-kw. converter if running in parallel with an independently-driven exciter of but one-seventh the capacity. The heating of the poles of that converter was pretty considerable, but he thought it was due mainly to the proportion between width of slot and air-gap. He would like to ask Dr. Thompson how the pole-heating of the converter compared with that of the same machine used as a continuous-current generator. The peaky and variable form of the resultant shown in Fig. 6 would lead one to expect that pole-heating might be pretty considerable. He noticed that the converter shown in Fig. 15 had laminated poles; that in Fig. 12 had solid poles, and it would be very interesting if Dr. Thompson would tell them which of the many machines he exhibited on the screen had laminated poles and which had not. Dr. Thompson exhibited one converter with two completely independent windings for working on a three-wire system; it was interesting to note that two converters working in parallel on the three-phase side could not be joined up to get a three-wire system on the continuous-current side. One way of connecting a single converter on a three-wire circuit would be to interpose between the three slip rings a three-legged choking coil wound on a three-legged magnetic circuit, taking the neutral point of the same as the starting point of the third wire. One could also connect a neutral wire to the neutral of the transformer, where these were used, doing away with an extra choking coil. That corresponded to Dobrowolski's method of connecting a continuous-current machine to a three-wire circuit by employing two slip rings and a choking coil. If the three-wire circuit were very unevenly balanced, a slight variation depending on the frequency of the supply was occasioned by that method of connection. In regard to the variable conversion ratio, that was of considerable importance. At any rate, one often wished to vary the volts in a simple way. In his paper Dr. Thompson had mentioned several ways of doing this. All had their advantages and disadvantages. The auxiliary booster on the same shaft was expensive on account of the large size of the commutator needed. That must carry the full current, and in consequence usually a small standard exciter or continuous-current machine could not be employed, but something quite special must be made. Also the reaction in the converter was no longer balanced, as the extra power necessary for a booster must be supplied. This meant larger armature conductors, heavier field winding, and altogether a larger machine. The type of armature winding in Figs. 9 and 10, with the three auxiliary star arms, should also

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give a variable conversion ratio dependent on the excitation. Dr. Thompson gave that as a method of obtaining an abnormal conversion ratio, not a variable one, but he thought it would do both. There was one important way of making a continuous-current voltage depend on the excitation, and that was by the use of leaky transformers. If the transformer had such magnetic leakage everybody knew that the terminal volts dropped enormously on the load, and especially when supplying a lagging current. If the current led, the volts rose. Now, with the rotary converter they had only to over- or under-excite it in order that the supply current might lag or lead. By altering the field excitation of the converter it was possible to effect a variable ratio of transformation on the transformer end of the converter. With the 30-kw. machines already mentioned the transformers supplied were very good ones, and he could not much over-excite the converter. He had, however, heard of a case in which the transformers were made specially leaky, and a variation of one to two could be obtained by varying the converter field. The method could not pay with large units for any considerable length of time. With regard to the hunting action of rotaries, he was very glad that the point had been raised, for it might assume a very serious character. They must remember that all converters from one form of electrical energy to another were to a certain degree unstable in their distribution of load when kept in parallel. For example, two transformers of different ratings and different makes very seldom divided the load in the right proportion when working in parallel. Now, when converters ran in parallel, what conditions determined the way of distributing the load? Under certain conditions they certainly had a tendency to oscillate, and Dr. Thompson threw out the suggestion that the remedy was to be found in making the field very stiff and bristly. Undoubtedly this helped greatly. Alternator designers nearly all tended to giving a field winding as near the pole-tips as possible to prevent the field being blown out sideways by the reactionary effect of the armature currents—to reduce the air-gap to get stiff and bristly fields. and if a larger air-gap was necessary, to reduce the armature self-induction it was not necessary to put it all at the polar surface. As far back as 1894, Mr. Kapp constructed his standard armatures of segments with ¼in. air-gap between for the express purpose of reducing the self-induction of the winding when working with small clearance between the armature and pole-faces. That might turn out to be an important point in connection with rotaries. He hoped some other speaker would give them more information about converters working in pairs starting from the three-phase side, and the use of series-wound to help or replace shunt-wound motors for this purpose.

Mr. J. Swinburne said he was afraid he could not say he had been into the matter so closely as the last speaker. In direct-current converters they had machines in which current was poured in on one side and came out the other, without having to do any work except drive its own commutators. But alternating machines had to do more than this. As with the direct-current converters, the currents in opposite directions neutralised the reactions, and it was possible to reduce the air-spaces very largely; but in alternating motors it was not advisable owing to the variation in the armature currents. Prof. Thompson put the rotary converters down as known in 1888. He thought that they had been used for some time previous to that date. The hunting or see-sawing action was discovered by Mr. Harrison at Faraday House, who asked his opinion on the matter. He (the speaker) wrote a paper on the subject at the time, giving his views as to the cause of it. When they had two alternators in parallel, one might be doing a little more than its share of work. If this corrected itself instantaneously it would not cause hunting. But while correcting itself it carried the reactions too far; thus throwing a little more work on the other alternator, and causing that to do too much. This again corrected itself, and in that way a see-sawing motion was set up. It should not be very hard to find a remedy for it. With regard to the tables, he found it much easier to work out his own calculations than to prove that other people's were right. Prof. Thompson had altered the word "rotary" to "rotatory." "Dynamotor" was also indefensible as an English word, but as he (the speaker) invented it, he defended it. Rotor and stator would not look well as "rotator" and "statator." As to altering the ratio, he could say nothing more than Mr. Field had said. It was not correct to take an armature uniformly wound all round to find the heated places. The winding should be so proportioned that all parts heated alike. A difficulty then occurred, because in a machine with a small air-space the variation in the size of the holes caused eddies.

Mr. W. B. Esson said that the diagrams which Prof. Thompson had shown were very useful. Rotary converters were first shown at the Frankfürt Exhibition. He well remembered the Schuckert exhibit. The first thing he did on getting back from the exhibition was to try the effect of slip rings on a dynamo. The more tappings put on to the generator, the more energy could be converted by a given machine. In the two phase there were four tappings, in a three-phase machine there were three tappings, and so on. The hunting action required more investigation than it had then had. He should like to ask if the wave form of the converter should not be like that of the generator? When machines were connected in parallel, currents also passed between the machines. Rotary converters were no doubt very good for tramway work, but they would not be suitable for lighting, because of the rise and fall in the voltage making the light unsteady. When a fall in voltage occurred on a tramway it made no great difference to the line, but in lighting it was absolutely necessary to have the voltage constant. He was connected with the fitting up of the first two-phase central station in this country. They converted two-phase into direct current. Very little was known about these converters, but more would be known once the station got to work. He did not think that rotary converters were so good for such high voltages as the two distinct machines. Mr. Field had said that in 1894 Mr. Kapp had designed a converter with an air-gap elsewhere than between the pole and the armature. He quite agreed with this, but he thought that Mr. Kapp did not do that for the purpose named, and in the next machine made the air-gap was omitted.

Mr. H. N. Hobart had sent in a communication, which the Secretary read. He said that Prof. Thompson referred to the tendency to "hunt" in rotary converters, and had suggested that "the cure for these troubles will probably be found in an analogous treatment to that adopted for securing good parallel running in alternators—namely, careful design so as to prevent armature reactions from unduly distorting the magnetic field." From his acquaintance with rotary converters, he should say that the cure for all erratic tendencies of that kind which they might exhibit was to be found in supplying steam-engines for generating plant which had a very uniform angular velocity. That was also a cure for most of the difficulties which ever beset the paralleling of alternating-current dynamos, which Prof. Thompson stated had been practically arranged by more careful designing. With regard to the phenomenon of "hunting," he considered that there was now no necessity for tolerating it. He knew of cases where some difficulties were at first encountered on this score. It came about in the following way. The rotaries were specially designed with laminated pole-faces for the purpose of eliminating eddy currents therein, and with perfect speed conditions that would have been obtainable with solid pole-faces, since with the motor there was a higher eddy-current loss than for the corresponding continuous-current generator owing to the cyclic rise and fall of the alternating-current component of the resultant current in the armature-face conductors as they swept past the pole-faces. But the elimination on that loss deprived the machine of the use of the induced currents in the pole-faces for using to keep the armature rigidly in synchronism, and it departed from synchronism by a sufficient fraction of a minute to induce disturbance of the smooth-running conditions. Consequently, it became necessary to resort to devices to correct the trouble. These devices involved some difficulties as regarded efficiency, the amount of the different loss entailed being entirely dependent upon the closeness of regulation of the engine used. With first-class multiple-crank engines with a liberal flywheel capacity, he should say that the loss in efficiency would rarely exceed 1 per cent., and would generally be less. But unless a fair engine specification was rigidly adhered to, it might often run up to 2 or 3 per cent. He might also mention that triple-concentric cables had been found to induce troublesome unbalancing of the voltage, and with rotary converter installations they should preferably not be employed. Symmetrically arranged, single cables were satisfactory, but instead of employing one three-core cable to transmit the power, it could without difficulty be divided up into two or more component cables, these being joined together in multiple at the ends and carried to the switch terminals as one set. He recalled a case where an engine speed was troublesome and corrective devices had not been applied—where attempts to run two rotaries in parallel often resulted in failure with only one three-core cable used in the service, although that was of ample capacity. The throwing in parallel of another smaller cable promoted the parallel running of the rotaries. The main argument in favour of transforming by means of rotaries, as compared with the motor-generator method, was because of the lower first cost and the higher combined efficiency. A good example of that was the Blackrock sub-station of the Dublin electric tramways, where 30-cycle 200-kw. rotary converters, fed by oil circulation transformers, were used. The combined efficiency obtained was 92 per cent. at full load, and 91 per cent. at half load. Taking the combined cost of rotary and transformers as 100, the cost of the equivalent motor-generator set would have been 110, and its combined efficiency 85 per cent. at full load and 82 per cent. at half load—that is, the total energy wasted in transformation would have been just about double. However, the motor-generator was much more useful than the rotary converter as regarded independent control of the alternating-current phase relations and the continuous-current voltage and output conditions. A range of adjustment of the commutator voltage in the case of the rotary converter was obtainable by virtue of lagging or leading. He did not think that sufficient emphasis had been laid upon the fact set forward by Steinmetz and Kapp, that in six-phase rotaries the alternating and continuous currents in the armature cancelled each other so much more effectually; while as regarded armature heating, the same machine appeared as a continuous-current generator. The corresponding advantage possessed by a six-phase rotary was no less than 95 per cent.—that is, almost twice the output might be taken from it, over line and static transformers, while it remained exactly as for three-phase current. The only difference was that all its secondary terminals were in the sub-station carried from the six secondary terminals of the three transformers to six collector rings on the rotary converter. Hence the only additional copper required was for these short leads. In rotary converters the current was incompletely commutated. On a certain plant he once introduced the low voltage coil of an 80-kw. transformer between the negative 'bus bar and the continuous-current side of the converter. Now, had the current really been uniform, there would have been but a trifling drop from the ohmic resistance of the transformer coil, but there was a very large drop across it. The 16-pole 600-kw. machine, running at 118 revolutions per minute from the Schenectady works, was, he was sure, a four-

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phase rotary and not a three-phase. This showed it to have been in accordance with the general practice.

Mr. W. M. Mordey said that the hunting difficulty pointed out in the paper was especially interesting, as Mr. Field had given to some extent the explanation. The hunting action might be lessened if a short-circuited copper coil were put round the field. He had been induced to mention it in view of what Mr. Field had said about loss in hot pole-pieces, etc. The short-circuit winding should be used with laminated poles, as then the loss was a minimum. He thought that now the subject had been broached a discussion should soon follow on two and three phase working. Now was a good opportunity to go into the question, and as there was a great deal to be said on both sides of the subject, a paper on it would be very interesting. As to variable-rate transformers, it was impossible to make them at all reliable. Prof. Thompson's paper was a very useful exposition of his subject, and he had explained it in a very clear way.

Mr. A. J. Lawson said that Prof. Thompson had spoken of the see-sawing or hunting action in rotary converters. Two years ago he was shown over the Tivoli installation, and motor-generators were used there. Motor-generators had been used exclusively in the Edison station. A regulation of pressure could be obtained with these that was impossible with converters.

Prof. Carus-Wilson, referring to the point about heating, said that the load at which an alternate-current motor would fail and stop depended on the heating of the armature. It was perfectly obvious that it was an entirely different question to the heating of a continuous-current machine. If Mr. Field's rotary converter had been a synchronous motor, and had fallen out of step, he should have been inclined to say that the load was so enormous that C^2R losses were an overload. In connection with the question of the load that would cause a rotary converter to fall out of step, he had heard no one say anything about the moment of inertia of the armature. The moment of inertia of the armature would hold up the machine in spite of the heavy load on the other side. If ever a very heavy load came on in such a case as the Central London Railway, where the line was being worked by such converters—and these things happened, a stop would be serious indeed. The hunting difficulty might be largely met by a similar remedy—*i.e.*, increasing the inertia. His idea was that there was a variation in the strength of the torque or twist which decreased the speed. If a high speed was obtained at a large moment of inertia the difficulty would be got over, or if they had an armature with two uniformly-loaded primary and secondary coils, there would be no torque. It was the current required to give this torque which alone reacted on the magnets. The synchronising or wattless component of the current did not distort the field. Hence the reaction in a rotary converter only depended on the amount of energy required to overcome the frictional losses of the machine. Mr. Esson was wrong in saying that a drop of pressure did not matter with a traction plant. Such a fall in voltage reduced the speed of every car on the line.

Mr. E. Kilburn Scott said that, with regard to tramway working, he did not know that the rotary transformer was necessary. On the Jungfrau, and other Swiss railways, the three-phase system was used directly on tracks with 20 per cent. or 25 per cent. gradient. Mr. C. E. L. Brown had written to the speaker to say that he thought the multiphase system might have been used on the Central London line, and that with anything above 2,000 volts the three-phase should always be used.

Mr. E. Thomas said that, as to the question of hunting, it had been remarked that in one or two places motors had been taken out and converters put in. These motors were evidently single-phase motors, and not multiphase. There seemed to be an idea that the hunting action was impossible to overcome. He had seen four or five converters in parallel; and the difficulties he knew, but were not hard to get rid of. Mr. Hobart had shown them that the difficulty might be got over in three-phase converters by carefully adjusting the machinery. The reactions only occurred when the machines were under- or over- excited. Unless there was a sufficient amount of current in the machine, it would be necessary to employ heavy compound-wound armatures. The load he found might vary considerably without altering the voltage very much. As to the comparison between the two and three phase systems, there was much more to be said in favour of the three-phase than of the two. There was only three-quarters the amount of copper in the three-phase that there was in the two-phase, and consequently less insulation was required. He might say that the street railway system in the States of New York was being reorganised, and would be worked from a large central station with rotary converters in the sub-stations. Four or five large generators of 3,500 kw. capacity would be used in the station, and experiments had been made to show that without any regulating on these machines the voltage would not vary between no load and full load by more than 4 per cent.

Dr. S. P. Thompson, in replying, said he was much obliged to Mr. Thomas for the criticisms he had given. He was not disposed to question Mr. Scott's statement that it would be better to work a central station with the three-phase system. The argument of Steinmetz, as given by Prof. Carus-Wilson, was right as far as it went. If there were no loss the two torques would be equal, and one would balance the other. If there were nothing else to reckon with, that would be all right; but there were armature reactions from moment to moment, and these made the difficulty. Mr. Lawson spoke about the Tivoli installation. These were all single-phase motors, and four sets of machinery were tried before they finally got them to suit. Mr. Mordey's advice was very good. Mr. Hobart's communication was very interesting. He did not wish to dispute his statement that it was necessary to have the design of the machinery better than was often found. He wished he could get Prof. Wilson to use the word "transformer" when applied to a stationary machine only. Mr. Esson mentioned that the first introduction to the rotary converter was at the Frankfürt Exhibition. That was not correct, as there had been one at Finsbury since 1885. The converter was more useful the more connections were made—viz., three-phase better than two-phase, four-phase better than three-phase, six-phase better than four-phase, etc. Mr. Field should be congratulated on the details which he gave in his remarks.

The proceedings closed with the usual votes of thanks.

The next meeting will be held on Dec. 8 when Prof. Oliver Lodge will read a paper on "Improvements in Magnetic Space Telegraphy," and, time permitting, Mr. S. Evershed will read one on "Telegraphy by Magnetic Induction."

METERS AND SYSTEMS OF CHARGING FOR ELECTRIC ENERGY.

BY WILLIAM ARNOT (MEMBER).

The following is the abstract of a paper read on Nov. 22 before the Institution of Engineers and Shipbuilders in Scotland:

To the public generally, the cost and mode of charging for any commodity is the main point. The machinery used in generating and the means adopted for distribution may be costly and complex, and the different systems may occasion many a wrangle and discussion among engineers; yet all these things are as nothing to the public compared with the correctness of the meter and the reasonableness of the charge.

To the engineer, there is no greater source of worry and annoyance than the meter; upon it all the disputes between supply and consumption arise and hang, and by it all have to be settled. It will, therefore, be easily seen that, of all the plant and mechanism required for the proper supply of electric energy, or, in fact, energy from any source, no part is more important than the meter.

The author, after describing the various types of meters now on the market, but which description we have deleted, says: However perfect the meter, both in design and workmanship, and however perfect the theory on which it is constructed, it will be a useless meter if not carefully calibrated before being placed in a consumer's house. The calibration of meters is almost entirely in the hands of the supply companies and local authorities who are undertakers, and I firmly believe they exercise every care to make their tests exhaustive and complete.

The London County Council eight years ago established a laboratory in London for the purpose of calibrating all meters used by companies within their control. Liverpool and Birmingham also had laboratories of their own, while the supply was in the hands of a company. I do not know whether Liverpool has continued its laboratory since taking over the supply from the private company, and I do not know that there is any reason why it should not continue to have its meters calibrated under an inspector appointed by the Board of Trade, as I think such an inspection is provided for in all provisional orders. I do not profess to be a lawyer, but I am of opinion that a consumer could refuse to pay a disputed account that was not rendered from a meter duly certified by an inspector appointed by the Board of Trade, and I do not think that local authorities are exempt from these conditions, though they are the undertakers. Of course, at the first it was impossible to appoint inspectors, as no meters were approved of by the Board of Trade until quite recently. For direct current there are only three meters approved of—the Ferranti and Hookham on Oct. 30, 1896, and the Aron, July 26, 1898. To bear out my contention, I will quote from the provisional orders:

Clause 27.—"The Board of Trade, on the application of any consumer or of the undertakers, may from time to time appoint, and keep appointed, one or more competent and impartial person or persons to be electric inspectors under this order, and from time to time remove any person so appointed. The duties of an electric inspector under this order shall be: (*b*) 'The certifying and examination of meters.'

Clause 40.—"The amount of energy supplied by the undertakers to any ordinary consumer under this order, or the electrical quantity contained in such supply (according to the method by which the undertakers elect to charge) in this order referred to as 'the value of the supply,' shall, except as otherwise agreed between such consumer and the undertakers, be ascertained by means of an appropriate meter duly certified under the provisions of this order."

Clause 41.—"A meter shall be considered to be duly certified under the provisions of this order if it be certified by an electric inspector appointed under this order to be a correct meter, and to be of some construction and pattern, and to have been fixed and to have been connected with the service lines in some manner approved of by the Board of Trade; and every such meter is in this order referred to as a 'certified meter,' provided that where any alteration is made in any certified meter,

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or where any such meter is unfixed or disconnected from the service lines, such meter shall cease to be a certified meter unless and until it be again certified as a certified meter under the provisions of this order."

Clause 42.—"Every electric inspector on being required to do so by the undertakers or by any consumer, and on payment of the prescribed fee by the party so requiring him, shall examine any meter intended for ascertaining the value of the supply, and shall certify the same as a certified meter if he considers it entitled to be so certified."

Such a system of inspection is already carried out in the gas department with gasmeters, and would be an easy solution for all disputes over electric charges. More important to the public than the construction of the meter or its certification is, perhaps, the charge made by the undertakers, and in considering this question of charge many points come up which have to be looked at before the system that will give most general satisfaction, and yet be remunerative to the supply companies of the different districts, can be decided on. It would be an easy matter to fix a price if the supply were taken regularly within a given number of hours each day throughout the year, but these conditions do not anywhere exist; whether it be a demand for light or power, that demand is very variable, depending upon the circumstances without the control of either party. The most favourable conditions we yet know of for the consumption of electric energy is the use for power by large engineering works, or a large tramway system, or a factory using electrolysis as a means of manufacture. These have a fairly consecutive load, but they have their peaks on the curve, though not to the same extent as in lighting. When electricity is used for lighting purposes the load is as variable as can well be conceived. There is not only a very light load every forenoon, but a specially light load for half the year. The maximum load occurs on one day and only continues for a very short time, not more than half an hour, and during the winter months clouds and fogs cause a continual variation on the output. All this has to be met by machinery which for the greater part of the year is standing idle, as is borne out by the fact that the proportion of actual output to the possible is about 10 per cent.; to meet all these varied circumstances a charge has to be made that will be remunerative both to the supplier and the consumer.

Looking at the tabulated costs taken from returns of the different undertakers, it is very difficult to place them on a common basis for comparison, for while one corporation puts all wages and salaries to maintenance, another divides this sum between revenue and capital account, on the ground that part of the time of their employés is occupied in the erection of new work. The amount set aside for depreciation varies very much, and the cost per unit generated is influenced by the number of public lamps erected in the streets. Taking all these points into consideration, one is unable to make a correct comparison between the different supply undertakings. It is, however, very interesting to compare the costs of two such towns as Edinburgh and Glasgow, when we have in Edinburgh such a large number of public lamps:

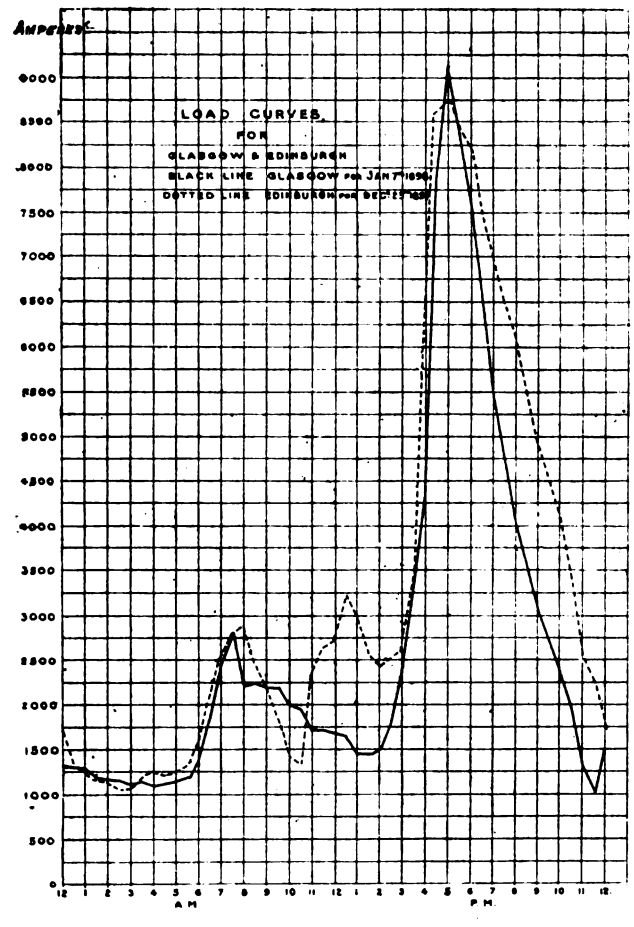
	Glasgow. For year ending May 31, 1898.				Edinburgh. For year ending May, 1898.			
	Units sold.				Units sold.			
Private lighting ..	1,885,902				1,973,123			
Motor power	—				86,654			
Public lamps	228,134				834,660			
Total	2,114,036				2,894,437			
	£	s.	d.	Pence per unit.	£	s.	d.	Pence per unit.
Fuel	3,945	15	0	·447	4,175	16	1	·346
Oil and stores.....	514	13	5	·058	676	16	3	·056
Wages	2,315	4	3	·262	2,181	0	4	·181
Repairs and maintenance	4,318	16	6	·490	2,279	8	11	·190
Rents and taxes..	2,647	19	5	·300	1 866	5	11	·154
Management	3,157	19	7	·359	3,313	11	4	·274
Depreciation	8,945	1	9	1·190				·637
Sinking fund	1,537	0	0	6·35 % on capital	7,686	0	0	2·96 % on capital
Interest on capital	4,814	3	10	·546	5 937	6	7	·492
Surplus	2,174	10	6	—	7,024	1	7	—
	34,371	4	3		35 140	7	0	
Street lamps	1,989	10	7		2,908	17	9	
Total ..... £	36,360	14	10		38,049	4	9	

The fuel in Edinburgh is better than the fuel in Glasgow, as Glasgow only burns gas char. The oil and engine stores are identically the same. Wages, though practically the same, are a little higher in Glasgow per unit, and being a standing charge are quite independent of the amount used. Had Glasgow as many street lamps as Edinburgh the cost per unit would be ·2d., or only ·02d. above Edinburgh. Repairs and maintenance show a greater difference, and I give below the details on the several items:

	Glasgow.			Edinburgh.		
Repairs and maintenance on buildings	£630	2	7	£144	8	11
,, ,, machinery and plant	1,686	17	7	1,476	8	4
,, ,, instruments.....	31	5	6	11	6	1
,, ,, mains	1,295	12	10	577	9	1
,, ,, meters	676	18	0	69	16	6
	£4,318	16	6	£2,279	8	11

Gas is greatly responsible for the greater cost of maintenance of the mains in Glasgow, where the manholes have to be continually examined and ventilated. How meters are maintained in Edinburgh for £69 per annum I do not know. It is not the wage of one man. There is also another side to repairs and maintenance. It is not merely the question of how much per unit have they cost, but what is going to be the life of the plant? In what condition is the plant at the end of the year?

Edinburgh seems to get off very easily in the matter of rates and taxes, for while Glasgow pays £2,256, Edinburgh only contributes £1,535. On management, the same remarks can be made as on wages. With respect to the depreciation and sinking fund, the difference between the two cities' accounts is borne out by the percentage which these bear to the capital invested, for while it is 6·35 per cent. in Glasgow, it is only 2·96 per cent. in Edinburgh. If Glasgow adopted the Edinburgh figures of 2·96, instead of 6·35, there would have been a surplus of £7,771, or £747 more than Edinburgh. Referring to the two load curves, the one for Glasgow, the other for



Edinburgh, I should like to explain that in Glasgow from 11.30 p.m. and throughout the night till 7 a.m. there is a battery charge of 750 amperes. Dec. 23, 1897, seems to have been a dull day in Edinburgh, judging by the peak of the curve at 12.30 p.m., and the larger Edinburgh output from 5.30 p.m. till midnight is partly accounted for by the large number of street lamps. To ascertain the watts delivered to the lamps, the Edinburgh curve must be multiplied by 230 volts, and the Glasgow by 200 volts. It is a commonly accepted statement that as the supply station increases, the cost per unit will very materially decrease. This is true to a limited extent, but depends in a very great degree upon the time factor in the maximum demand. Mr. Wright, in his paper on the cost of electrical supply, says: "The sum total of all stand-by expenses follow, as a rule, the rising line connecting the annual maximum demand on the mains," and I think it will be self-apparent that the cost per unit generated, when the peak is very sharp, will be much higher than when the maximum load continues for some time, the longer the better.

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A unit of electricity, as already stated, consists of three elements—namely, pressure, current, and time. The pressure being a constant, it may be put aside, seeing we are not able to alter it; we have thus left two elements, current and time, which are both variable. Now, current costs something to produce, and time does not, so that if any means can be devised to place a tax on the current and put a premium on the time, so that the units to be paid for will increase in time and be reduced in current, it will greatly tend to diminish the cost per unit in the station. When units have more current than time in them, the consumer should pay more than when the reverse is the case. For example:

If A's units are 50, made up of 100 volts, 250 amps., 2 hours,
and B's ,, 50, ,, ,, 100 ,, 25 ,, 20 ,,

it means that A requires plant to the extent of 40 h.p., and B only 4 h.p., to be erected in the supply station for their use respectively, and the copper in the street has to be 10 times heavier for A than for B. This can easily be shown to be the case from the different conditions under which the supply has to be maintained for lighting. Take the mercantile offices whose requirements extend over only the winter months; they shut not later than five o'clock, and therefore do not use light more than about from ·7 to 1 hour per day at the outside. Large warehouses and many shops, which close at about 7 p.m. and 2 p.m. on Saturdays, will require light for about 1·12 to 2 hours per day; public-houses, 2·5 to 4 hours per day; hotels, about 3 hours per day; clubs, about 5 hours per day; and motor power may be anything up to 8 hours per day. Public lighting, when all the lights are used throughout the night, will reach 10·6 hours per day.

The annual expenditure of a supply station is made up of the following items: (1) interest on capital; (2) sinking fund; (3) depreciation on plant; (4) management; (5) rents, rates, and taxes; (6) wages and salaries; (7) repairs and maintenance; (8) fuel; (9) oil and stores. Of these the first seven items are, to a very large extent, independent of the amount of current generated; whether the peak be a sharp or a flat one makes no difference on these items—only the two latter items are affected by the total amount of the load; and when it is said that these two only cost in a fairly developed and economically worked station not more than ·5d. per unit, the seven items of cost, which are the same for all loads, must be considered the ruling factors in the charge. These costs have been called standing charges. They remain the same, and have all got to be met whether the plant supplies one unit or a thousand, or whether lamps are used for one hour each day or 10 hours per day. If lamps are used for one hour per day, that hour's lighting must pay for all these standing charges, while if used for 10 hours' lighting the charge is the same, the only extra expense being in fuel and stores.

There are therefore two conditions to be met in making the charge—viz., (1) a very varying demand from ·7 to 10 hours per day, and (2) a cost that is independent of the time, and entirely in proportion to the amount demanded. A uniform rate with discounts in no way meets these conditions; in fact, it does quite the reverse, for it is quite possible for a consumer to so increase the number of units he uses, by the addition of lamps, to enable him to benefit by the discount to such an extent that, from being a profitable customer, he becomes a loss to the undertaking. Nor does a uniform rate without the discounts meet the case, as it forces the undertakers to make the long-hour consumer pay for the loss incurred in supplying those who do not use sufficient energy to pay for their proportion of the standing charges. In a very short time—when the mains have been extended beyond their present limits, to such districts as Bridgeton Cross and New City-road—the great bulk of the consumers will be of a class that will require light to eight or nine o'clock at night, and it would be an injustice to them, as well as all small consumers, who are generally long-hour users, to make them pay for the losses incurred in supplying to the great bulk of offices and large establishments in Buchanan-street. The late Dr. Hopkinson was, I believe, the first to see the necessity of making a charge that would recognise these different demands, and the great importance in reducing the charge as the time factor increased. To carry out this principle different systems of charging have been imposed, so that each user requires first to pay his own proportion of the fixed charges.

The amount expended on plant and mains put down for the supply is determined by the requirements of those demanding the supply, and the yearly extensions are to a very great extent governed by the maximum load on the works. Maximum output, or demand, as shown by Mr. Wright and already quoted above, is followed very closely by the stand-by charges. It therefore follows that if a charge can be made on the demand of each consumer that will meet these fixed charges, a small charge can be made per unit metered to pay for fuel and stores. But here it may be said that the maximum demand of each consumer does not necessarily amount to the total number of lamps on his premises, nor does the actual maximum of the town amount to the aggregate maximum of each consumer. These points necessarily raise the questions—On what demand is the first charge to be made? And how is the demand of each consumer to be determined? The actual maximum demand on any supply works never exceeds, and is generally below, 50 per cent. of the quantity required, if every light and appliance attached to the mains are in use at one time. There are some lamps that are only occasionally lighted, and users make their demands at different times. A private house of, say, 100 lights seldom has more than 25 lights burning at one time, while theatres light up after the city shops are closed. On what demand, then, has the charge to be made? There are two ways of considering a consumer's demand—either it is the number of lights installed, or it is the greatest number of lights used at any one time. If the charge is made on the number of lights originally put into a house, then the consumer will only adopt such lights as are only absolutely necessary, leaving them out in basements, back premises, kitchens, passages, and perhaps bedrooms. Preventing the consumer putting lights in places where they would perhaps only be used for a very short time, and which would be a very great convenience to the user, would naturally take away from the supply company a very large source of income. In other words, this system of charging puts a tax upon all lights, and in consequence tends to reduce the number of lights attached to the mains. If the charge, however, is made on the greatest number of lights in use at one time, then there is no restriction on the number installed, and odd lights can be used throughout the day without increasing the demand.

Mr. Wright, of Brighton, was one of the first to recognise the necessity of carrying out in some practical way these principles, and he set himself to devise an instrument that would indicate the actual demand of each consumer. For this purpose he brought out what has been called the demand indicator. The current to be measured passes round a glass bulb at one end of a U-shaped air thermometer, the liquid in which rises in the right-hand limb, is trapped, and passes down into the indicating tube. The readings on the scale alongside the tube are calibrated to give either the amount of current used at any one time or the number of units to be consumed per quarter or half-year, at the initial charge, before any rebate is given.

I will now mention how these two systems of charging on the demand work out, and in so doing will use the figures lately adapted by the Glasgow Corporation as follows: (1) Under the first or demand indicator system the rates are—(*a*) where a quantity not exceeding the maximum demand for 365 hours in the 12 months (being an average of one hour per day) is used, the charge is 6d. per Board of Trade unit; (*b*) all current consumed over the above quantity at 100 volts pressure, 2½d. per Board of Trade unit; (*c*) all current consumed over the above quantity at 200 or 250 volts pressure, 2d. per Board of Trade unit. (2) Under the alternative or fixed charge system, the rates are—(*a*) a fixed charge of 4s. 6d. per annum for each 8-c.p. lamp or its equivalent fixed in consumer's premises (or £7. 4s. per kilowatt), this charge being spread uniformly over the 12 months; and (*b*) an additional charge for all current used as recorded on the meter if taken at 100 volts pressure, 2½d. per Board of Trade unit; (*c*) if taken at 200 or 250 volts pressure, 2d. per Board of Trade unit.

Assuming the supply to be 200 volts in both cases, then under the first method the charges will be 6d. and 2d. per unit; and under the second 4s. 6d. per 8-c.p. lamp and 2d. per unit. One 16-c.p. 60-watt lamp, lit only one hour per day for a year, will consume 21·9 units—practically 22 units—which at 6d., under method 1, will be 11s. per annum, and under method 2, 12s. 8d. per annum, being (4s. 6d. × 2) + 22 units at 2d. All additional hours of burning are charged at 2d. per unit in both methods, so that no matter how long lights may be used each 16-c.p. lamp will cost 1s. 8d. per annum more by the second system under these rates; of course, it is quite possible to make them equal—a charge of 3s. 8d. per 8-c.p. lamp instead of 4s. 6d. would do so. This equality will hold good only when all the lamps are used for at least one hour per day. The great difference, which shows in favour of the charge being made on the actual demand, and not on lamps installed, is when we compare the two systems on lights that are not used for at least one hour per day. If the light is only used for one hour per week, that will mean a little over three units, say three, which at 6d., under the first method, is 1s. 6d., whereas under the second method there is the lamp charge of 9s., and three units at 2d. per unit, in all 9s. 6d. In my own house I have 16 gas-jets, of which not more than eight are alight at one time. If instead of gas I introduced 16-c.p. lamps, on the demand system for one hour of burning throughout the year, the charge would be £4. 7s. 6d., whereas if I have to pay an initial charge of 4s. 6d. per 8-c.p. lamp and 2d. per unit, the cost would be £8. 11s. This naturally means that I should fix lights only in the public rooms. It is not only unfair, but almost impossible to make a charge on the number of lamps installed. After one has completed his installation and finds a lamp would be a great convenience in an odd corner, which would in no way increase his demand on the station, is he to put it up and pay, or put it up and say nothing about it? Does the corporation intend to

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have a continual inspection of the number and candle-power of the lamps, for consumers are continually making additions or deductions in their lights? Apart altogether from the question of changing lamps from a lower to a higher candle-power or *vice versâ*, there is a possibility of a consumer wishing to reduce the number of his lights within the year, and why should he be charged on lamps that have been discontinued?

Other methods have been suggested, and in a few instances tried, such as at Norwich, by Mr. Andrews at Hastings, and by the Ayr Corporation. Mr. Kapp and Mr. R. P. Wilson have also suggested methods by means of a time switch controlled by clockwork, so that all current used for a given time is charged at the initial price. After that the switch goes over and the cheaper meter is used. The latter methods entail a very much larger expenditure in meters, double the number being required, in addition to the clockwork switches. Some have raised the objection to such a mode of charge that it is contrary to the Act of 1882, Clause 20, which says, "The undertakers shall not, in making any agreements for a supply of electricity, show any undue preference to any local authority, company, or person, but, save as aforesaid, they may make such charges for the supply of electricity, as may be agreed upon, not exceeding the limits of price imposed by or in pursuance of the license, order, or special Act authorising them to supply electricity." Now, I hold that this mode of charge, in a very marked degree, does not contravene this clause, but is strictly in accordance with it, which cannot be said for the discount system. It has been held by the gas undertakers that discounts on large consumption gives undue preference, as it permits a lower price for a large warehouse burning short hours than for a small user or motor running long hours. The demand indicator is not hard on small consumers, as it puts the small consumer on the very same platform as the large; all have the same privileges, and all pay their exact proportion of the cost of production. This surely should be the object of all charge, that that which costs most should be paid for at the highest rate, and the less the cost of production the lower the rate. I believe these conditions are, as far as it is possible, met in the demand indicator system.

In dealing with the charges for electricity, I have not made any difference between electric lighting and power, but simply looked at the question generally, and considered that a consumer may use electricity for what purpose he pleases. It may be said, however, and that with a great deal of truth, that the consumer who uses electricity for power and not for lighting is a better customer, and should be supplied at a cheaper rate. From the consumer's point of view this may seem an unanswerable argument, but let it be remembered that all consumers of power do not stop their works at three o'clock in the afternoon, when the peak of the load is coming on the station, hence plant has to be supplied to meet not only the lighting load, but the power load at the same time; and, given a sufficiently low charge after the initial cost has been met, I see no reason why power consumers should not be charged the same as electric light consumers. Say the charge of 6d. is made for the first hour and 1d. afterwards, this would make it for power purposes practically 1½d. a unit. Many towns charge different rates for power than for lighting. For instance, Edinburgh charges 3½d. for lighting and 1½d. for power; Manchester has a sliding scale for lighting from 5d. to 1·69d. according to the hours used, and a 1½d. rate for motor power, provided a certain quantity is used. In this connection an interesting paper was read by Alexander Siemens before the British Association, in which special reference was made to the generation of energy in his own works at Woolwich, where there is about 1,000 h.p., with an annual output of 1,178,286 units, giving a load factor of ·18. According to Mr. Siemens, the cost was 1·287d. per unit, this including interest, depreciation, rent, and taxes, but not the loss in distribution. From this it would appear that a large central station would be able to supply public works at a cheaper rate than they can make it for themselves. I fully believe the time is not far distant when a supply that is now being given at 1½d. will be reduced to something like ¾d. per unit.

THE ELECTRICAL ENGINEERS (ROYAL ENGINEERS) VOLUNTEERS.

We have received a copy of the regimental orders, dated Nov. 29, announcing the following promotions from the rank of sapper:

To be quartermaster-sergeant: E. Rorke.

To be sergeants: H. W. Jessup, J. H. S. Phillips, W. S. Entwistle, W. Bunn, T. Brown, L. Birks, J. F. Lister, A. Charlton, C. H. Warren, J. H. Field, H. F. Bigge, G. A. Poynton, S. B. Marshall.

To be corporals: B. Pontifex, H. H. Bicker Caarten, A. F. Evans, H. Hamilton, F. W. Dalton, E. G. Sheppard, J. Stone, E. E. Wiltshire, E. V. Watson, H. Walker, A. H. J. Graham, T. O. Mullings, W. G. Webb, and R. F. Carpenter.

The orders are signed by Captain D. Brady, R.E., Adjutant E.E.R.E. (Volunteers).

THE PLATINUM INDUSTRY IN RUSSIA.

Mr. W. R. Holloway, the United States Consul-General at St. Petersburg, includes in his report the following details of the platinum industry of Russia: The Urals have been, up to the present, practically the only source from which platinum has been procured for the international market. Its part formed over 95 per cent. in the total production of that precious metal. A small group of platinum mines, concentrated in the Verkhotursk district of the Government of Perm, includes about 70 separate mines, of which only 40 are being worked, and the remaining 30 are either inactive or under investigation. During 1897 the production of platinum amounted to about six tons. There are only seven great platinum enterprises in the Urals, of which five have been purchased by foreigners. When one considers that no new veins of platinum have been discovered during late years, that those now existing will soon be exhausted, and that no other platinum mines have been found in the Urals, one must come to the conclusion that the Russians have let out of their hands an important industry, and the only one which enjoyed a monopoly of the world's supply.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

FRIDAY, DEC. 2.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Sunlight Gold-bearing Reef, Lydenburg, Transvaal," by Charles Benjamin Saner, Stud.Inst.C.E.

MONDAY, DEC. 5.

Royal Institution of Great Britain.—At 5 p.m., general monthly meeting.

Society of Arts.—At 8 p.m., Cantor Lecture by Prof. Vivian B. Lewes on Acetylene. Third of four lectures.

Society of Engineers.—At Royal United Service Institution, "Bacterial Treatment of Sewage," by Mr. G. Thudichum, F.G.S.

TUESDAY, DEC. 6.

Institution of Civil Engineers.—At 8 p.m., discussion on "The Effect of Subsidence due to Coal-Workings upon Bridges and other Structures," by Stanley Robert Kay, Assoc.M.Inst.C.E.: and, if time permits, a paper on "The Ventilation of Tunnels and Buildings," by Francis Fox, M.Inst.C.E.

Rontgen Society.—At 11, Chandos-street, at 8 p.m., a discussion on "Dermatitis in Relation to Röntgen Ray Work," introduced by Mr. Ernest Payne and Dr. Walsh.

WEDNESDAY, DEC. 7.

Institution of Electrical Engineers.—Annual dinner at Hotel Cecil, at 7 p.m.

THURSDAY, DEC. 8.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., "Improvements in Magnetic Space Telegraphy," by Prof. Oliver Lodge, D.Sc., F.R.S.; and, if time permits, "Telegraphy by Magnetic Induction," by Sydney Evershed.

Northern Society of Electrical Engineers.—At Grand Hotel, Manchester, at 8 p.m., "Superheated Steam and its Application on Steam-Engines," by Mr. Paul Schou.

FRIDAY, DEC. 9.

Physical Society.—At Burlington House, at 5 p.m., (1) "Longitudinal Vibrations in Solid and Hollow Cylinders," by C. Chree, Sc.D., LL.D., F.R.S.; (2) "On the Thermal Properties of Normal Pentane," by J. Rose-Innes, M.A., B.Sc., and Sydney Young, D.Sc., F.R.S.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 8 p.m., "British Cable Tramways and their Construction," by Mr. E. A. Heath.

North-East Coast Institution.—Annual dinner at the Westgate Assembly Room, Newcastle-on-Tyne.

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THE
ELECTRICAL ENGINEER.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XXI. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE INSTITUTION.

There seems to be no finality in the changes which take place with regard to the Institution of Electrical Engineers, but though the changes have been somewhat rapid, they have been brought about by the wonderful progress in the science and in the industry which the Institution represents. The internal management of the Institution is a question for the members themselves, and many regulations must necessarily be of the nature of a compromise. The interests to be served are very large and diverse. At some periods one branch of applied electricity predominates above all others in the world, and it has seemed that the Institution sometimes failed to realise this or to provide information which should be, to use a vulgarism, of an up-to-date character. Of late, in the early and exhaustive publication of abstracts, in conjunction with the Physical Society, and in the class of papers read at the Institution, there has been a decided improvement. The new departure should lead to still further improvement. Broadly, the change now introduced is the formation of a new group of members to be called associate members. But we should prefer to call attention to a detail of qualification in one or two classes for transfer to a higher class, which ought to be productive of some valuable papers. We have long contended that each member, of whatever class, should be expected to contribute either to the papers read at the meetings or printed in the *Transactions* something of the nature of a thesis upon a subject interesting to the members. A glance at the qualifications now required will show that the gaining of a senior premium or a premium will qualify an associate member or an associate, if of proper age, to be transferred to a higher class of membership. This qualification should be supported to the fullest extent possible, and to assist associate members and associates in the preparation of such papers a long list of subjects worthy of consideration should be drawn up and distributed. The Institution has followed so much in the wake of the parent Institution of Civil Engineers that it may well copy this particular also. Unfortunately, the reader of a paper too often imagines that it is necessary to lengthen out his paper with a condensed history of the whole subject, when in reality he would be serving his own and everybody else's interests by confining attention to one solitary detail. This brings us to one of the weakest spots in the management of the Institution. The papers are often too long—filled up with matter of no earthly interest at the meeting, wasting time that might be more profitably spent in discussing a detail, and lengthening out the meeting to an inconvenient hour to those who do not keep carriages or live within a short distance of Great George-street. There is no necessity to support verbose twaddle either in the papers or in the discussion, nor is it in the interests of the Institution to get men upon their legs who have nothing new to say, but only speak in order that there may be a semblance of lengthy discussion. The question of the additional class of members has been fully considered by the

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Council, and also by the members. We see no reason to differ from their conclusions, and believe that the change will work greatly for the good of the Institution.

THAT PACIFIC CABLE AGAIN.

The terms between America and Spain with regard to the Philippines have been practically settled, and immediately upon the settlement the question of cable connection has been mooted in America. We on this side the Atlantic, and some of our colonies, have been discussing the Pacific cable for years. It is just possible—nay, we should think it very probable—that a little more procrastination on our part will see another link in the world's cable system laid which is not a link in an all-British route. Canada has agitated this question, some of the Australian colonies are ready to guarantee their share of the cost, but the home Government is the culprit which stops action. As we have pointed out long ago, this cable would serve a double object. In the first place, it would be a link in a cable system for Imperial purposes; in the second place, it would be of use commercially. A collective guarantee from the colonies interested and the home Government of 4 or 5 per cent. on the capital, is all that is absolutely necessary. Let the various authorities give that guarantee and there would be no difficulty about the capital, and the cable would soon be laid. That is one way. The other is for the Governments interested to find the capital in certain proportions and carry out the work, making as good a thing as possible commercially out of the venture, and paying the loss, if any, in the ordinary way in certain predetermined proportions. We doubt, if a cable was actually "in being," whether America would duplicate a Pacific system; but while no cable exists and business may be promoted, the opportunity to take the wind out of our sails exists.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CABLE MORTGAGES.

SIR,—*Re* the interest on cables in long-distance transmission, the only feature in Prof. Forbes's paper that is likely to be considered as important is the suggestion he makes that the capital for the cables should be raised in mortgage debentures, but, as you rightly urge, this suggestion is certainly not new. It was *originally prepared* and supported by an elaborate argument by Mr. B. H. Thwaite in his paper on the "Electrical Transmission of Power from Coal Fields," read before the Manchester Association of Engineers in 1892, and the paper was reproduced in most of the technical journals. The final paragraph in Mr. Thwaite's argument is as follows: "This rate, $3\frac{3}{10}$ per cent., the author proposes, would be a fair rate of interest for the class of security represented by large weights of copper conductors. The author further ventures to suggest that this part of the capital, or the part to cover the cost of trunk transmission lines, should be obtained by the special issue of mortgage debentures at the rate of interest ($3\frac{3}{10}$) stipulated." *Verb. sap.*

Prof. Forbes should be more careful in making suggestions that are already well known and which are certainly not original.—Yours, etc.,

HORACE ALLEN.

REVIEWS.

Lecture Notes on the Theory of Electrical Measurements. By Prof. W. A. ANTHONY. John Wiley and Sons, New York. Chapman and Hall, London.

This little book is just what it professes to be, and can be used either as lecture notes to be expanded by a teacher, or as notes made by the student upon lectures he has heard. We would suggest that all books of this kind be issued interleaved with writing paper, so that teacher or student might jot down anything of importance not contained in the skeleton text. Lecture notes necessarily depend to a large extent upon the syllabus of the course, and these are prepared for the third-year classes at a night school of science. The syllabus seems carefully chosen, and certainly the notes are excellent as aids to memory. One fault cannot be overlooked. Problems for solution are given, some of a character requiring numerical answers, but the answers are not given.

LONG-DISTANCE TRANSMISSION OF ELECTRIC POWER.*

BY PROF. GEORGE FORBES, F.R.S., M.I.C.E.

This subject has been much talked about, but little has been done, and even at this moment there are few people who realise what a vast field there is in this way for investment of capital on a sound commercial basis. Hitherto people have been appalled at the capital required for copper conductors. In the present paper I bring forward nothing new. I use the methods which have been used for shorter distances, and I do not propose to suggest the use of electric pressures which have hitherto been considered unattainable. In all cases it is assumed that the power is generated by a waterfall driving a turbine which rotates a dynamo machine. The electric pressure may be raised by transformers. It is then carried by bare copper conductors to a point perhaps hundreds of miles distant; the pressure may there be lowered. The current is then passed through an electric motor which drives stamps, or mills, or pumps, or hoists, etc. In this paper there is no time to devote to consideration of different systems or kinds of machinery, or of replacing copper by aluminium. It is a plain unvarnished tale of the ordinary methods in use, extended to somewhat greater distances. During the progress of the electric works at Niagara Falls, attention was much given to the economic problems involved in the transmission of electric energy to a distance. But in that case clearly the following financial conclusion ruled the conditions: it is always more profitable to bring the works requiring power to the electric source of power than to transmit the power to a distance provided—and in most schemes this is a large IF—you can find consumers to come to your locality. At Niagara this seemed likely, and, consequently, distance transmission beyond 25 miles was considered undesirable in the first instance. I am here as an advocate of very distant transmission in all cases where it pays, and I know that it will yield a splendid return in many cases that have come under my notice. In all cases it would pay if there were a demand for the power at suitably high rates.

TO GOLD MINERS AND OTHER USERS OF POWER.

Of all industries to which it is applicable, gold-mining is the one which has come mostly to my notice as wanting a continuous supply of power day and night, and often without any economical means of getting it except by electric transmission. In these cases it will often be profitable to the gold miner to pay a high price for his power. The distances which I have had to deal with go up to 250 miles in India, New Zealand, and Egypt, and if the Rhodesia mines show generally such returns as the Geelong and Selukive mines have done, I have shown that the power of the Victoria Falls may be economically transmitted in some cases to 500 miles, and pay well.

Waterfalls will be valuable assets in the future. At present the difficulty of using their power generally lies in the fact that there is no demand for power in the neighbourhood. Some industries, like aluminium and carbide of calcium ones, are ready to go considerably out of their way to plant their works near a source of power. There are not many such industries.

In 1893, I sat on a committee appointed by the Indian Government to see whether the water power incidentally created by the Periyar irrigation works, could be used for making aluminium electrically out of the corundum found in the neighbourhood, and for other purposes. We found that power could be generated very cheaply, but that the corundum

* Paper read before the Society of Arts, Nov. 23, 1898.

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was not suitable, and no other important demands for power were brought to our notice. Years afterwards, I found that the Mysore, Kolar, and other gold mines could easily be reached by the power, and save great cost in coal. Here we have a transmission of 250 miles which will pay well if the mines are likely to continue producing gold as they have done.

Another specially favourable case of gold mines is in New Zealand in the North Island. The Waihi mines already work their mills by electrical and water power, but there is no adequate supply of water in summer. At many of the other mines there are no roads, and power cannot be obtained. In 1896, I was asked to explore the Waikato River, in order to find the best site for developing power to be transmitted to all the gold mines on the Coromandel peninsula near Auckland. I finally settled on the Haka Falls, near the centre of the island, with a transmission line of from 180 to 250 miles, 20,000 h.p. being generated to supply not only all the gold mines but every freezing works and factory on the North Island. I spent six weeks on the survey of sites for the works, and furnished plans which would already be executed except for what I must call the dog-in-the-manger policy of the Government. The site was peculiarly favourable.

To take another case of gold-mining. I was engaged in 1895-6 on a project without water power and a transmission of 300 miles as a maximum. The Coolgardie goldfields are so far from a port that coal is very expensive, and water for the boilers could hardly be obtained. I found that it was actually more economical to generate power by steam-engines at the coast, where coal and water were available, and to transmit power all the distance electrically, rather than to transport coal, which was otherwise a necessity in all cases as well as water in many cases. In this case the miners were prepared to pay as much as £180 per annum for the horse-power.

In 1894, before I had completed the first electric works at Niagara, I was asked by letter from Johannesberg whether it would be possible to transmit power from the Victoria Falls, on the Zambesi, to all the gold mines in Rhodesia, varying from 350 to 500 miles distance. At first I was inclined to throw the letter into the waste-paper basket. No one, up to that date, had, to my knowledge, seriously considered the financial aspects of so distant a transmission of electric power. But the letter required an answer; so I sat down to work out and quote some figures which should show the absurdity of the scheme. I had been supplied with maps and costs of fuel, etc., and in a short time I found, to my astonishment, that if the facts were as stated, the scheme was financially and electrically a sound one. I was assured that at least 10,000 h.p. would be required at the mines, and that from £70 to £100 per annum would readily be paid for the horse-power. Upon this I was asked to go to South Africa to negotiate with Mr. Cecil Rhodes and Dr. Jameson for a concession. They both appreciated the value of the enterprise to the country, and prepared a draft of the concession, which was only awaiting the sanction of the Chartered Company's Board when the Jameson raid and the Matabele rising closed negotiations. Here is a case where, if there be really good gold mines, it will pay handsomely to transmit electric energy a distance of 500 miles, provided the surveys of the falls prove as satisfactory as the photographs do, and provided the fever is not an insurmountable obstacle.

At this stage let me point out to those unacquainted with the difficulty of obtaining power at some gold mines that £100 per annum for each horse-power continuously delivered would readily be paid in many cases. Broadly speaking, the power required for rock-breakers, stamps, etc., may be taken as being such that 1 h.p. mills one ton of ore per day. The value of the gold is, say, £3 or more per ton in a rich mine. I am not speaking of soft conglomerate like the Rand ore, where 1 h.p. mills two or three tons per day, but hard quartz. Now, when I speak of £100 per annum for a horse-power, this, at the rate of one ton a day, means 5s. 5d. per ton of ore for milling expenses. There are plenty of places where they would pay double this. You have now heard of a number of cases where gold-mining can be assisted by long-distance transmission of electric power, for which I have worked out plans and estimates. There are hundreds of other cases about which I could not speak with the same authority.

But while I expect that gold-mining is the principal industry to be benefited, there are many others, the chief requisite being a continuous demand for power day and night. This is met by electro-metallurgical processes, but these can generally be brought to the power. It also includes irrigation, which in some countries wants power day and night, and, to a certain extent, throughout the year. The quantity of water pumped does not need to be perfectly constant, and this enables intermittent demands for lighting, railways, and factories, to be met by slight variations in the pumping. Thus the plant is always fully at work and earning its dividend. In speaking these words, I am naturally thinking of the utilisation of the Nile cataracts, upon which I have been engaged during the years 1897-8. My report on this subject is in the hands of the Egyptian Government, and is their property; but I am not divulging secrets when I tell you that the electric lighting of Cairo could be done cheaper by power generated at the First Cataract than by steam-engines at Cairo. The distance is 400 miles as the crow flies. Do not imgaine that I propose lighting Cairo immediately in this way. The Government has far more important uses for the power, not only in the irrigation of the country as it is, but still more for the perennial irrigation, which will be so much extended when the great reservoir designed by Mr. Willcocks, Sir William Garstin, and Sir Benjamin Baker shall be completed by Mr. John Aird. You may take it as certain that before long the cataracts will be harnessed and forced to assist in developing not only Egypt proper but the Soudan, and specially the Dongola province up to the Fourth Cataract, which, with efficient irrigation, may become the most fertile country in the world. Higher up the Nile I have not travelled or made surveys, but I notice that Sir William Garstin is undertaking a journey to Khartum and the Blue and White Niles to determine the value of the country there. A time will doubtless come when the Murchison and Ripon Falls will also be turned to account. I trust that I have said enough to lead the users of power in certain industries, and specially gold miners, to see that it is well worth their while to look into the relative costs of steam and electro-hydraulic works, even when the transmission is for a distance of many hundreds of miles; and it will be seen that many a gold mine hitherto considered worthless because of the cost of power, will be valuable if there be water power available within a few hundred miles.

I will now speak to the financiers who may think of taking up electric transmission.

To Financial Men.

The financiers in the City of London or elsewhere, who enable the projects of engineers to be carried out, even when they possess no technical knowledge, have a wonderful instinct by which they know the important points to be certain about before supporting a scheme by their money. Erroneous opinions on the engineering points may for a time prevail, but not for long. Many examples of this insight might be given, but let us confine the matter to long-distance electric transmission. I will give you four objections which are always raised:

1. "Has electric power ever been carried to such distances as you speak of? The answer is "No." But electrical practice is advancing by strides. In 1882, at Munich, Marcel Desprez earned great credit for transmitting electric power 35 miles and getting a return of 25 per cent. But, in 1891, 70 per cent. efficiency was obtained between Lauffen and Frankfort, the distance being 108 miles.

2. "Are you sure that no new electric difficulties will arise when you go beyond the 108 miles of transmission which has been accomplished?" The answer is, "We are sure of this from the tests made at Frankfort." [Only one difference between short transmissions and the 108 miles from Lauffen to Frankfort was found to exist, and it had been anticipated by me in preparing the Niagara works. In 1892 I laid it down as essential for the works at Niagara, in order to be prepared for long-distance work and for other reasons, that the frequency of the alternations should be as low as the construction of a good dynamo would warrant. In 1894, the tests at Lauffen-Frankfort were published, showing that without this low frequency no good efficiency could be got from the long-distance power transmission owing to the great self-induction of the line.]

3. The financier again asks, "Are not the losses by leakage on a long line insurmountable?" The answer is, "There is hardly any loss by leakage. There is loss of power used up only in warming the transmission lines." But this loss can be calculated accurately, and in these cases the wasted power costs little enough, and we are glad enough to waste it if it saves copper, which is the great cost.

4. The business man then asks, "Well, but if you allow a great loss of current in transmission, do you not require an enormous quantity of copper to carry the extra current which you have to generate?" The answer is that this is perfectly true if you allow the losses to be too great, but up to a loss of 50 per cent. on the transmission line you are always saving copper by having greater losses on the way. In fact, every engineer who has made a serious study of long-distance transmission will bear me out when I say that the cases in which electric transmission will pay can be clearly differentiated from those which will not pay, and the whole question is principally one of £ s. d. Also, that all engineers will agree as to what is the principal item of expenditure—viz., the cost of copper under the conditions of existing practice. Improvements may reduce this cost, but cannot increase it; hence the financier may be very sure of the data of expense, and if he can be equally well assured of the data of revenue, he has before him everything required for forming a sound judgment. Let us take three cases.

1. Suppose a water power is utilised for distant transmission of 200 miles to a gold mine where transport is difficult and the ore rich. Suppose that the miners are ready to pay £100 per annum for each horse-power delivered continuously to the

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stamps, etc. I am taking what may be looked on by some as an extreme case, but there are many such places in the world. Suppose that it is a goldfield employing only 1,000 h.p. continuously, the gross income is then £100,000 per annum. This is a large sum, and will warrant a very large capital expenditure. Now, if it is a case in which 20,000 volts of electric pressure may be used, less than 900 tons of copper is required, after 50 per cent. has been added for self-induction, giving an inefficiency (inverse of efficiency) of only 1·4. Thus, 1,400 h.p. will have to be generated at the waterfall end of the transmission line for 1,000 h.p. delivered at the other end—the gold mine. The hydraulic and electric machinery are not likely in a favourable case, even with costly transport, to exceed £14,000. The working expenses are small, and clearly the great thing to be considered is the cost of copper. If transport is costly this might amount to £80 per ton of copper laid, or £72,000. Very likely the whole cost would be under £100,000, which, with a maximum possible annual expenditure of £20,000, would produce a revenue of £80,000 per annum, or 90 per cent. I am sure that actual cases exist where this might be done.

2. If the distance were 400 miles, all other things remaining the same, the only serious difference is in the cost of copper, which rises to £288,000; and taking £32,000 for the other expenses, the capital expenditure is £320,000. If the annual expenses were £20,000, which seems impossible, the net income is £80,000, or 25 per cent.

3. Suppose the distance still 400 miles, and all other things remaining the same, but only £50 being paid per annum for the horse-power; here we have still £320,000 of capital expenditure, and a net income of £30,000 for 1,000 h.p. delivered, or 9 per cent.

Of course, it is understood that while cases can occur where these figures apply, each case must be examined on its merits. Looking at the last case quoted, the delivery of 1,000 h.p. at 400 miles, using 20,000 volts (or 200 miles with 10,000 volts), the financier would say 9 per cent. was not good enough for such a venture. I will now show how he may get 40 per cent., using the same machinery, the same copper, and the same annual expenses. This leads me to say a few words to the great copper companies.

To Copper Merchants.

I have now the pleasure to lay before you a simple financial transaction which copper merchants or others would willingly make, and which may avoid the huge capital hitherto required by those who transmit the power, and will increase the dividends on money spent on the transmission. What I propose is to divide the capital account into two parts—ordinary stock which may be looked upon as speculative, and bonds on the copper which would be as sound an investment as could be desired.

Taking the last case mentioned, the capital charges are:

3,600 tons of copper at the extreme value of £75 a ton	£270,000
Putting it in place at £5 a ton	18,000
Hydraulic and electric machinery, etc.	32,000
Total capital required	£320,000

Most of this capital is required for copper which may be taken away if the company fails, and is an absolutely safe security.

The value of the copper is	£270,000
Cost of removal [uncalled capital]	18,000

On the £270,000 a mortgage may be raised, and 4 per cent. ought to cover the chances of a change of market value. Thus we have:

Annual payment on mortgage	£10,800

All we have done is to raise a mortgage on the best possible security. This might be done by the copper companies, who often have too much material in stock not paying interest, or the money could easily be obtained from independent capitalists. Let us now see what difference this has made upon the balance-sheet. The capital charges are:

Putting copper in place	£18,000	
Hydraulic and electric machinery	32,000	
		50,000
Annual gross receipts—1,000 h.p. at £50		50,000
Less annual expenses, £20,000; and mortgage on copper, £10,800		30,800
Annual net receipts		19,200

or almost 40 per cent. By this simple transaction we reduce the total capital required by the transmitters of power from £320,000 to £50,000 for 1,000 h.p. delivered, and we have increased the rate of interest from 9 to 40 per cent., which ought to satisfy most people. This scheme I have laid before the manager of one of our largest copper companies, and he entirely approved of the general lines.

Before leaving this part of the subject, I wish to make it quite clear that none of the figures which I have given up to the present must be taken as applicable to every case that may arise; the cost of developing the power at a waterfall depends so much upon the height of the fall, accessibility, etc., that no kind of an idea can be given of the cost without some data to go upon. The costs used in the above calculation are over the mark for the most favourable cases, and the cost of copper is also too high. Another factor is the size of the works. The larger the scale the smaller is the relative cost of works. All that I have tried to make clear is that if there be a large and continuous demand for the power, and if the value of the mechanical power to the gold miner or others is great, the distance to which it can be transmitted with financial success is not limited to one or two hundred miles.

To Engineers.

Up to the present date financial men have not realised the value of long-distance transmission. Engineers, too, have been so much engaged with electric lighting and traction that few have devoted much time to its study. The last nine years of my life have been devoted almost entirely to electric transmission, and the last four years to very distant transmission. At present there exist no printed tables for facilitating calculations, such as civil engineers possess in other branches of the profession. In the case of electric transmission, every engineer must prepare his own sets of tables and curves to work from. I have been compelled to work these out for myself in various units. In England we use miles, tons, and pounds sterling. In America the units are 1,000ft., the pound avoirdupois, and the dollar. In Egypt the metric system prevails. The flow of water, too, must be taken in cubic feet per minute, gallons per day, metres per second, the Californian "miner's inch," or the New Zealander's unit, which is called a "bead." You will believe, then, that I possess a mass of tables and curves, and these might be worth publishing if the time had arrived, which is not yet perhaps. During these years, however, my methods have gradually become so simplified that I venture to bring to your notice one curve in relation to the one special question of efficiency and cost of transmission lines. It is so simple in its present form through a gradual evolution that I cannot help thinking that it may be of use to others.

(To be continued.)

ELECTRIC TRACTION.*

BY PROF. CHARLES A. CARUS-WILSON, M.A., M.I.E.E.

LECTURE IV.

(Concluded from page 694.)

You see then what a valuable contrivance this would be; it would enable us to get rid of the heat loss entirely, theoretically, and even with the practical limits that we may suppose to exist we could reduce the heat loss very greatly. I may point out in passing that the limit would be determined not by the practical difficulty of constructing a contrivance with an infinite velocity ratio, but by the initial acceleration at which slipping of the driving wheels would take place.

Now, I do not wish to discourage any inventor amongst my audience to-night when I say that we have ready to hand a contrivance that does all that I have been imagining, and even more, as the contrivance that I now speak of acts automatically. I refer to what is known as series winding.

You have already seen that the three quantities, M, v, and d, are so related that whatever change we make by varying any one of them we can effect precisely the same change by varying one of the others. For instance, all that I have just said about varying the value of v applies with equal truth, though with insuperable practical difficulties, to varying the diameter of the driving wheel.

It follows that if we can increase the value of M at the moment of starting, and make it gradually get less as the car speeds up, we can do all that we could do with a variable velocity ratio. Now, series winding does this for us automatically. By winding the magnets in series with the armature so that the whole current passes through both, we can reduce the time during which the starting rheostat is in circuit as much as we please.

Suppose, for instance, that we design our motor so that when 45 amperes are passing through the magnets the induction factor is twice what it is when 15 amperes are passing. We shall get acceleration and current curves as shown you in Fig. 27. The point, g, now marks the moment at which the starting rheostat is all out. The high initial current is thus passing for four seconds instead of for 20, and the corresponding saving in the

* Cantor lectures, delivered before the Society of Arts.

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heat loss is shown by a comparison of the areas of the current curves.

In Fig. 29 I have drawn the new current curve and divided the area so that you can at once see by comparison with Fig. 28 where the saving has been effected. In each case 500ft. has been covered. You see that the saving is almost entirely on

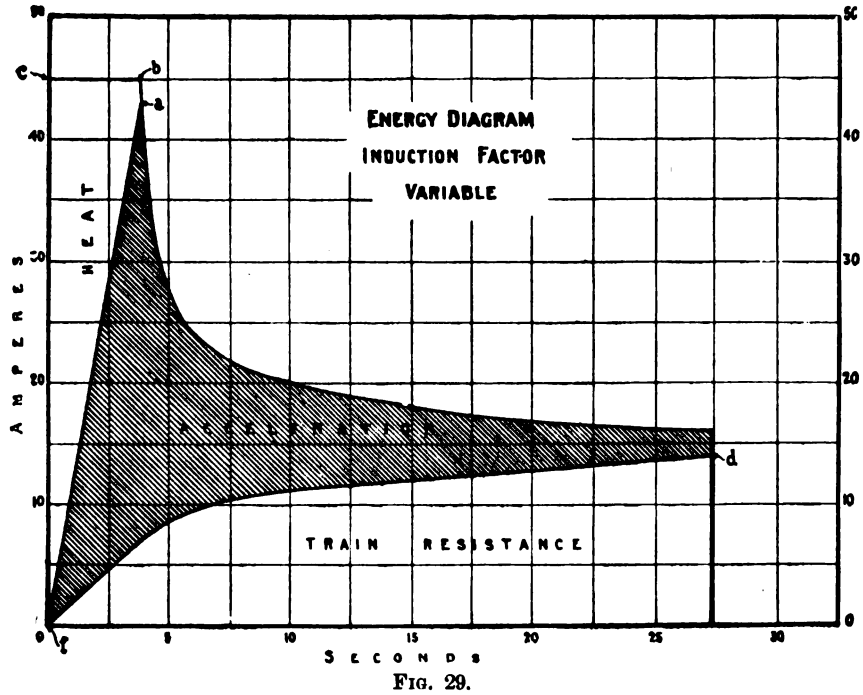

FIG. 29.

the heat loss. The actual values are given in the following table :

	Induction factor.— Constant. Foot-pounds.	Variable. Foot-pounds.
For acceleration	109×10^3	$88{\cdot}7 \times 10^3$
For train resistance.....	109×10^3	$109{\cdot}0 \times 10^3$
For C^2R loss.....	169×10^3	$32\,2 \times 10^3$
Total for half-car.....	387×10^3	$229\,9. \times 10^3$

You see, then, that by making use of the principle of series winding we have been able to reduce the heat loss, and in consequence to carry the car through the required distance in the given time for 40 per cent. less energy than with motors of constant induction factor.

I wish now to direct your attention for a few minutes to the induction curve of the motor that enables us to effect this saving. In Fig. 30, horizontal ordinates represent amperes through the motor, and vertical ordinates represent values of the induction factor. We know that our motor must have M=35·5 for 15 amperes, and M=71 for 45 amperes. These values are shown by the points *b* and *f* in the figure. The point *a* is, of course, a third point on the curve, which has then to pass through the three points thus shown. The point *b* is determined by the final speed that has to be attained, and the point *f* should be taken as high up as possible in order to get as large an initial acceleration as possible.

It should be clear to you from the figure that the point *f* is not the highest possible value of M. This would be obtained by drawing a straight line through *a* and *b* to cut the vertical through *f* in *c*. The value of M thus obtained, M=106, is the greatest possible value consistent with having M=35·5 for 15 amperes. Now what does a straight induction curve mean? It means that the iron in the magnetic circuit is nowhere carried up to the point of saturation; in fact, it means that the only magnetic reluctance in the circuit is that of the air-gap. This involves large cross-sections of iron, and consequently greatly increased weight, the increase being nearly proportional to the valve of M for the maximum current of 45 amperes.

If we used motors with M=106 at 45 amperes we should

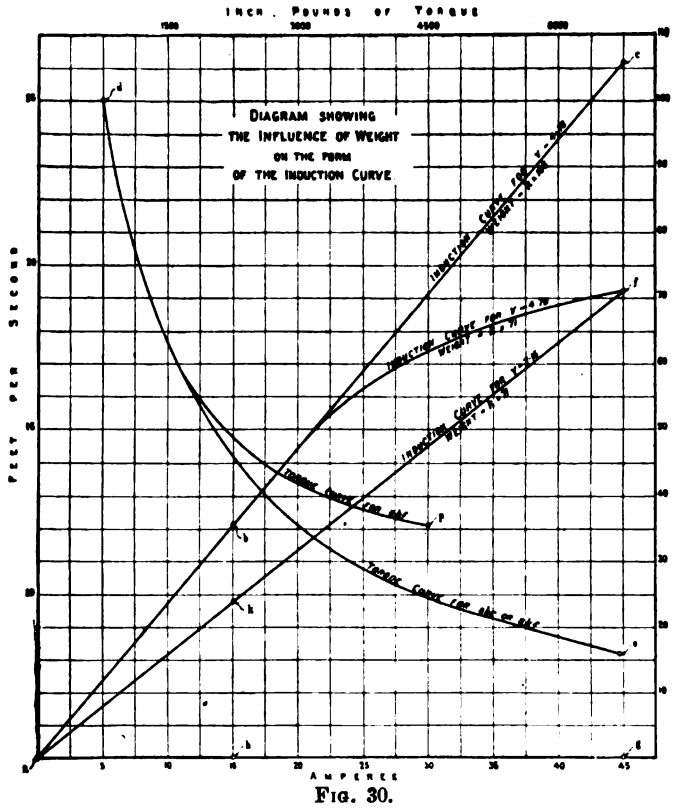

FIG. 30.

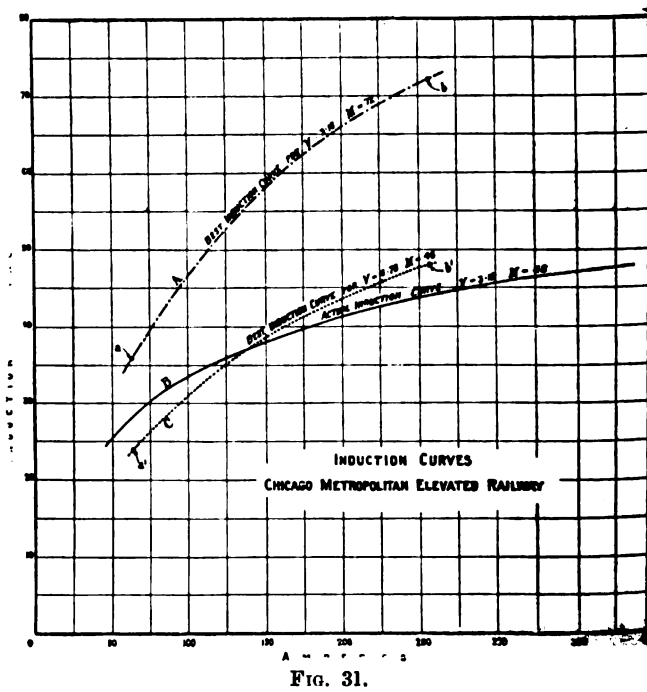

FIG. 31.

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reduce the heat to the lowest possible limit, 13×10^3 foot-pounds, as compared with $32{\cdot}2 \times 10^3$ for M=71. But we should then have an initial acceleration of more than 4·5 feet per second per second, and this would exceed the limit at which the driving wheels slip. We must then choose such a value for M as will give us the greatest possible initial acceleration. For M=71 the acceleration is 3·1 feet per second per second, which we may take to be the highest permissible value. The acceleration curve in Fig. 27 is obtained by a graphic method from the passenger cars. The former weigh 62,000lb. and are 47ft. in length; the latter weigh 46,000lb. when fully loaded. The motorcars are mounted on locomotive trucks, with 33in. driving wheels and a velocity ratio of 3·18. I shall take the case of a train weighing 90 tons, consisting of one motor and three passenger cars. I shall suppose that we have to design motors that shall drive this train through a distance of 2,500ft. of level track in 100 seconds from start to stop. The tension of the line is 500 volts; the drop at full speed is limited to five volts.

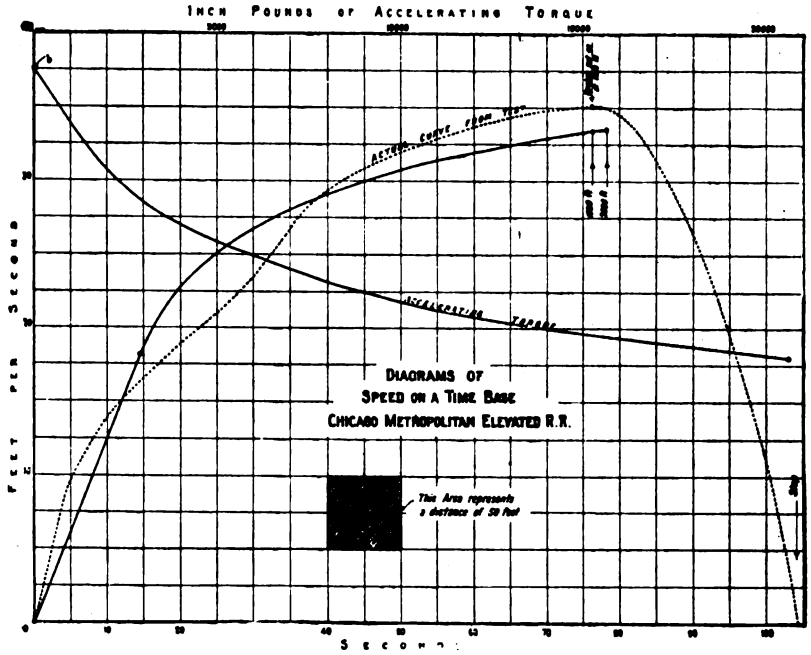

Fig. 32.

curve $a\,b\,f$, in Fig. 30; the curve $d\,e$ is the corresponding curve of torque on a speed base.

You will remember that the value M=35·5 for 15 amperes, was obtained on the assumption that the velocity ratio was to be 4·78. If we take a larger value of v, say 7·15, the value of M at 15 amperes is reduced to 24. This is shown by the point k in Fig. 30. If we draw a straight line through $a\,k$ it will pass through f. We have here then obtained a new induction curve with a different velocity ratio, giving us the same results as curve $a\,b\,c$, but with a motor lighter than the former in the proportion of 4·78 to 7·15. Hence the larger the velocity ratio the lighter the motor. We must then take a value of v as large as is consistent with practical conditions of clearance, etc.

I propose now briefly to apply the principles which we have been discussing to a railway with which you must be more or less familiar—the Chicago Metropolitan Elevated Railroad.

The rolling-stock of this railway consists of motorcars and

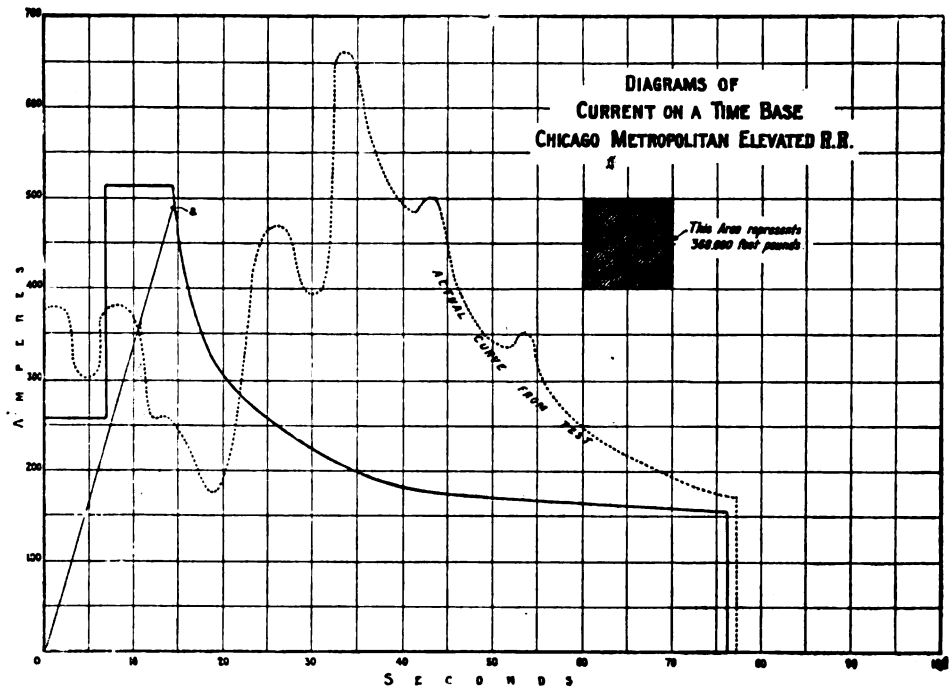

Fig. 33.

The resistance to motion is 614lb. horizontal pull per motor when two motors are used, this resistance including the gear loss.

I shall assume that the train can be brought to rest in 20 seconds in 500ft., leaving 2,000ft. to be covered in 80 seconds. This gives us the final speed, from which we deduce $\frac{M}{d}\,v = 3{\cdot}46$. Now $v = 3{\cdot}18$ and $d = 33$in., so that we get M = 35·9, and the corresponding current at full speed is 63 amperes per motor, and the resistance, to give a drop of five volts, must, therefore, be 0·075 ohms. We have thus found one point on the induction curve, shown at a in Fig. 31.

The accelerating current can be found from equation (2) which I gave you, and is 226 amperes. If we take M at the start twice what it is at full speed, the frictional current at the start will be only 31·5 amperes, so that the total current is 257 amperes, and the initial acceleration 1·27 feet per second per second, a value well within the practical limits of adhesion

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Point *b* in the figure gives M=72 for 257 amperes. The curve *a b* then is the required induction curve.

In Fig. 32 you see the curve of acceleration obtained by a graphic method from the induction curve in Fig. 31—that is to say, if the train was fitted with motors having this induction curve, it would speed up in the way indicated by this acceleration curve. You see that the area of the curve represents almost exactly 2,000ft. at 80 seconds. The dotted line in this figure gives the acceleration curve as actually obtained in practice, from an experiment with a train of equal weight.

From the acceleration curves you might suppose that the performance of the motors actually used was very much like that of those we have been designing. If, however, you look at Fig. 31, you will there see the induction curves of the motors actually used, given in the curve B. You see that this curve is quite different from A, the calculated induction curve. You may reasonably ask how it is that two motors with such different induction curves give nearly identical results? The answer is to be found in a comparison of the respective current curves. These are given in Fig. 33: the full line is the calculated curve, and the dotted line that obtained by experiment, corresponding to the experimental acceleration curve of Fig. 32. Series-parallel control is used in both cases.

You can see at a glance that the area of the actual curve is much greater than the calculated curve, the values expressed in foot-pounds being 963×10^4 respectively. This great difference is explained by the fact that the values of M for large currents in the actual motors are not much more than half of those calculated; hence in order to get the initial acceleration necessary to carry the train through the given distance in the given time, far greater currents have to be used. Thus, on the series step the current per motor is 380 instead of 257 amperes, while the current from the line on the parallel step is 660 instead of 515 amperes. The expenditure of energy in the two cases is 85 and 60 watt-hours per ton-mile.

By reducing the vertical ordinates of curve A in Fig. 31, in the proportion of 3·18 to 4·78, we obtain a third curve, C, which is the induction curve for motors, which will give the same results as curve A, but with $v=4{\cdot}78$ instead of 3·18. This new curve, C, very nearly coincides with curve B—that is to say, the motors in actual use would work with nearly the same economy as those calculated, if the velocity ratio were increased from 3·18 to 4·78. You see then how important it is to determine the right velocity ratio. In fact, we come back to the point on which I insisted at the outset, that the problem before us in designing for rapid acceleration involves a careful consideration of the proper proportions of the whole equipment, and that the economy of running may be increased greatly by giving attention to the principles underlying the action of the motors in these peculiar circumstances.

I hope you will not imagine that I have referred to American practice simply in order to criticise. The Americans have made immense strides in electric railway design during the last few years, far in advance of anything that has been done in this country. We should make it our aim to do even better than they have done. To this end we should carefully examine their designs and get all the benefit we can from their experience, learning as much from their failures as from their successes.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

120. Please give reliable figures as to steam and coal consumption in a parallel-flow steam-turbine in pounds per kilowatt at the terminals.—H. B. S.

121. What is meant by the capacity and resonance effects when speaking of a concentric cable?—F. A.

ANSWERS.

Question No. 114.—In low-pressure three-wire networks, where copper strip supported on porcelain insulators and run in culverts is employed, the "earth leakage" is invariably in excess on the negative side of the system. How is this?

Best Answer to No. 114 *(awarded* 10*s.)*.—It is due to the formation of numerous white incrustations on the negative main, which considerably diminish its insulation resistance. This growth has been fully investigated and reported on by a committee of members of the Royal Society and the Institution of Electrical Engineers, which was appointed to investigate into the cause of an explosion in the mains of the St. Pancras Vestry early in 1895. An analysis made by Prof. Thorpe of a large number of specimens of this white incrustation taken from the St. Pancras mains shows that its composition is as follows:

Potassium carbonate	52·77
Sodium carbonate	34·40
Caustic soda	7·69
Caustic potash	4·88
	99·74

In addition there were traces of alumina, silica, and lime. This incrustation is produced by the electrolytic decomposition of alkaline salts, chiefly derived from the soil, and conveyed by moisture along the porcelain insulators to the negative conductor. The committee recommended that the bearers formerly used by the St. Pancras Vestry should be replaced by other devices through which moisture was prevented from travelling, and a pattern of insulator adopted which would interpose a larger insulating surface between the conductors and the bearer. They also recommended that means be adopted to secure continual inspection of the culverts, so as to detect and remove large growths of the incrustation. Electrolysis also affects the positive copper strip. In this case the current flows from the copper to the earth, and hence the copper is corroded away, and if the leakage is large, green salts (verdigris mainly) appear on the surface. If the culverts are damp, therefore, we must expect the insulation resistance of the conductors to diminish, and also that the negative should have much the larger metallic incrustations on its surface where it touches the porcelain insulators, as it is receiving continually fresh deposits. The negative conductor has therefore the smallest insulation resistance, and therefore it will have the largest earth current.—J. C. R.

Answer to No. 114 *(awarded* 5*s.)*.—This effect is due to what is known as electric osmosis, and always occurs with bare conductors laid in conduits. The cause is this: moisture constantly creeps from the sides of the conduit over the porcelain insulators to the negative conductor, always creeping away from the positive conductor, leaving it dry and of high insulation resistance. An experiment clearly showing this has been made in the Siemens Laboratory, King's College (see "Electrical Traction," by E. Wilson). A porcelain insulator, the same as used for electric lighting, etc., having slots in the top for the reception of strip conductors, was placed in a shallow vessel, and water poured in till it just touched the bottom of the insulators. Two copper strips were then laid in the grooves and connected to the poles of a 56-cell battery, with an arrangement for reversing the current when required. The results are given in these figures:

Time	10.55	...	12.10	...	1.0
Positive leakage current	...	51	...	14	...	14
Negative „ „	...	40	...	75	...	74

The unit of current may be anything, the above being only to show their relative magnitude.—X.

Answer to No. 114 *(awarded* 5*s.)*.—This effect is primarily due to the electrolytic action of the current. At all times, and more especially in damp weather, the porcelain insulators become covered with a thin film of moisture, which acts as a conductor or medium for forming leakage, not only to earth, but from pole to pole—*i.e.*, positive to negative. The resistance of such a path is comparatively high, and so a short-circuit between the outers (positive and negative) is not usually established. But there is a sufficiently large current from the positive to the negative, then from the negative to earth, and thence back to the positive, to electrolyse the insulators, and more particularly the glazing material on them. This material is electrolysed into its "salts," and as the negative conductor becomes the "kathode" electrode, the salts are carried along by the current and deposited on the conductor just where the

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insulator touches or nearly touches the bare strip. These salts are naturally conductors of somewhat high resistance, but they retain moisture, which increases their powers of conductance. Thus the leakage goes on, the more the moisture and the worse it becomes. The only way of obviating it is to keep the culverts as dry as possible—that is, either by blowing dry air through them by means of a fan or simply by taking off the covers of adjacent surface boxes and letting fresh dry air in. There is comparatively little leakage on the positive conductor, simply because it is the "anode" of the electrolytic circuit, and salts are not deposited upon it. The neutral conductor is not much affected, because it is sometimes negative to the positive and at other times positive to the negative. If a deposit were formed in the first case, it would be dissolved in the second.—H. B. S.

Question No. 115.—How do you find the loss of steam pressure in a steam-pipe when you know the velocity of the steam in the pipe?

Best Answer to No. 115 (*awarded* 10*s.*).—To obtain the loss of pressure in a length of steam-pipe where the velocity of the steam is known, it is also necessary to obtain some other details of the arrangement, such as the diameter and length of the pipe and its working pressure; then, provided there is a straight run of pipe with a fairly smooth interior, the loss can be found from the formula

$$P = \frac{V^2}{(9{,}000)^2} \times \frac{L}{d} D;$$

where P = loss of pressure in pounds per square inch.;
V = velocity of the steam in feet per minute;
L = length of pipe in feet;
D = density of the steam in pounds per cubic foot at the specific pressure in question; and
d = diameter of pipe in inches.

As an example of how this works out suppose the loss of pressure is required in 100ft. of 6in. main working at 150lb. per square inch,

then $$P = \frac{(6{,}000)^2}{(9{,}000)^2} \times \frac{100 \times \cdot 3377}{6}.$$

A velocity of 6,000ft. per minute has been taken in this instance as being a fair example of what occurs in practice; the weight, D, of a cubic foot of steam at 150lb. per square inch absolute = ·3377.

$$\therefore P = \frac{6^2}{9^2} \times \frac{33{\cdot}77}{6}$$

$$= 2{\cdot}48\text{lb. per square inch.}$$

Now this is the loss of pressure that would occur in a straight length of pipes without valves or bends. If there are any of these, then there will be a further loss. The equivalent length of pipe to an ordinary globe valve is found by the formula—

$$L = 8{\cdot}66 \frac{d}{1 + \frac{3{\cdot}6}{d}}$$

$$\therefore L = 8{\cdot}66 \times \frac{6}{1 + \frac{3{\cdot}6}{6}}$$

$$= 32{\cdot}49\text{ft.},$$

and the equivalent length for a bend or elbow is

$$L = 5{\cdot}76 \frac{d}{1 + \frac{3{\cdot}6}{d}}$$

$$\therefore L = 5{\cdot}76 \times \frac{6}{1 + \frac{3{\cdot}6}{6}}$$

$$= 21{\cdot}6\text{ft.}$$

so that presuming that there is one valve and one bend in each 100ft. of piping, then the loss of pressure will be equivalent to that in 100ft. + 32·49ft. + 21·6ft. = 154ft.; or at the velocity and pressure quoted above, about 3·85lb. per square inch.

There are so many factors entering into the laws of flow of steam in pipes that it is somewhat difficult to arrive at the exact loss which will occur in any system of pipe work. There is a still further loss due to radiation, which increases with the size of pipe and the working pressure, but since no details are given as to the diameter of pipe, etc., it is evident that the loss by friction only is required, and therefore the above formula gives the desired results.—F. S. B.

Answer to No. 115 (*awarded* 5*s.*).—If we make the assumption, known to be true for fluids, that in any pipe the loss of head in a length equal to 33 diameters equals the head theoretically necessary to produce this velocity, then we can prove mathematically the following formula:

$$p = D \left(\frac{v}{9{,}170}\right)^2 \frac{L}{d};^*$$

where p = the loss of pressure in pounds per square inch;
D = the density of steam in pounds per cubic foot;
v = the velocity of steam in the pipe in feet per minute;
d = the diameter of the pipe in inches.

Suppose, for example, that the pressure of steam in the boiler was 150lb. per square inch (absolute), then from tables we find that the temperature of the steam would be 358·3deg. F., and hence from the tables we find that the density of steam at this temperature is 0·3377lb. per cubic foot. Suppose, also, that the pipe is straight, 50ft. long, 6in. in diameter, and that the velocity of the steam in it is 2,000ft. per minute,

then $$p = 0{\cdot}3377 \left(\frac{2{,}000}{9{,}170}\right)^2 \frac{50}{6}$$

$$= 0\ 1139.$$

If the velocity were 9,170ft. per minute, the loss of pressure would only be 2·814lb. Rankine gives 6,000ft. as the velocity which should not be exceeded, but makes no mention of the diameter of the pipe. In the above pipe the loss of pressure at the above velocity would be about 1lb. per square inch. For small velocities it will be seen from the formula that the loss of pressure is inappreciable.

In practice we can take into account elbows, globe valves, or openings in the steam-pipe by adding on certain amounts to L in the formula. The amounts to be added on are found in books on hydraulics. For example, in a 6in. pipe you would add on 21·6ft. to L for each elbow, and 32·5ft. for each globe valve.—J. C. R.

PROVISIONAL ORDERS.

Advertisements have been issued *re* provisional orders by the following corporations, councils, companies, etc.:

Aldershot and Farnborough Light Railway.
Ashford—electric lighting.
Audenshaw—tramways.
Aylesbury—electric lighting.
Baker-street and Waterloo Railway—new railways, extension of time, etc.
Barking—tramways.
Barmouth—electric lighting.
Barnstaple—electric supply.
Belfast—tramways.
Bethnal Green—electric lighting.
Bexhill and St. Leonards—tramways.
Bexley—electric lighting.
Birkenhead—tramways.
Birmingham—acquisition of the electric lighting undertaking.
Blackheath and Greenwich—electric lighting extension.
Blackpool—tramways.
Bognor—electric lighting.
Bootle—electric supply, baths, etc.
Bournemouth—electric lighting.
Bradford—new tramways in the city of Bradford and urban districts of Thornton, North Bierley, Calverley, Farsley, and Pudsey, to be worked by animal, mechanical, and electrical power, power to supply electric energy, run over tramways of Corporation leased to Bradford Tramways and Omnibus Company, and Bradford and Shelf Tramways Company, to supply electric fittings.
Brentford—electric lighting.
Broadstairs, Westgate, and Birchington—electric lighting.
Brompton and Piccadilly-circus Railway—extensions.

* "Electrical Engineering Formula," Geipel and Kilgour, pp. 47, 513, 514.

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Camborne—electric supply.
Carshalton—electric supply.
Castleford—electric lighting.
Cawood, Wiston, and Selby Light Railway.
Central Electric Supply Company, Limited—power works in Marylebone.
Charing Cross, Euston, and Hampstead Railway—new railway.
Cheltenham—electric lighting.
Cheriton—electric lighting.
Christchurch, Pokesdown—electric lighting.
City and Brixton Railway—further powers.
City of London—electric lighting.
Cobham Gas Company—electric supply.
Colchester Company—tramway.
County and London (South-East)—electric lighting.
County of London and Brush Provincial Electric Light Company—extensions of district.
Cromer—electricity supply.
Crowborough Gas Company—electric lighting.
Darfield—electric lighting.
Darwen—tramways.
Derby—tramways.
Devonport—tramways.
Doncaster—light railway.
Drake and Gorham Electric Power and Traction Company—light railway from Hounslow Barracks Station through Whitton into Twickenham to Richmond Bridge, and up to Fifth Cross-road.
Drake and Gorham Electric Power and Traction Company—light railways in and near Gorleston, Kessingland, and Lowestoft.
Dukinfield—electric lighting.
Dundee—tramways.
Durham—electric lighting.
East Barnet—electric lighting.
Eastbourne Corporation—electric supply.
East Retford—electric supply.
Eccles—tramways.
Edinburgh Corporation—increased access to and accommodation at central electric lighting station, construction of tramways, telephones and telephonic licenses, extension of time for acquisition of lands under the Edinburgh Improvement and Tramways Act, 1896.
Electric Traction Company—to construct light railways or tramways in Dewsbury, Batley, and adjacent towns.
Erith—electric lighting.
Essington and Ashmore Light Railway.
Exeter—tramways.
Failsworth—electric supply.
Farnborough—electric lighting.
Fenton—electric lighting.
Finchley—electric lighting.
Finchley—light railway.
Gateshead—electric lighting.
Gateshead—tramways.
Glossop—electric lighting.
Gorton—electric supply.
Gosforth and Ponteland Light Railway.
Gravesend, Rotherville, and Northfleet—tramways.
Grays Thurrock—electric lighting.
Great Grimsby—street tramways.
Great Northern and Strand Railway—electric railway.
Great Yarmouth—tramways.
Halesowen—electric lighting.
Handsworth—electric supply.
Haslemere and District—electric supply.
Haslingden—electric lighting.
Hastings, Bexhill, and District Eelectric Light Railway.
Heywood—electric supply.
Horsham—electric lighting.
Hounslow and Twickenham Light Railway.
Hythe, Sandgate, and Cheriton—electric lighting.
Ilkeston—electric supply and tramways.
Ipswich Tramways Company—construction of additional tramways, use of electrical power on proposed new and existing tramways, sale of undertaking to Drake and Gorham Electric Power and Traction Company.
Isle of Thanet Light Railways (Electric) Company—for powers to produce and supply electricity for motive power and all public and private purposes at Broadstairs and St. Peters, the whole of the contributory place of Westgate-on-Sea, in the rural district of the Isle of Thanet, and the whole of the contributory place of Birchington-on-Sea, in the rural district of the Isle of Thanet, in the county of Kent.
Keighley Corporation—electric supply.
Kelvinside Electricity Company—to produce and supply electricity for public and private purposes within the district in the county of Lanark known as the burgh of Partick.
Kensington and Knightsbridge Electric Lighting—extension to Hammersmith, etc.
Lancashire Electric Power Company—electric supply in Lancaster and Chester.
Lea Bridge District Company—telephones and telegraphs.
Leeds—tramways.
Leicestershire and Warwickshire Electric Supply Company—for power to construct works and to produce and supply electrical energy within part of the counties of Leicester, Warwick, and Derby.
Lewisham—electric lighting.
Liverpool Overhead Railway—tramways.
London County and Brush Company—Battersea and Fulham, Stoke Newington, Hackney, Bethnal Green, Poplar, and Whitechapel.
London United Tramways—tramway to Hampton Court, passing through Isleworth, Twickenham, and Hampton Wick.
Loughborough—electric supply
Lymington—electric lighting.
Maerdy—electric lighting.
Manchester—electric lighting and tramways.
Mansfield—electric lighting.
Matlock—tramways.
Merthyr Tydfil—electric lighting.
Metropolitan Electric Supply Company—electric tramways and lighting.
Mexborough—electric lighting.
Midland Power Distribution and Lighting.
Mirfield—electric lighting.
Moss Side—tramways.
National Telephone Company (two Bills)—telephones, etc.
Nelson, Colne, and Trawdent Light Railway.
Newcastle-upon-Tyne—tramways.
Newcastle-under-Lyme—electric supply.
Newport—electric lighting.
Newton Abbot—electric lighting.
North Wales Narrow-Gauge Railway—Beddgelert extension.
Nottingham—tramways.
Notting Hill Electric Lighting Company—extension to Hammersmith, etc.
Nutley, Crowborough, and Groombridge Light Railway.
Oystermouth—railway or tramway.
Penzance—electric lighting.
Penzance, Newlyn, and West Cornwall Light Railway.
Power and Traction Company—electric lighting of Farnborough.
Rawtenstall—electric light.
Reading—tramways.
Rhyl and Prestatyn—light railway.
Rhyl—electric lighting.
Royal Leamington Spa—electric light and power.
Rushden and Higham Ferrers District Gas Company—electric lighting powers.
Ryde—electric supply.
St. Marylebone—electric lighting.
Salford—tramways.
Sandown and Shanklin—electric lighting.
Shipley—electric lighting.
Shirebrook and District Gas Company—electric lighting.
Slough and Datchet—electric lighting.
Smithfield Markets Electric Supply Company—City and Holborn.
South Lancashire and Cheshire Electricity Company—for power to construct works and to produce and supply electrical energy within part of the counties of Lancaster and Chester.
Southport Corporation—tramways.
Southport and Birkdale—street tramways.
Southport and Lytham—tramways.
South Staffordshire—light railway.
South Staffordshire Tramways—electric supply.
Stockport—electric supply and tramways.
Stourbridge and Lye and Wollescote—for powers to supply the electric light in the districts controlled by the Councils; the same urban districts are included also in the application which the Midland Electric Corporation for Power Distribution are making for a provisional order for the extension of the area of supply already authorised.
Stretford (2)—gas and tramways.
Sunderland—tramways.
Swinton and Pendlebury—tramways and electric lighting.
Teignmouth—electric lighting.
Telegraph Act, 1892—extension.
Trent Valley—light railway.
Twickenham and Teddington Electric Supply Company—electric lighting.
Wallasey—tramways and improvements.
Walton and Weybridge Electric Works Company—electric supply.
Wath-upon-Dearne—electric lighting.
Wednesbury—electric supply.
West Kent Electric Supply Company—electric supply.
Weston-super-Mare Tramways Company—tramways.
Whitehaven—electric lighting extension.
Whittington—tramways.
Winsford—electric lighting.
Wolverhampton—tramways.
Worksop—electric lighting.
Wrexham Tramways—tramways.

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ELECTRIC TRACTION IN GLASGOW.

REPORT BY MR. J. YOUNG.

The following is the full text of Mr. Young's report to the Glasgow Tramways Committee dated Nov. 16:

Two years ago—in 1896—deputations from the Tramways Committee reported strongly in favour of electric traction, and to-day it is further ahead of its rivals than ever. At that time the system of distributing the current by means of a slotted conduit in the centre of the track was only being experimented with. Mechanically it seemed successful, but considerable doubt existed as to the commercial success of a system so costly to construct. On the other hand, the overhead or trolley system had for several years been abundantly proved a commercial success, and to have completely revolutionised tramway travelling wherever it had been adopted. Your deputations, therefore, felt that the only choice left them was to recommend the Corporation either to give a demonstration of the overhead system on one of the tramway routes, or simply to wait further developments. The former was the recommendation which was subsequently given effect to, and the overhead construction on the Springburn route, especially in West Nile-street, where rosettes are used instead of side poles, shows the system practically at its best, and I do not think that any slight improvement it may admit of would alter anyone's opinion of the system generally.

It is only within the last fortnight that the horse cars have been entirely displaced by electric cars on the Springburn route, and the power-station plant has not yet been completed so as to be taken off the hands of the contractors. Our figures for operating can, therefore, scarcely be said to have settled down to normal. The results, both as regards efficiency and economy, are, however, very satisfactory. For the week ending Saturday last, Nov. 12, the total operating expenses for the electric route were, as near as may be, 6½d. per car mile, while the receipts amounted to 1s. 4½d. per car mile. I do not wish to attach too much importance to the increased traffic, although there can be no doubt electric traction does very appreciably increase the revenue. Apart from this consideration, important as it is, financial success is assured by the fact that, during the first full week of operating our small electric installation, working only at half its power, we can show a saving on working expenses, as compared with horse traction, of 2d. per car mile.

The position we find ourselves in at present is this. We have with difficulty kept pace hitherto with the unprecedented increase in our tramway traffic, and still we find ourselves pressed to give travelling facilities to meet this increasing demand upon us. It would be unfortunate at this time of day to propose to build more stables or horse cars. The only little present relief we can otherwise have until a general scheme for electric traction has been adopted is to electrically equip the route in continuation of High-street from Glasgow Cross to Govanhill, and across Coplaw-street to Coplawhill car works. An electrical connection between the car works and the power station at Springburn is absolutely necessary at any rate. It is calculated that the engines and dynamos now in the power station can operate this extension, and, of course, better results will be shown when full advantage is taken of the power plant. Some extra boiler power will be required.

The desirability of this extension is very apparent, but the question which, in view of the latest developments, has just arisen is, should this extension be on the overhead or underground system, or, rather, should we have a demonstration of the conduit system before finally discussing a complete scheme of electric traction for the city?

Perhaps one of the most important communications upon electric traction which has yet been made public came into our hands a few days ago. It is the "Comparative Costs and Profits of Cable, Electric Conduit, and Horse Tramway Operation in New York City." This communication is published in this month's issue of the *Street Railway Journal* (New York), and for the information of members I would ask you, with the sanction of the editor, to have it reprinted in the minutes. The figures contained in this article, as supplied to the editor by Mr. H. H. Vreeland president of the Metropolitan Street Railway Company of New York City, seem to confirm the commercial success of the conduit system in that city of great traffic, and its great superiority to cable and horse traction.

The report states that for the year ending June 30, 1898, the operating expenses of the cable lines were 16·42 cents (8·21d.) per car mile, of the horse lines 17·87 cents (8·93d.), and of the electric conduit lines 10·23 cents (5·11d.): while for the three months ending Sept. 30, 1898, which is more favourable to the electric conduit system on account of its operation being more settled, the cable lines cost 17·55 cents (8·77d.), the horse lines 17·89 (8·94d.), and the electric lines 10·06 (5·03d.). For comparison, I may interject here that last year it cost us in Glasgow 8·3d. to operate with horses. Upon examination of the detailed figures, it is evident that some little addition will soon fall to be made to the cost of operating the conduit on account of increased maintenance of permanent way and equipment when these have been longer subjected to tear and wear.

Another very remarkable statement in the report is that "during the 12 months' period the cable lines operated at 47·7 per cent. of their passenger receipts, the electric lines at 37·9 per cent., the horse lines at 65·3 per cent., and the entire system at 53·3 per cent. During the three months' period the cable operated at 52·7 per cent. of their passenger receipts, the electric lines at 38·6 per cent., the horse lines at 62·1 per cent., and the entire system at 50·9 per cent." This very low percentage of 37·9 of the receipts has never before been reached, so far as I know. It, of course, points to very large traffic as well as to economical working. On our system last year the percentage of cost of operation to receipts was 74·49.

I confess my surprise that the cable in New York, with its immense traffic, should have been so very far surpassed. With these figures before him, and also the significant fact that the cable system in Broadway, after a short history of five years, is now being superseded by the electric conduit, the writer of the article seems fully justified in saying: "There is no place for the cable in modern street railroading."

But it is the overhead and the conduit systems of electric traction that you are more immediately interested in.

Your deputation, in their report of July, 1896, said: "All other things being equal, a system which provides the power without any overhead construction is preferable." No one will dispute this. I do not think it is possible, however, with the very much greater initial cost of the conduit, that the result can be economically equal to the overhead, but it may very properly be asked, in view of the latest experience, how near does it approach economic equality? This I have tried to estimate.

The total length of the tramways owned by the Glasgow Corporation, including those recently constructed, although not yet opened for traffic, measures, in round figures, 37 miles of double track. This, of course, excludes the Govan tramways, which are leased. Prior to 1894 the section of rail used weighed 79lb. per yard, and from 1894 to 1896 89lb. per yard. Since 1896 a new section has been adopted, weighing 100lb. per yard. In both of the older sections (designed for horse traction) the groove is so shallow that, when new, the rail admits of a wear of only ¼in. until the flanges of our electric car wheels touch the bottom of the groove. The new 100lb. section gives a wear of ⅜in. before the same thing occurs. Our experience in relaying and operating the Springburn route has practically dispelled any hopes that may have been entertained of the economy of bonding and wearing out any considerable portion of the old shallow-grooved rails.

Of the 37 miles of double line in question, 22 miles are laid with 79lb. rails, and six miles with 89lb. rails, making altogether 28 miles; and nine miles with 100lb. rails. From what I have said we may take it that, in the event of conversion to electric traction, the former 28 miles will practically require new rails throughout, while the present rails on the latter nine miles will be suitable for the new form of traction.

On this basis I have made up the following relative estimates of the cost of conversion. These estimates do not include anything for feeders, rolling-stock, equipments, buildings, power and transforming stations, etc., which are common to both the overhead and conduit systems, and which, for our present purpose, may be estimated at equal cost:

I. OVERHEAD.

Renewing 28 miles of double track, and electrically equipping same, including overhead construction, bonding, and ducts for feeders, at £11,000 per mile ...	£308,000
Converting nine miles of double track now laid with 100lb. rails, at £4,500 per mile	40,500
	£348,500

These figures for the overhead system are based upon the costs of converting the Springburn route.

II. CONDUIT.

Renewing 28 miles double track, and electrically equipping same, at £20,000 per mile.....	£560,000
Converting nine miles of double track, using the present rails, at £18,000 per mile.....	162,000
	£722,000

These figures for the conduit bear the same relative proportion to the overhead as do the figures in the very able report recently presented to the Liverpool Corporation by Mr. F. S. Pearson, engineer to the Metropolitan Street Railway Company, who designed and constructed the conduit system in New York now reported upon. Mr. Pearson's figures for conversion in Liverpool are, however, somewhat higher than those given here both for overhead and conduit.

There is, of necessity, considerable uncertainty in any estimate for constructing a conduit in the streets of the city, arising from the unknown number and character of water, gas, and other pipes and sewers, which may require to be removed, and special work at bridges, etc. In fact, the real cost will be determined by the amount of this extra work.

According to the present estimates it would cost £373,500 (in round figures, £10,000 per mile of double track) more to convert the 37 miles of double track under consideration to the conduit than to the overhead system, or rather more than double. The greatest sacrifice for the conduit is, it will be observed, in lifting to the foundation the lines more recently laid with 100lb. rails.

To construct the conduit on a road on which there are no tramways at present would probably cost about £6,000 per mile of double track more than the overhead. This would apply to extensions.

Taking an average running of 9,000,000 car miles per annum, or 122,000 per mile of single track, the interest and sinking fund on the extra cost indicated for conversion is practically equal to ½d. per car mile. There will probably be slight excesses on other points, such as maintenance, leakage, cleaning, etc., but from all the evidences available I think we may assume that the excess on all points would not in any event exceed 1d. per car mile. It

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should be observed, however, that on the mileage in question 1d. per car mile amounts to £37,500 per annum.

Where the traffic is not great this excess would be serious, or even prohibitive, and it would tend to check extensions quite feasible with the trolley.

There is also the very serious matter of the girders of the Central Railway in the line of Argyll-street coming within 10in. of the surface of the causeway, as, for instance, at Dunlop-street and Mitchell-street. From the description in Mr. Rankine's report of Feb. 5, 1891, the depth varies from 10in. to about 18in., more or less, all the way from Dalmarnock-road, at Bartholomew-street, to Anderston Cross. I am also doubtful if there is sufficient depth for a conduit on a good many of the railway bridges where these form part of the streets. To prove this, however, it would be well to pit the streets at as many points as necessary. The depth of the shallowest electric conduit yet formed is about 21in. It will be a question for engineers to decide whether this difficulty can be overcome. Meantime I shall set it aside, satisfying myself with mentioning the facts.

The interference with the streets would undoubtedly be very great during the reconstruction for conduit, but this would just require to be borne at its possible minimum. Where the street would require to be taken up for the overhead system it would only be a question of degree.

There is also the question of climate. Glasgow has more damp and slush than New York, but I have assumed that the maximum excess of 1d. per car mile over the trolley would cover all such points.

If we for the moment suppose the more expensive conduit system to be quite practicable from an engineering point of view, then its commercial success would depend upon the prospective traffic and receipts.

We are naturally most anxious to give the community the cheapest possible means of comfortable tramway travelling, and there is no doubt that for cheapness and efficiency combined the overhead electric system holds the field. It is, however, a question worthy of fair and full consideration whether, if the conduit should prove equally efficient and reliable, and be considered safer as well as less obtrusive (even if the preference be, to a large extent, sentimental), and if it could be operated at no greater extra cost over the trolley than 1d. per car mile, it should not have a trial at this stage. In other words—Is the gain, which is almost entirely æsthetic, worth the difference? Were this the only question involved, I believe the available traffic on the thoroughfares of Glasgow would justify this extra cost over the trolley if by it one were sure of securing for the city the best all-round system. But we have not this assurance.

The extra cost can be better afforded now that the electric power can be produced at what a few years ago would have been looked upon as merely a nominal addition to the cost per car mile run.

It is fully anticipated that the new 70,000-h.p. station in Ninety-sixth-street, New York, for the tramway service of the entire city, through high-tension primary lines and low-tension secondary circuits, will reduce the cost of power to somewhere between ·60 cent (·30d.) and ·75 cent (·37d., or practically one-third of a penny) per car mile run.

I believe this is possible of realisation. Experience in Brooklyn, Chicago, and Montreal, as well as in New York, justifies the expectation. I am also convinced that, with the wages and prices in this country, if the Glasgow Tramways Committee lay down their own power station on similar lines, they will be in a better position to attain this result than the Metropolitan Street Railway Company in New York.

I may mention here that, from tests made so far, our cars on the Springburn route, which is hilly and requires considerable sanding, seems to use about 1¼ kilowatt-hours, or Board of Trade units, per car mile run, or about 1½ units, including current used for lighting and heating the cars.

Coming now to the question of the proposed extension from Glasgow Cross to Govanhill and Coplawhill, there is nothing, if it be not insufficient depth on the bridges, to prevent a portion of this extension being altered to the conduit system, and the working of the same cars over both systems, if the committee wish it. The cars would be fitted with the trolley for the overhead portion, and the plough for the conduit portion. The one would be thrown off, and the other on, at the junction—which would be a stopping place—without much detention. The changing may not be altogether desirable, but it is quite workable. One system, however, for the entire city would certainly be preferable. Otherwise there would be difficulty in determining where one system should end and another begin.

From Glasgow Cross to the north end of Albert Bridge, 330 yards, the lines were renewed with 100lb. rails in August, 1897; on Albert Bridge and Crown-street to Govan-street, 364 yards, with 89lb. rails in 1896; and from Govan-street to Dixon Halls, 1·26 miles, the lines are worn out, having been originally constructed in 1880. The whole distance from Glasgow Cross to Dixon Halls is 1·66 miles. The Central Railway girders are supposed to be fully 1ft. under the street surface at Glasgow Cross, but this can be proved by pitting. To convert the whole track from Glasgow Cross to Dixon Halls for overhead traction would cost about £16,000; for overhead from Glasgow Cross to Rutherglen-road, and conduit beyond, about £27,000; and for conduit throughout, from head of Saltmarket, about £33,000. The overhead lines on Coplaw-street and in car works and sheds would be about £4,000 additional.

Even a small demonstration of the conduit system on this route would mean losing a considerable time in having it electrically operated. For my part I should much prefer to have the direct line from the power station to the car works operated throughout on the one system, and to have this carried out at once.

If the available depth makes it practicable, and a demonstration of the conduit system is wanted, what I would suggest is this: Proceed at once to equip the Govanhill route, as proposed, on the overhead system throughout, and arrange, at any time you think fit, to demonstrate the conduit system on the Dennistoun route from St. Vincent-place to the terminus. The current for this demonstration could easily be supplied from the present power station *viâ* High-street, and the working costs kept quite separate. The Kelvinside cars could simply turn at St. Vincent-place, as in former times, and this would completely isolate the Dennistoun route for this purpose.

In a postcript dated Nov. 24 Mr. Young says:

Since this report was written I have ascertained by pitting the streets that the depth from the surface of the street to the railway and bridge girders at the points undermentioned are as follows:

Central Railway at Glasgow Cross	15in.
Albert Bridge	16½in.
Caledonian Railway, Cathcart-road	15½in.
North British Railway, Dennistoun terminus	10⅜in.
New Glasgow Bridge	16in.
Glasgow, Barrhead, and Kilmarnock Joint Railway, Victoria-road	10in.
Glasgow and South-Western Railway, near Paisley-road toll	11in.
North British Railway, Dumbarton-road, Finnieston	6in.
Kelvin Bridge, Dumbarton-road	25in.
Kelvin Bridge, Great Western-road	15½in.
Caledonian Railway, near Barracks, Maryhill-road	22in.

I have not had time to examine in the same way the actual depth over the Central Railway along the line of Argyle-street, from Dalmarnock-road to Anderston Cross, but for our present purposes the figures in Mr. Rankine's 1891 report may be accepted. With this information before me I am afraid that, if there is to be one system for the Corporation tramways, the engineering difficulties peculiar to Glasgow will be found so great and so uncertain as, from a general and practical point of view, to place the conduit at too great a discount.

The circumstances in New York are different. New York City (Manhattan Island) is entered by only one railway—the New York Central—and it does not to any extent interfere with the streets. The only other railways apart from street railways (tramways) are overhead. I mention this to show that in all questions of this kind local circumstances must be considered.

CHELSEA.

The following report has been submitted to the Lighting Committee of the Vestry *re* the provisional order for Kensal Town, by Mr. T. W. E. Higgens, the surveyor:

Gentlemen,—In applying to the Board of Trade for the provisional order for lighting Kensal Town, the Vestry will have to deposit with the Board of Trade: (*a*) a map showing the boundaries of the district to be supplied with electricity and the streets in which it is proposed to lay down mains within a specified time—probably two years; (*b*) a list of the private streets, the railways, and the tramways which it is proposed to break up; (*c*) a list of the canals and navigable rivers within the proposed area of supply; (*d*) a statement of the sums to be expended in connection with the proposed undertaking.

(*a*) So far as the map is concerned, the Ordnance map, of 25in. to the mile, includes the whole of Kensal Town on one sheet, and this sheet will therefore be suitable for the purposes of the application. As regards the streets through which the Vestry are to lay distributing mains within two years, I suggest Harrow-road and Kensal-road, Wedlake-street and Wedlake-street footbridge.

(*b*) The schedule of private streets, railways, and tramways to be broken up will be as follows: streets—Conlon-street, Great Western-terrace; railways—the Great Western Railway (I have inserted this in order to open up communication with Wornington-road, without going outside the parish. It was considered desirable to omit this railway in the Vestry's application to the Board of Trade, as there is at present no intention of breaking up the railway lines belonging to the Great Western Railway); tramways—the tramways of the Harrow-road and Paddington Tramways Company.

(*c*) Canals within the area of supply—the Grand Junction Canal.

(*d*) As regards the sum to be expended in connection with the undertaking, there is, first, to be considered the sum necessary to provide an installation for the compulsory area; and, next, the sum required for providing a fairly complete installation throughout Kensal Town. In dealing with the compulsory area, however, it will be necessary to make the installation for that area the nucleus from which the complete installation shall grow. Sufficient land must be provided for the larger requirements, and the buildings, etc., must be designed to admit of additions being made to them from time to time. A site alongside the canal is a necessity, both for obtaining supplies of coal and for dealing with condensed steam. Any other site would mean great extra cost for cartage

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of fuel. A piece of land about 200ft. by 100ft. would be required. For dealing with the compulsory area I have indicated, and for providing a 120-kw. plant with reserve power in case of repairs, etc., the estimate would be :

Site by canal	£3,500
Buildings, chimney, yard paving, foundation, etc.	2,750
Boilers, generating plant, electrical apparatus	4,000
Mains and street work	3,250
	£13,500

(It is possible that if the installation was worked by means of a "Dowson" gas plant, such as is used at Leyton, the total cost might not be more than £12,750.) This is the lowest sum for which a proper start could be made with any prospect of future success ; and, to obtain that future success, this expenditure of £13,500 must only be the stepping-stone to the £36,000 mentioned in my report of Oct. 30, 1897, which sum is the estimate for a fairly complete installation at Kensal Town.

It has, however, been suggested that the Vestry could obtain their electricity in bulk from the Metropolitan Electric Supply Company, and I have been directed to make enquiries from the company on the subject. The secretary writes that his company would be pleased to quote for such a supply, but they would first desire to know the amount of electricity we would require, and also whether we would be prepared to guarantee a minimum quantity daily, as these considerations would, of course, affect the price. We may, I think, therefore, rely upon being able to obtain electricity in bulk from the Metropolitan Electric Supply Company when their Willesden station is completed and their mains are laid alongside the canal. If it is thought desirable to come to terms with them, the estimate for the Vestry's portion of the works for distributing the supply in the compulsory area only—viz., Harrow-road and Kensal-road—would be :

Site and buildings	£800
Mains	3,250
Transformers and electrical apparatus, etc.	1,200
	£5,250

But is it advisable to commence buying electricity in bulk from a private company? Is it not a short-sighted policy, and one which will afterwards be regretted by the Vestry? I am strongly of opinion that if it is carried out it will put an end to any possibility of giving a cheap supply of electricity to Kensal Town for many years, and no high-priced supply will ever come into general use and pay interest on the capital invested. If we are to do any good with our provisional order, it can only be by rapidly extending our mains and reducing the price of the current. With a supply in bulk, reduction in the price of current will not easily take place. The current will always be dear. We have to pay for the current delivered to our transformers, and will pay our proportion to the directors' fees, company's profits, etc., on the current so delivered. As shown in *Lightning*, the cost of production per unit in the Metropolitan Company's area is 4·13d. per unit, without allowing for the company's profit. But that is the price at their side of our transformers, and in the transformers and mains we very easily lose 15 to 25 per cent. of our energy—possibly more—and, in addition, the expense of distribution and maintenance of mains, etc., has to be borne, so that the Kensal Town consumer (especially if he has to pay extra for his current on account of free wiring) must not hope for a cheap supply for a long time. And will he be a consumer if he does not get it cheap?

It has been urged that one element in the success of a municipal undertaking is that the householders, being persons interested in the success of the enterprise, are likely to become consumers ; but if the supply is obtained from a private company, as a bulk supply will be, any advantage which accrues from the co-operation of householders, as persons interested, will probably be absent. Is it therefore advisable to frame our estimate on the basis of a bulk supply?

Of course, there is another alternative, which I mention only to show what some public bodies have done. Local authorities have gone to the Board of Trade with bogus estimates, got their provisional order, and then hawked it round to various companies to see who would give the biggest price for it. Such undignified proceedings have been carried on before now, but, of course, such a thing is quite out of the question here.

In conclusion, I may say that I am of the same opinion I was in October, 1897. If the Vestry obtain a provisional order they should obtain it to light Kenal Town—the whole of Kensal Town, and should lay out their installation accordingly. If that installation is complete in itself, and worked entirely by the Vestry, and for the good of the whole district, it will have success in the end. But if the installation is laid down with the intention of lighting only a few shops in Harrow-road just to show that the Vestry are doing something, it will be conducted on a wrong principle, it will never pay, and the Vestry will not in future years be disposed to vote the money for giving it a chance of success.

LEGAL INTELLIGENCE.

ACTION AGAINST THE NATIONAL TELEPHONE COMPANY.

Mr. Justice Wills and Mr. Justice Lawrance have given judgment in the case of Holliday *v.* the National Telephone Company, Limited. **Mr. Justice Wills**, in giving the decision of the Court, said this was an appeal from the decision of the deputy-judge of the City of London Court, who had entered judgment for the plaintiff for £25 under the following circumstances : The defendant company were laying down some telephone wires at The Pavement, Clapham, and in order to solder the joints of the tubes in which the wires were placed they entered into an arrangement with a plumber named Highmore, who contracted to do the work for so much per joint. The work of soldering had to be performed to the satisfaction of the defendants' foreman. While Highmore was melting the metal for soldering purposes the benzoline lamp used for heating the receptacle in which the metal was to be melted exploded on account of the valve being defective. The result was that the molten metal flew about and some of it struck the plaintiff, who was passing at the time, thus causing the personal injuries in respect of which he brought the action against the company. The case for the plaintiff was that the accident was due to the negligence of Highmore in using a lamp which was defective, and that as Highmore was the servant of the defendants they were liable to pay compensation. The Court now held that Highmore was in no sense a servant of the company, but a master plumber who was in the habit of accepting contracts of this nature. The deputy-judge of the City of London Court was wrong in holding that Highmore was a servant of the defendant company. The appeal would therefore be allowed, and judgment entered for the defendants, with costs.—*Financial News.*

BLACKPOOL, ST. ANNES, AND LYTHAM TRAMWAYS.

At the sitting of the Chancery Court in Manchester last week a petition was granted for the winding up of the Blackpool, St. Annes, and Lytham Tramways Company, which was incorporated in 1893. The company was originally established for making, maintaining, and working the tramways from Blackpool to Lytham. On Sept. 19, 1898, an agreement was entered into between the company of the one part and Mr. E. H. Turner on behalf of a company to be called the Blackpool, St. Annes, and Lytham Tramways Company, Limited, by which, subject to the consent of the Board of Trade, the petitioners sold and assigned their estate to Mr. Turner for the sum of £115,000. The consent of the Board of Trade to this course has been obtained. On Oct. 15, 1898, the new company was incorporated with a capital of £100 000 in 50,000 ordinary shares of £1 and 50,000 preference shares of £1. The former company still retain possession of the undertaking pending the winding up, but the new company are carrying on the business of the company.

RECKLESS DRIVING.

Another case of alleged reckless driving of an electric car in Glasgow was heard at the St. Rollox District Police Court last week. William Gerland, 36, Wellfield-place, Springburn, pleaded guilty to having, on 12th inst., in Parliamentary-road, recklessly driven an electrically-propelled car, so that the car ran into and collided with a lorry. The **Magistrate**, in finding the charge not proven, said they were all aware that the trolley system was new in Glasgow, and that the electric cars went perhaps a little faster than the horse cars. He believed it would take some time before the electric cars and the traffic adjusted themselves to each other, but he thought the difficulty would eventually be got over.

COMPANIES' MEETINGS AND REPORTS.

LONDON ELECTRICAL CAB COMPANY, LIMITED.

Directors : H. H. Mulliner (chairman), the Hon. Reginald Brougham, the Hon. Evelyn Ellis, J. H. Mace, R. R. Paterson.

Report of the directors to be submitted to the general meeting of shareholders to be held at the Westminster Palace Hotel, S.W., on Monday, Dec. 5, at 11 a.m. :

The directors regret that the profit and loss account shows a debit balance of £6,207. 15s. 6d. Although the Company was incorporated on Nov. 12, 1896, they were unable to run any cabs at all until Aug. 20, 1897, and so were without any means of earning profit, and since the latter date only a very limited number have been on the streets, whereas the whole of the standing charges have continued during that time. The cost of purchasing electricity proved so excessive that the directors decided to lay down a complete manufacturing plant ; this plant is now working, and enormously reduces the cost of electric current. The maintenance of the accumulators and the cost of renewals of rubber tyres have also caused much anxiety and expense, but different arrangements are on the point of being completed, which will place these matters on a much more satisfactory basis. The directors purpose shortly making an issue of £12,000 in 5 per cent. debentures, which, together with the final call on the recent issue, will, it is believed, be ample to pay all liabilities after the premises, new plant, stock, etc., have been put in thorough working order, and also to provide sufficient working capital. At the meeting the chairman will speak very fully as to the past, present, and future working of the business, also as to

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the policy of the directors and the position of the Company generally, and the works will be open to the inspection of shareholders after the meeting. For the benefit of shareholders who are unable to be present, a copy of his speech will be forwarded to each member. The directors retiring by rotation are Mr. H. H. Mulliner and the Hon. Reginald Brougham, who being eligible, offer themselves for re-election. The auditors, Messrs. Monkhouse, Stoneham, and Co. retire, but being eligible offer themselves for re-election.

PROFIT AND LOSS ACCOUNT FROM AUG. 20, 1897, to JULY 31, 1898.

Dr.	£	s.	d.
Cab maintenance, including electricity, repairs and renewals, yard superintendent's salary, lighting, repairs and maintenance of plant, etc., and general expenses	7,121	3	3
Directors' fees	484	10	3
Salaries of managing director, engineer, and secretary	709	19	6
Consulting engineer's fees	160	6	6
Office expenses, including salaries of staff	349	14	3
Rents, rates, and taxes	384	19	8
Stationery, printing, and advertising	231	1	9
Legal expenses	238	18	3
Licenses and insurance	272	0	5
Royalty	67	10	11
Compensation claims (balance of account)	62	0	9
Bad debts written off	21	8	0
	£10,103	13	6

Cr.	£	s.	d.
Cab hire after deducting drivers' wages	3 242	2	4
Storing vehicles	45	1	8
Profit on sales (estimated)	145	0	0
Interest on deposit account, etc.	453	11	0
Transfer fees, etc.	10	3	0
Balance as per balance-sheet	6,207	15	6
	£10,103	13	6

Dr. BALANCE-SHEET, JULY 31, 1898.	£	s.	d.
Share capital authorised—150,000 shares of £1 each	150,000	0	0
Subscribed and issued—			
63,612 shares of £1 each fully paid up	63 612	0	0
12,908 shares of £1 each (10s. called up)	6,454	0	0
76,520	70,066	0	0
Less 144 shares forfeited	144	0	0
76,376	69,922	0	0
Less calls in arrear	7	10	0
	69,914	10	0
Add amounts paid in advance of calls	16	0	0
	69,930	10	0
Vendors—balance of purchase consideration to be satisfied by the allotment of fully-paid shares*	24,811	0	0
Sundry creditors	5,052	19	8
Amount received on forfeited shares	60	15	0
Premium on shares after deducting expenses of issue, £301. 5s.; less premiums in arrear, £3. 15s.	297	10	0
	£100,152	14	8

Contingent liabilities: for cabs, cells, plant and machinery, alterations to premises and engineering work, exact total of which is not ascertainable, but will not be less than £13,396. 3s. 9d.

* These shares do not participate in profits and are deferred as regards capital until a dividend of not less than 6 per cent. for one year shall have been paid on shares subscribed.

Cr.	£	s.	d.
Purchase price of licenses as per agreement dated Nov. 12, 1896, of which £25,189 has been paid in cash and the balance is to be satisfied by the issue of 24,811 full-paid shares of £1 each	50,000	0	0
Expenditure on premises, including cost of adapting same for purposes of charging station and cab depôt, and plant and machinery	8,285	6	3
Rolling-stock, including outlay on account of cabs and cells, etc., contracted for but not delivered	20,827	13	5
Office furniture, fixtures, etc.	251	0	5
Insurance, licenses, and rates unexpired	94	4	11
Preliminary expenses, including registration fees, stamp duties, legal charges, and cost of testing cells, etc.	1,358	6	3
General expenditure to Aug. 20, 1897 (the date when the cabs commenced to ply for hire), including directors' fees, salaries, rent, and general expenses, £1.946. 19s. 1d.; less interest and transfer fees to Aug. 20, 1897, £337. 2s. 5d..	1,609	16	8
Sundry debtors	1,819	3	4
Cash on deposit, £8,000; current account and in hand, £1,699. 7s. 11d.	9,699	7	11
Profit and loss—balance as per account	6,207	15	6
	£100,152	14	8

NOTE.—The directors have waived their claim to fees amounting to £662. 10s., to which they are entitled under the articles of association.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. Tenders by Dec. 15.

Glasgow.—The Corporation invite tenders for providing and erecting switchboards and instruments at the new electricity works, Port Dundas. Tenders by Dec. 5.

Glasgow.—The Corporation invite offers for the purchase of boilers, engines, and dynamos. Further particulars appear in our advertising columns. Tenders by Dec. 6.

Shoreditch.—The Vestry invite tenders for the supply of six direct-current rotary transformers, etc. Further particulars appear in our advertising columns. Tenders by Dec. 13.

Beckenham.—The Urban District Council invite tenders for the various works in connection with their proposed electric light station, particulars of which appear in another column. Tenders by Dec. 17.

Ramsey.—The Town Commissioners have asked the Isle of Man Tramway Company and the Ramsey Gas Company to tender for the better lighting of the promenades by electricity and gas respectively.

London.—The Acton District Council invite plans and tenders for the erection of a dust destructor. Specifications, etc., may be obtained of Mr. D. J. Ebbetts, surveyor, 242, High-street, Acton, W. Tenders by 3 p.m. on Dec. 6

Barnsley.—The Corporation invite tenders for erection of a tall chimney, and engine, dynamo, and boiler house, storage rooms, and offices in Beckett-square, Barnsley. Specifications, etc., can be obtained on personal application to Mr. J. Henry Taylor, A.M.I.C.E., borough surveyor, St. Mary's-place, Barnsley. Tenders by 12 noon on Dec. 12.

Sutton (co. Dublin).—The Great Northern Railway Company (Ireland) invite tenders for erection of buildings for an electric power station, brick chimney, etc., near to Sutton railway station, co. Dublin. Specifications may be seen at the office of the Company's Engineer-in-Chief, Amiens-street, Dublin, or at the office of the District Engineer, Belfast, from either of whom copies may be obtained on payment of £2. 2s. Tenders by 10 a.m. on Dec. 5.

York.—The North-Eastern Railway Company invite tenders for the following articles, in such quantities as they may require, during six months ending June 30, 1899, delivered carriage paid at the company's telegraph stores at York: (1) telegraph apparatus; (2) telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by noon on Dec. 5.

Richmond (Dublin).—Sealed tenders, accompanied by detailed estimates, addressed to the Secretary, Board of Control, Custom House, Dublin, are invited for engines, dynamos, and wiring for about 100 e.h.p. at Richmond District Lunatic Asylum, Dublin. Plans and specifications can be seen at the offices of the electrical engineer, Mr. Walter Leake, 51, Victoria-buildings, Manchester, and of Mr. W. H. Byrne, 20, Suffolk-street, Dublin. Copies of plans, etc., will be furnished to contractors by the Electrical Engineer on payment of £1. 1s., not returnable. Tenders by Dec. 5.

Barnsley.—The Corporation invite tenders for the supply and erection of (1) Lancashire boilers and Green's economiser, and setting of same; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of electricity supply works, and engine, etc., foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and service boxes, and service connections. Specifications, etc, can be obtained on application to Mr. Thos. L. Miller, M.I.E.E., 7, Tower-buildings, N., Water-street, Liverpool, on payment of £5. 5s. (or £1. 1s. per section), which will be returned on receipt of a bona fide tender. Tenders by 12 noon on December 12.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai: "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being

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supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O P Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Redditch.—The Council have accepted the tender of Messrs. Johnson and Phillips for the supply of two dynamos at a cost of £1,725, to be delivered in four months.

Bolton.—The following tenders have been accepted by the Corporation: J. Booth for the supply and fixing of a new iron roof at the electricity works; Thomson-Houston Company, Limited, for the extension of the new switchboard at the works; Musgrave and Sons for two foundation plates for two new 1-h.p. engines.

Edinburgh.—The following tenders have been accepted by the Corporation for the supply of machinery to the electric lighting station in McDonald-road: Six engines and dynamos of 13 h.p. each—Mather and Platt, Salford Ironworks, Manchester. Boilers (13)—Sinclair, Leith (seven); and D. Stewart and Co., Glasgow (six).

London, E.—The following tenders have been received by the Electrical Power Storage Company, Limited, for new laboratory, etc., at Millwall:

Jones and Groves	£1,681
T. D. Lang	1,608
Jerrard and Sons	1,573
W. Mills	1,502
Windsor and Co.	1,345

BUSINESS NOTES.

Leigh.—The Local Government Board have sanctioned the borrowing of £10,216 for the erection of electricity works by the Council.

Kensington.—The House-to-House Electric Supply Company are extending their mains in Pembroke-square, Tregunter-road, and Stanhope-gardens.

St. Pancras.—From this week's agenda of the Vestry, it appears that there is a great tendency to raise the salaries of the non-technical staff of the electricity department.

Prestwich.—The Lancashire Asylums Board have granted a sum not exceeding £22,000 out of the asylums fund to cover the cost of the electric light installation at Prestwich Asylum.

Dover.—A letter from the county court judge suggesting the introduction of electric light in the police court, which is used as the county court, has been referred to the surveyor of the Town Council.

Southampton.—Mr. Kincaid has been asked to submit at an early date a full and detailed report and estimate of the entire cost of constructing and equipping the lines for electric traction on the overhead system.

Yarmouth.—At a public meeting, convened by the Mayor, to consider the Corporation's decision to promote a Bill for powers to carry out electric tramways, on Tuesday, a resolution expressing approval of the scheme was carried.

Ipswich.—At a general meeting of shareholders in the Ipswich Tramway Company on Wednesday last an offer of £20 000 from the Drake and Gorham Electric Power and Traction Syndicate, Limited, for purchase of the Ipswich tramways was agreed to.

Portsmouth.—The municipalisation and conversion of the tramways has now been formally agreed upon by the Town Council, and the Tramway Committee has been instructed to report as to the probable new routes and the estimated cost per mile.

Personal.—Mr. David Stevenson, who was formerly connected with the old "E.P.S." Company, and with Messrs. Drake and Gorham, and lately a partner in the firm of Edlin and Stevenson, has now settled in London, and has taken offices at 17, Victoria-street, S.W.

Birmingham.—A ratepayers' meeting has authorised the Council to make an application to Parliament in the next ensuing session for an Act to authorise the transfer of the undertaking of the Birmingham Electric Supply Company, Limited, to the Corporation of Birmingham.

Airdrie.—Owing to the want of support by the Coatbridge Council, the New General Traction Company have withdrawn from the field. The Town Council have now agreed to join with Coatbridge in supporting the British Electric Traction Company's scheme in Parliament.

Liverpool.—The fire which occurred last week at the Sandon Dock Station of the Liverpool Overhead Railway resulted in the destruction of all the wooden erections comprising the station buildings. For some time the station has not been used except for storing electrical plant.

Colwyn Bay.—The electric lighting of the district by the District Council is practically abandoned, but the electric lighting plant already purchased for illuminating the promenade, lying idle during the winter months, is to be utilised for lighting the streets in the centre of the town.

Bolton.—A new main is being laid and two others have been under consideration and deferred, one until the laying of the feeder mains for the tramways is commenced, the other pending enquiries into the probable number of consumers. The question of lighting in the streets is under consideration.

Removal.—The manager's and secretary's offices of the Western and Brazilian Telegraph Company, Limited, and the London Platino-Brazilian Telegraph Company, Limited, are removed to Winchester House, Old Broad-street, E.C. The transfer offices remain, as heretofore, at Blomfield House, London-wall, E.C.

Presentation.—On Saturday last Mr. Brandreth, on behalf of the staff and employés of the Hammersmith Vestry Electricity Works, presented Mr. Leslie A. Hack, one of the engineers-in-charge, with a travelling rug and umbrella, the occasion being his leaving the Vestry to join the firm of Messrs. Ferranti, Hollinwood, Manchester.

Swansea.—A company is being formed in Swansea for the purpose of supplying a service of motorcars for the town. The share capital of the proposed company is to be £20,000, divided into 2,000 shares of £10 each. In addition to the motorcar service, the company propose running steam, oil, or electric cars to the Mumbles and other outlying districts.

Electric and General Investment Company, Limited.—The directors have declared an interim dividend of 10 per cent on the capital paid up on the ordinary shares of the Company, being 2s. per share, less income tax. The dividend is for the six months ended on the 30th ult., and will be payable on the 15th inst. to shareholders registered in the books of the Company on Nov. 30, 1898.

Greetland.—At the meeting of the Greetland District Council on Monday last, a discussion took place with respect to the proposed extension to the district of the Halifax electric tramways. The Chairman said he believed that the next parliamentary Bill would include provision for a line to Greetland and Stainland. It was stated that both the Greetland and Stainland Councils were unanimous on the question.

Wealdstone.—The Urban District Council claim that the Harrow Electric Light and Power Company have exceeded their statutory powers by supplying Greenhill Vicarage. They are anxious to preserve their powers against the day when they hoped to light Wealdstone with electricity, and have asked the company for an undertaking that they would, when called upon to do so, disconnect the vicarage from their mains.

Arbroath.—At a recent meeting of the Gas Corporation, a letter was submitted from the Edmundson Electricity Corporation, Limited, urging the Corporation to enter into an agreement with them, so that in the event of the Board of Trade striking out the transfer clause in the order to be applied for by the burgh, the company would be able themselves, and at their own expense, to apply for an order for the electric lighting of the burgh. It was decided not to entertain this proposal.

Croydon.—The memorials from the neighbourhood of South Norwood praying that the public streets there may be lighted by electricity have been referred to the borough electrical engineer for his full report. The committee have also requested a report upon suggested extensions of mains in the district of Selhurst-road and Beulah-hill. With reference to what is known as free wiring, which has been carried out in a few instances at Upper Norwood, it has been resolved that this principle should be extended to other parts of the borough.

Hammersmith.—At the last meeting of the Vestry the Electric Lighting Committee reported that the electric installation was progressing in a very satisfactory manner. The number of applications received for private lighting was 249 for a total of 19,464 lamps of 8 c.p., the number of consumers already connected was 190, with 13,847 lamps, and the maximum number of lamps alight at one time was 11,806; and also that they had received a letter from the West Middlesex Water Company agreeing to charge 6d. per 1,000 gallons for the whole of the water consumption at the electricity works, although a small part of the service came under the high-pressure system. The report was adopted.

New Mains.—The following notices to lay mains, etc., have been agreed to by the London County Council: House-to-House Electric Light Supply Company—Stanhope gardens and Pembroke-square. County of London and Brush Provincial Electric Lighting Company (1) under the Camberwell order, College-road and High-street, Dulwich; (2) under the County of London (North) order, Percival-street, Goswell-road; (3) under the Wandsworth order, Thornton-avenue and in and across Sternhold-avenue, Streatham. Blackheath and Greenwich District Electric Light Company—along the south side of Eliot Vale hill and place, Aberdeen-terrace, and Haddo-villas. Vestry of St. Pancras—Arlington-road.

Appointment Vacant.—Applications are invited from persons competent to act as electrical engineer, to prepare specifications, drawings, etc., and superintend the works required for the installation of electric lighting of the new infirmary in course of erection at Highgate-hill, Upper Holloway, for the Guardians of St. Mary, Islington. Further information may be obtained on application at the office of Mr. William Smith, architect, 65,

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Chancery-lane. Applications, stating qualifications and experience of applicants, and remuneration required, must be addressed New Infirmary Building Committee, Highgate-hill Temporary Workhouse. Upper Holloway, N., and delivered there by 10 a.m. on Dec. 7.

Beckenham.—The Electric Lighting Committee are considering the advisability of allowing the Bromley Electric Light and Power Company to bring their cable to South-hill. Several residents there have applied to the company, and the latter is prepared to comply with their request forthwith upon receiving the permission of the Beckenham District Council to do so, and an undertaking by them to take over the cable at cost price or by valuation in the usual way whenever such permission was withdrawn. The cable would be laid to the satisfaction of the Council's surveyor, and the surface made good. The company will undertake to supply sufficient current within a month from the date of the Beckenham Council's license.

Foreign Orders.—We are informed that the Thames Valley Launch Company, Limited, whose chief offices and works are at Weybridge, Surrey, recently dispatched to Colombo specially-designed launch motors, patent single-lever controlling switches, and the stern tubes, propellers, shafts, rudders, cables, fuses, charging terminals, etc., to fit out on their system two boats which are to be built at that port. Each separate part had been tested, prepared, marked, and labelled, so that but little knowledge would be required to fit them in the boats. We learn that this firm make a speciality of this business, which appears to be taking in the Colonies and abroad, where often hulls can be built, while a difficulty exists in getting the necessary gear.

Redditch.—At a special meeting of the Council on Tuesday, held to consider certain developments in connection with the electric lighting scheme, the Clerk reported that the original contractors for the supply of the two alternating dynamos had gone into bankruptcy, which interfered with the arrangements. Considerable correspondence had taken place between Mr. McMullin, the electrical engineer, and the official receiver, who proposed to carry out the contract at an addition of £200 to the sum originally mentioned, and the committee were prepared to accept the contract at the increased price of £1,638; but in further correspondence and interviews it transpired that the official receiver was not prepared to guarantee any time for delivery, nor to bind himself in any form. The report of the Electric Lighting Committee was adopted.

Manchester.—A deputation from the Manchester Corporation has waited upon the permanent secretary of the Board of Trade (Sir Courtenay Boyle) on the subject of the Corporation's Tramways Bill, which is to be laid before Parliament in the ensuing session. The proceedings were private. The measure proposed to be introduced will give the Corporation power to lease lines from the Corporations of Salford, Oldham, Stockport, Ashton-under-Lyne, Stalybridge, and Eccles, the Urban District Council of Swinton and Pendlebury, and the urban districts between these places and Manchester, and to work them as one system, in the same manner as the Manchester Tramway Company now covers the area. With a view to giving the Corporation a wide choice in the method of traction, authority is sought to utilise different kinds of motive power—oil, gas, coal, electricity, etc.

Edmonton.—At the last meeting of the Urban Council a letter was received from the Finchley District Council stating that, in consequence of the lack of support received by their Highways Committee in reference to the proposed lighting of Edmonton and other districts by electricity, they did not see their way to call a further meeting on the subject, and the Council had resolved themselves to apply for a provisional order. The North London Electricity Company enquired whether the Council had arrived at any decision either as to supporting an application of the company for a provisional order, or as to applying for an order themselves. In the latter case they asked if the Council would be willing to consider proposals from them for the leasing of the order upon terms to be arranged. The clerk was instructed to inform the company that the Council had decided to apply for a provisional order, and to answer their second question in the negative.

Catalogue.—We have received from the Electrical Company, Limited, a catalogue of their "Luna" arc lamps, etc. The book is very useful as a guide to the prices of different sorts of arc lamps, of which many diagrams are given. The metric system is entirely used throughout the catalogue for the various weights and dimensions. Besides arc lamps, a large variety of arc lamp connections, hoisting apparatus, resistances, choking coils, transformers, etc., are shown. In particular we notice improved types of direct-current lamps and an automatic compensator, by means of which three arc lamps can be run in series on 110-volt circuits. Also we note the "Motor" type of alternating-current lamps, which have several distinct advantages. The "Luna" enclosed arc lamps, for both direct and alternating currents, we are informed, command a large sale, which is steadily increasing. The monthly output by the Electrical Company of arc lamps of all types now averages 10,000.

Southgate.—At the last meeting of the Urban District Council, a letter was read from the Finchley District Council stating that, in consequence of the lack of interest displayed in reference to the question of electric lighting, the Council had decided not to hold another conference of local councils, but had decided to apply for a provisional order for themselves. The Chairman said it was through no feeling of indifference to the subject that the Southgate Council did not send a deputation, but because they thought it better to discuss the matter with councils more in their immediate vicinity, and it was decided to reply that the Council were about to apply for a provisional order for electric lighting. A letter was also read from the North London Electric Lighting Company applying for permission either to lease the provisional order from the Council or to supply the Council with electricity from a central generating station. The Council resolved to take the matter into consideration in due time.

Cardiff.—At a recent meeting of the Cardiff Electrical Committee, in reply to a question whether the Corporation were in a position to supply current suitable for driving motors, and whether the committee could arrange to furnish such motors with current sufficient to drive the machinery of small manufactories, the electrical engineer, Mr. Appelbee, said they supplied current suitable for small motors, say of 3 h.p. or 4 h.p. At 2½d. per unit the price would prove cheaper than gas, and certainly cheaper than steam. The Tramways Committee of the Cardiff Corporation have opened negotiations with the tramways company with a view to an arrangement whereby the company will, in executing repairs during the short interval before the Corporation become possessors of the lines, make them of more permanent character than the company could be expected to do under the circumstances. The Corporation are prepared to make allowances for any work of this character carried out with the approval of the borough engineer.

Fulham.—The surveyor in his report on motor dust-vans reviews offers ranging from £575 to £275. The latter is from the Electrical Vehicle Syndicate, and the fact that no drawings were supplied is mentioned in the report.—The Vestry have taken steps to oppose the applications for provisional orders of the County of London and Brush Provincial Electric Lighting Company, Limited, and the House-to-House Electric Light Supply Company, Limited.—The Vestry's consulting engineer is preparing a report as to the advisability of sinking a well on the Town Mead-road site in order to obtain a supply of water for the proposed electric light works.—A sub-committee is considering the consulting engineer's report with reference to the advisability of including in the specification generating machinery for the output of an equivalent to 28,000 8-c.p. lamps instead of for 14,000, as originally proposed, and also the question of obtaining a supply of electric current from the mains of the Hammersmith Vestry and reselling the same.

Stockport.—The Corporation have agreed to the following clauses of their proposed Bill: (1) To empower the Corporation to supply by agreement electrical energy in adjoining districts or within the area of the gas supply of the Corporation; additional borrowing powers, and the alteration of the date of the filling up of the annual accounts for electric lighting and other purposes. (2) To empower the Corporation to make and maintain stations for generating electrical power on lands belonging to them or on lands to be acquired by them for that purpose. (3) To supply electric fittings in the borough and adjoining districts. (4) To enable the Corporation to purchase by agreement or lease tramways inside or outside the borough, to work by animal or mechanical power such tramways when acquired by them, and to combine with other authorities for the more effective or economical working of the tramways within the borough and the neighbouring district; to empower the Corporation to levy tolls, rates, and charges for the use of the proposed tramways, and for the conveyance of traffic upon the same.

Greenock.—A conference was held on the 25th ult. between representatives of Greenock, Port Glasgow, and Gourock Corporations with reference to the projected Bill of the tramways company for authority to use electrical and other mechanical power. It was agreed that the representatives of Gourock and Port Glasgow should report to their respective Boards, without being meantime committed to any course of action. The Greenock Sub-Committee afterwards considered the matter further, and resolved that Mr. Fedden, electrical engineer, and Mr. Turnbull, master of works, should prepare a report as to the amount involved in taking over the undertaking of the Greenock and Port Glasgow Tramways Company, so far as situated within the burgh of Greenock, and the cost of converting it into an electrical tramway between Boundary-street on the east and Berryburn on the west, which are the boundaries of the town. The present tramway line from Port Glasgow through Greenock to Gourock is about eight miles long, and consists of three distinct sections. The portion from Port Glasgow to Rue End-street, Greenock, belongs to the company, which also has running powers under a lease over the portion belonging to the local authorities.

Walker.—At Tuesday's meeting of the Urban District Council the Special Electric Lighting Committee reported that the provisional order had been advertised and plans had been prepared in accordance with the rules. A memorial had also been prepared, and it was recommended that this be signed. It was also reported that the Walker and Wallsend Gas Company had notified its intention of applying to Parliament for a Bill giving them power to supply electricity in the district. A letter was read from the Walker and Wallsend Gas Company enclosing a copy of a letter containing terms offered by the company to the Wallsend Urban District Council, and which had been accepted by the Wallsend Council as a basis of negotiations in reference to the company's proposed application to Parliament for electrical powers, and asking if the Walker Council would enter into a similar arrangement with the company with a view to coming to an amicable arrangement which would largely diminish the otherwise very heavy expense which might be incurred before the Parliamentary Committee. After discussion, the part of the report having reference to the signing of the memorial for the provisional order was adopted, the question of the offer from the gas company and the reply to be made to it being left over for future consideration.

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Middlesbrough.—Referring to the considerable extensions about to be made in connection with the Tees-side electric tram system, the *North Eastern Daily Gazette* says: "No little surprise was caused when it was noticed that the proposed extension by Grove-hill and Breckon-hill to North Ormesby was not included in the application which is to be made to the Light Railway Commissioners for power to carry out the proposed extensions, and amongst the inhabitants at Normanby and Eston disappointment was felt that the full extension desired in that direction was not likely for the present to become an accomplished fact. Owing to the opposition met with the tramway company had to take such action as would meet with least resistance. Seeing that on the one hand there was an absolute refusal to treat in connection with the Breckon-hill route to North Ormesby, whilst the opposition to the toll-bar route was a matter of what amount of compensation should be paid, this, as the line of least resistance, was included in the application, in the hope that the Commissioners would rightly estimate the opposition and concede the right of laying the lines. It was felt that uncompromising opposition would be offered to the Breckon-hill route, and as the recent Board of Trade rules for the guidance of the Commissioners prohibits the inclusion of alternate lines, the only alternative for the tramwya company was to try to force a route through the toll bar."

Burnley.—On the 24th ult. Colonel A. G. Durnford, R.E., held an enquiry on behalf of the Local Government Board into an application for sanction to borrow £10,000 for electric lighting extensions. The town clerk stated that the electric lighting station was opened in September, 1893. The number of consumers on Sept. 31, 1894, was 71. There was then 4,513 8-c.p. lamps, with a capital expenditure of £19 359. In 1895 there were 122 consumers, 7,765 8 c.p. lamps, and a capital expenditure of £21,003; in 1896, 148 consumers, 10,009 8-c.p. lamps, capital expenditure £23,828; in 1897, 179 consumers, 13,548 8-c.p. lamps, capital expenditure £26,359; and in March, 1898, 216 consumers, 16,128 8-c.p. lamps, capital outlay £28,842. On Oct. 25 last there were 238 consumers, and 17,999 8-c.p. lamps connected with the station, but the capital expenditure could not be given exactly, because the committee were engaged in extending the station for the purpose of putting down new plant with a view of extending the system into various outlying parts of the town. The station had been carried on at a profit ever since it was opened, the profits averaging about £500 per year up to the present time. The total amount sanctioned for the department was £53,570 An enquiry was held in January, when they asked for £25,000 to cover an extension of the station, and also an extension of the mains into various outlying parts of the towns, and on Aug. 4 the Local Government Board sanctioned the borrowing of over £24,000. They had expended nearly £10,000 of that amount. New engines had been purchased, and the committee were now considering the laying of the new mains.

Gorton Gas-Engine.—We are informed by the makers of this engine, the Unbreakable Pulley and Mill Gearing Company, Limited, that they have now completed arrangements enabling them to increase their output. Six sizes, varying from 3½ i.h.p. to 37 i.h.p., are being made. Some of each size are kept ready for instant dispatch. It is claimed that the efficiency of these motors has been of late greatly increased, whilst the consumption of gas has been further reduced, in some cases to as low as 15 to 16 cubic feet per horse-power per hour. It may be timely to remind users of these engines of the necessity for taking precautions against the serious damage which will be caused if the water in the cylinder jacket and connections should become frozen during the coming winter. We understand that the best way to prevent this is as follows: As soon as the engine is done with for the day, the cock on the bottom water circulating pipe should be shut, and the water drawn off through the drain tap in the same pipe until both the cylinder jacket and top circulating pipe are empty. Before starting the engine again, the cock on the bottom water-pipe must be opened before the tanks are filled up to the usual working level, as if the tanks are filled first before the cock is opened, a body of air may be left in the pipes, and serious mischief may result. If the method described above cannot be carried out, then a gas-jet or small Bunsen burner should be left burning under the water jacket after the engine is stopped for the day. There is, however, always the possibility of the gas flame going out from some cause, therefore the emptying of the jacket and pipes as first described is the more recommendable plan.

Camberwell.—The General Purposes Committee of the Vestry have had under consideration a circular letter from the Hammersmith Vestry dealing with the report of the Joint Committee of both Houses of Parliament on electrical energy. In the report it is stated, *inter alia*: "Question 3. In the case of powers being given for the erection of a generating station outside the area of supply, they think that powers may properly be given for laying the mains in streets leading from the generating station to the boundaries of the area of supply. In such case the local authority liable to maintain these streets should have the same option of themselves breaking up and reinstating the streets at the undertakers' expense as is now given in the provisional orders to local authorities within the area of supply, and should be empowered accordingly. The committee are of opinion that while it may be advisable to maintain the veto of local authorities as to the erection of overhead wires, given by Section 14 of the Act of 1882, in respect of other electric wires, it is not advisable that in the case of overhead wires for traction purposes the local authority, other than the London County Council and county boroughs, shall have an absolute veto. While due weight should be given by the Board of Trade to the representations of local authorities, the committee think that in the case of wires for the purposes of traction it would be sufficient to give a *locus standi* to such local authorities. The committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto only to be dispensed with in special cases by the Board of Trade." As regards the first paragraph of question 3, the Hammersmith Vestry is of opinion that the local authority within the area of supply should have the power of deciding the route the mains are to be laid, as well as the power of breaking up and reinstating the streets. It further strongly objects to the second and third paragraphs, and has resolved, in the event of any legislation being brought forward on the lines indicated in those paragraphs, that it should take up a strong position in opposition and use every endeavour to retain the power of veto, both in regard to wires for the purpose of traction and applications for provisional orders. The Camberwell Vestry was asked to agree with these views, and has decided to co-operate with the Hammersmith Vestry. The probable cost of lighting the central library, the art gallery, and the Livesey library, Old Kent-road, with electricity, is being enquired into by the Libraries Committee.

PROVISIONAL PATENTS, 1898.

NOVEMBER 21.

24508. Improvements in electric traction. Percival Pinckney, 15, Middle-street, Portsmouth.

24530. Improvements in and relating to electrical accumulators. Carl Tunstill John Oppermann, 2, Wynyat-street, Clerkenwell, London.

24532. Electric cables for high-tension currents. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (La Société Française des Câbles Electriques, Système Berthoud, Borel, et Cie., France.)

24533. Improvements in or relating to converting electrical energy into mechanical motion. William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Schenck Bradley, United States.) (Complete specification.)

24559. Improvements in electrically-propelled vehicles. Henry Gurney Morris and Pedro Grotjan Salom, 47, Lincoln's-inn-fields, London. (Complete specification.)

24563. Improvements in dynamo armatures. Albert Charles James Guénée, 40, Chancery lane, London.

24566. Improvements in means or apparatus for opening and closing electric circuits Guy Carey Fricker, 46, Lincoln's inn-field, London.

NOVEMBER 22.

24570. Improvements connected with electric batteries. William Stepney Rawson, 21, Greycoat-gardens, London.

24593. Improvements connected with the lighting of miners' and other lamps by means of an electric current. Osmond Yeadon Rhodes and the Miners' Lamp Electric Lighting Company, Limited, Commercial street, Halifax.

24605. Improvements in secondary battery plates, grids, and the like. William Henry Hanson, 58 Lombard-street, London.

24641. Improvements in secondary batteries. Nathan Huntley Edgerton and Arthur Henry Masters, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24655. Improvements in electric cables. Edwin Truman Greenfield, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 23.

24708. A new or improved instrument for interlocking railway point and signal levers with electric block or train signalling switch on double lines of railway. David Smith Burns, 115, St. Vincent-street, Glasgow. (Complete specification.)

24714. Improvements in or connected with trolleys for the overhead system of electric traction. Richard Hill, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

24727. Improvements in apparatus for measuring a supply of electricity. William Arthur Price, Teign House, Westcombe Park-road, London.

24734. Improvements in electric traction. Percival Pinckney, 15, Middle-street, Portsmouth.

24747. Improvements in or connected with electric sparking devices, more particularly for igniting devices of motors operated by explosive mixtures. Emile Houpied and Charles Victor Girard, 6, Lord-street, Liverpool. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 13, 1898, being date of application in France.) (Complete specification.)

24757. Improved manufacture of lead plates for secondary batteries. Marcel Wuillot, 111, Hatton-garden, London.

NOVEMBER 24.

24795. Improved method of making insulating conduit tubes. Carl Bollé, 57, Barton-arcade, Manchester. (G. Brandt, Germany.) (Complete specification.)

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24812. Improvements in electrical meters. Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

24833. Improvements in means for suspending electric motors on electrically-propelled vehicles Sidney Howe Short, 321, High Holborn, London. (Complete specification.)

24843. A new or improved method of connecting shunt dynamos to the switchboards of electric generating stations. William Court Parsons Tapper, 322, High Holborn, London.

24855. Method of and apparatus for electrically transmitting orders or signals, suitable for use as a ship's telegraph and the like. Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

24859. Improvements in electric sparking plugs for explosion engines or motors. Frederick Richard Simms, 4, South-street, Finsbury, London.

NOVEMBER 25.

24872. Improvements in electric dynamos and motors. James Atkinson, The Woodlands, Marple, Cheshire.

24887. An electric alarm clock specially applicable for use in public works and other institutions. Thomas Millar, 115, St. Vincent-street, Glasgow.

24905. Preparation of hydrocyanic acid and other cyanogen compounds from rhodanic acid and its salts by means of electrolysis. Richard Bayer, 102, Burdett-road, Bow, London.

24912. Improvements in and pertaining to lamps, gas, and electric fittings, and the like. Charles Steele Bradford, Fairfield, Kingston-on-Thames.

24914. Improvements in electric current conducting hinges. Frank Eugene Chandler, Fairfield, Kingston-on-Thames.

24949. A regulating transformer for rotary-phase current or polyphase current installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Aktiengesellschaft Germany.) Complete specification.)

NOVEMBER 26.

24965. A new or improved electrical resistance measuring instrument. George Tilden Hanchett and Frederick Brittan Sage, 70, Market-street, Manchester. (Complete specification.)

24982. Improvements in appliances for overhead electric traction. William Rose Smith, 117, Victoria-street, London.

24992. Automatic telegraph apparatus. Giulio Giorgi, 321, High Holborn, London. (Complete specification.)

25009. A new or improved electric arc lamp. Charles Vernier, 7, Southampton-buildings, Chancery-lane, London.

25013. Improvements in or connected with electric arc lighting. Alexander Vosmaer, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED.

1896.

21956. Electric accumulators.** Julien. (Amended.)

1897.

25388. Compositions for use in the construction of electrical heating apparatus and resistances, and the processes for their manufacture. Parvillée.

25581. Lighting regulator for gas and petroleum motors lighting electrically. Henry Marie Leon Crouan.

27569. Meter for electric current. Möhrle.

27683. Electrical storage batteries. Lane.

28338. Pumps for exhausting electric incandescent lamps. Satchwell.

28726. Lamp and shade holders for incandescent electric lamps. Booth.

28727. Insulating blocks connected with holders for incandescent electric lamps. Booth.

28728. Holders for incandescent electric lamps. Booth.

30832. Arc lamp carrier. Brockie.

30848. Operating railway points by electromotors. Timmis.

1898.

11518. Electrical lighting devices for kerosene and other burners. Meyer.

12322. Electric batteries. Edwards. (Emanuel.)

12393. Safety devices for electrical circuits. Steele.

16877. Desk telephones. Byng and Bell.

17622. Method of manufacturing incandescent electric lamps. Allison. (Lister and Chamberlain.)

17984. Electric railways and tramways. Warwick.

19951. Electrical gas lighters. Seiler.

20279. Apparatus for registering the number or duration of telephonic conversations. Hadden. (Eichwede.)

20418. Motors for electric railways. Short.

20894. Trolley cars for electric railways. The British Thomson-Houston Company, Limited. (Geisenhoener.)

20895. Electric surface contact railway systems. The British Thomson-Houston Company, Limited. (Potter.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Nov. 26	3,491	3,167	+ 324	—	—
Blackpool and Fleetwood Tramroad	,, 18	211	—	—	13,566	—
Bristol Tramways and Carriage Co.	,, 25	2,454	2,339	+ 115	—	—
City and South London Railway	,, 27	1,114	1,060	+ 54	21,519	20,785
Dover Tramways	,, 26	134	85	+ 49	7,786	—
Dublin U.T., elec. cars	,, 25	304	†343	− 39	10,395	7,708†
Dublin S.D. Electric Tramways	,, 25	544	406	+ 138	20,479	18,908
Halifax Corporation Tramways	,, 23	214	—	—	5,622‡	—
Liverpool Overhead Railway	,, 28	1,317	1,257	+ 60	—	—
South Staffordshire Tramways	,, 25	559	544	+ 15	29,739*	29,862*

* Receipts since Jan. 1. † Horse cars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	17-18
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10¼-10⅝
—— 4½ per cent. Cum. Pref	10	10¾-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13¾-14⅛
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	103-105
Callender's Cable Company, Debentures	100	111-114
—— Ordinary	5	9¼-10¼
Central London Railway, Ordinary	10	9⅝-10¼
——	6	5⅝-6¼
—— Pref. Half-Shares	1	1⅛-1⅜
—— ,, ,,	5	4⅝-5
Charing Cross and Strand	5	11⅛-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	24-25
—— 90,001-100,000	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	65-68
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	134 136
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12½-13½
—— ,, ,, No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅝-2
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-146
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	99-101
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5¼
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	2⅜-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	1-1⅛
Elmore's Wire Company	2	1⅞
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9¼-10¼
Imperial Tramways, Limited	6	15⅜-16⅜
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7⅞-8¼
London Electric Supply, Ordinary	3	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oriental, Limited, 1879	1	1⅛-1⅜ xd
—— £5 Shares	5	7-7½ xd
—— £4½ Shares, New	4½	6⅛-6⅜ xd
Oriental Telephone and Electric Company	1	1-1⅛
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1⅛	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-105
South London Electric Supply, Ordinary	3	2⅛-2⅜
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	159-164
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

The Civil Engineers of France.—The president of the Société des Ingénieurs Civils de France has addressed to all the members an autograph letter asking them to indicate any work which they think should be mentioned in the *Proceedings* commemorating the fiftieth anniversary of the society.

Dynamo Literature.—We understand that the English translation of Mr. J. Fischer-Hinnen's excellent treatise on "Continuous-Current Dynamos" is practically ready for issue. The final proofs have been passed, and copies of the book will be obtainable from Messrs. Biggs and Co. in the course of a few days.

Light Railways.—The November applications to the Light Railway Commissioners number 54, out of which 32 are for lines to be worked by electricity. In 15 of these the gauge will be 3ft. 6in., and 4ft. 8½in. in the rest. The total proposed mileage of the electric lines is 237¾ miles, and the total estimated expenditure is over £1,760,000.

Electric Tramway Statistics.—The 1898 number of the *American Street Railway Investments* has been issued by the *Street Railway Journal*, and can be obtained at their Westminster office, 139, Victoria-street. This volume is the usual financial supplement issued by the *Street Railway Journal*, and the information it contains should be of great service to everyone interested in electric traction.

Daily Doses.—We have received from the Telephone Users' Association a batch of letters on the telephone question, with the request that we shall insert one letter per day. This being a weekly journal, we do not see our way to do so. As the contents of the letters consist mostly of incorrect statements about the Post Office and the telegraph service, shall not further spread the author's erroneous ideas.

Central Technical College.—The following is the list of the scholarships awarded for the present session of the above college: Clothworkers' scholarship, £60 a year, to A. J. Cook; Mitchell scholarship, £50 a year, to R. H. Collins; John Samuel scholarship, £30 and free education, to F. C. Hounsfield; institute's free studentships, to R. H. Buckie, A. W. Harrold, and W. H. P. Brounger. We also note that Prof. Henry E. Armstrong is now dean of the college.

Telephone Conference.—Yet another conference on the subject of the telephone monopoly is to be held in London. The position has altered somewhat since the last conference, and now the interest centres around the advisability of the local authorities of London taking advantage of the opportunity afforded them to set up a competitive system. We learn from the *City Press* that permission has been granted for the conference to be held at the Guildhall, and it is hoped that the Lord Mayor will find it convenient to preside.

Erratum.—In a note in our issue for Dec. 2 we referred briefly to a lecture delivered by Mr. J. W. de Grave. We have since heard from the author of this lecture that our report misrepresented his views on the question of the belt driving of coal-cutters. In his lecture he advised the use of belts for transmitting the power required for hauling and pumping work, but in no case would he advise this means of driving an electric coal-cutter. We may be able to refer to this subject again, when the full text of the author's paper has been forwarded to us as promised.

The City Lighting.—At the meeting of the Court of Common Council of the City of London, held last week, it was reported that letters had been received from the Smithfield Markets Electric Supply Corporation, Limited, and the Charing Cross and Strand Electric Supply Corporation, Limited, asking for the formal consent of the Corporation to their intended applications to the Board of Trade for provisional orders for the supply of electricity within the City. It was agreed that the companies should be informed that the Corporation regretted that it was unable to give its consent to the applications.

The Baker-street and Waterloo Railway.—Work on this line is being pushed forward by the contractors, Messrs. Perry and Co., and the tunnelling itself will soon be commenced. The staging in the Thames near Charing Cross is now being fitted up with the necessary plant, and the vertical shafts are being sunk. It is surprising how the name of the late Mr. Greathead, whose system is to be used for the tunnelling, is handled by the untechnical reporters. Thus, we learn again that "the method of constructing the actual tunnel by means of the great head shield is too well known to need description."

Conservative Eastbourne.—Mr. G. F. Chambers, in his presidential address to the Eastbourne Natural History Society, spoke up bravely for electrical traction. He remarked, however, how strongly new schemes are opposed in the town, and hence concluded his remarks in the following words: "At the possible risk of being pelted with brickbats, I will venture to say that I hope the day is not far distant when we shall see electric tramcars running from Langney Point to Beachy Head *viâ* the Grand-parade in one direction, and *viâ* South-street and Seaside-road in another." The mover of the vote of thanks threw the first stone.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 5th inst., Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding. The following were elected members: Mr. Herbert William Allingham, F.R.C.S., Mr. T. Newbold Piddocke, Mr. Edward Preedy, Mr. William Munro Tapp, LL.D., the Hon. William Frederick Cuthbert Vernon, Mrs. Adela Wetzlar, and Dr. Charles Theodore Williams, L.R.C.P. The special thanks of the members were returned to Dr. George Wyld for his present of a portrait of Dr. Thomas Garnett, first professor in the Royal Institution.

The Colchester Works.—The electric lighting enterprise at Colchester will be formally inaugurated next month, but already the supply has been commenced. The number of consumers is rapidly increasing, and great interest is being taken in the new illuminant. Mr. W. H. Massey, of Messrs. Massey and Allpress, has designed the works, and the contract was given to Messrs. Siemens Bros. We note that the charge for electrical energy is to be rather high—*i.e.*, 8d. per unit for the first hour's average use and 5d. per unit afterwards. We think the municipal authorities would do better to charge less than this from the first, and thus get a larger number of satisfied consumers.

Telephone Test Case.—An interesting test case between the National Telephone Company and Mr. A. Austin, of Elgin, is about to be tried at the Elgin Sheriff Court. The cause of dispute arises out of the use of inter-urban trunk wires. The defendant agreed in 1894 to subscribe £6. 10s. to the Telephone Company for their local service, and to increase this amount to £8. 10s. as soon as the trunk wires had been erected, to allow him to speak to other towns. These were expected to be ready in 1896, but until the Post Office completed them this year no inter-urban service has been given. The company now claim the increased rate of subscription, in spite of the

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fact that the defendant will have to pay trunk-line fees in addition. This case is a test one, and is causing much interest.

American Institution of Electrical Engineers.—We have received the October number of the *Transactions* of the American Institution of Electrical Engineers. In it are included a paper entitled "An Electrical Survey in New York City," by Mr. A. A. Knudson, showing results of stray current, measurement between electric railways, underground pipes, etc., and also the results of tests on the Brooklyn Bridge. There is also given a lengthy paper by Mr. C. F. Scott on "High-Voltage Power Transmission." The discussion on the "Photometry of the Enclosed Arc" is continued in this number. A list is given of members elected on Sept. 28, and also an obituary notice of Mr. C. G. Davenport.

A New Honour.—It is stated by the *St. James's Gazette* that Prof. W. C. Röntgen, the celebrated discoverer of the X-rays, has been offered a chair in the Faculty of Philosophy in the University of Leipzig with exceedingly flattering inducements. It is believed that the professor will accept the appointment. Not long ago, in recognition of valuable services to his native country and to all the world, Prince Ludwig of Bavaria created Prof. Röntgen a baron. The Emperor William has decorated the great scientist with the Order of the Royal Crown. All sorts of honours have been showered upon the inventor, and at the invitation of the Kaiser he illustrated his discovery by a number of experiments in the Imperial Schloss. Baron Röntgen was born in 1845 in Zürich, Switzerland, where he graduated and received his medical diploma.

A New Source of Mica.—In five or six localities in Coorg, India, sheets of mica, well up to the marketable size, have been obtained. The largest were, says the Royal Institute *Journal*, procured on Elk Hill, where, from immediately under the soil, sheets, free from warping, and measuring some 30in. across, were removed from the outcrop of the vein. All samples show a high degree of elasticity and good colour, but much of the material will have its value depreciated by ferruginous inclusions between the cleavage planes, whilst some of the mica is badly warped. It is extremely unlikely that the best veins have been the first to be "struck" in an area so completely soil-covered, but enough has been shown to prove that the mica-bearing pegmatites extend over a wide area, and will probably be a source of profit if worked with discretion.

Dublin Disputes.—In the Southern Division of the Police Courts last week, the Dublin Corporation was prosecuted at the suit of the Sun Fire and Life Insurance Company for making default to supply the complainants with electric light, whereby they rendered themselves liable under the lighting order of 1892 to a penalty of £2 for every such default. Euidence was given on the part of the Corporation to the effect that the cable laid down in 1891 was defective, but was the best then known. The Corporation was now engaged in putting down a new cable at a cost of £100,000. The magistrate said it was clear that this was an unavoidable accident. At the time the cable was laid down the Corporation took every possible precaution to get the best material they could. He dismissed the summonses without costs. This is the first attempt we know of to enforce the penalty prescribed by the Electric Lighting Acts of 1888.

Undue Influence.—The National Telephone Company must surely have a large percentage of Irishmen amongst its directors and staff, to judge from the following letter which has been addressed by Mr. A. R. Bennett to the town clerk of Glasgow. The letter reads: "Messrs. L. M. Ericcsson and Co., the manufacturers of telephone apparatus at Stockholm, have officially informed me that they have entered into an agreement with the National Telephone Company not to supply any telephone apparatus for exchange purposes to any municipality or corporation within the British Isles, or any license of her Majesty's Postmaster-General, and that any order must be accompanied by an agreement that the would-be purchaser will not sell, let, lend, or dispose of to, or suffer or permit to be used by, any such municipality, corporation, or license. I think that this is a matter that should be brought to the cognisance of the Telephone Committee before any consultation with the National Company takes place. Probably attempts will be made to induce other suppliers to conclude similar agreements." The firm in question will naturally conduct its business on its own lines, but we trust that English manufacturers will refuse to join them in boycotting all rivals of the National Telephone Company. Such procedure as is disclosed in the above does not tend to a peaceable issue. We trust that no Government orders will be given to the above firm in future, and that English manufacturers may profit by this move.

Police Telephones.—The crusade against the Metropolitan and City Police because they are not users of the telephone system has been run to death by the *Daily Mail*. As a sensational finish, the editor announces that, as no arguments as to the uselessness or inconvenience of the telephone in London police stations have been brought forward, there can be only one reason for the neglect of the telephone—*i.e.*, the officials are afraid of the expense. This reason will not be allowed to stand, and our contemporary's leader finishes up as follows: "We hereby offer to pay from the coffers of the *Daily Mail* the entire expense of putting all the London police stations on the telephone for one year." In another place we are told that the "public is also desirous that police stations should be, by means of the telephone, in instantaneous communication with each other." We doubt if even the circulation of the daily paper in question entitles it to speak for the public, and it certainly does not make them telephone experts. Nothing could do more to defeat the ends of justice than to have the messages between the different police stations transmitted by the present telephone system. The messages can be overheard at the exchanges in circuit, and often by outside subscribers also. While we think it should be possible to call for police assistance by telephone, we are sure that the public telephone service as at present arranged should be used as little as possible for police messages. The private telegraph answers much better for inter-official communications as it is both secret and self-recording.

Royal Society.—The annual meeting of the Royal Society of Great Britain was held last week to receive the report and elect officers for the new year. The following is the list of alterations: Lord Lister, of course, remains president. Sir John Evans is succeeded as treasurer by Mr. Alfred Bray Kempe, and Prof. Michael Foster, with Prof. Arthur William Rücker and Sir Edward Frankland, continue to be the principal secretaries. The new members of council are Captain Ettrick Creak, R.N., Prof. D. J. Cunningham, Prof. James Dewar, Prof. W. D. Halliburton, Prof. W. A. Herdman, Prof. Victor A. H. Horsley, Sir Andrew Noble, Prof. Arthur Schuster, Dr. George Johnstone Stoney, and Prof. Joseph J. Thomson. The medals presented this year were awarded to the following gentlemen: the Copley Medal to Sir William Huggins, for his researches in spectrum analysis applied to the heavenly bodies; the Rumford Medal to Prof. Oliver Joseph Lodge, for his researches in radiation and in the relations between matter and ether; a Royal Medal to

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Dr. John Kerr, for his researches on the optical effect of electrical stress and on the reflection of light at the surface of a magnetised body; a Royal Medal to Mr. Walter Gardiner, for his researches on the protoplasmic connection of the cells of vegetable tissues and on the minute histology of plants; the Davy Medal to Prof. Johannes Wislicenus, for his contribution to organic chemistry, especially in the domain of stereochemical isomerism; and the Darwin Medal to Prof. Karl Pearson, for his work on the quantitative treatment of biological problems.

The Cork Tramways.—On Monday last a few electric cars ran trial trips on the Cork tramways, which were eminently successful. The official inspection by the Board of Trade inspector was to take place yesterday, and granting that the certificate from the Board of Trade is promptly obtained, it is hoped that the tramways will be open for traffic on Saturday. During the trial the local jarvies showed active opposition to this new rival. The *Cork Examiner* states that when the cars reached the stand between Marlborough-street and Prince's-street, two or three of the jarvies refused to remove their cars out of the way of the electric cars, which had, as a result, to be abruptly pulled up. The city engineer warned the driver directly in front of the leading electric car that he was creating an obstruction, and ordered him to move to one side or the other, but the jarvey stoutly refused, and then the conductors of the electric cars and the hackney car drivers sat looking at each other for some minutes while one of the officials of the tramway company went in search of a policeman. The jarvey whose inside car was nearest to the electric cars, however, refused to budge, and loudly protested that the jarvies had received no notice of this trial of the trams, that he was within his legal right in remaining on the stand, which he had to pay for, and that if he did leave it without a fare, he was liable to be prosecuted for loitering. Before the arrival of the police, in a minute or two the jarvey who had thus asserted his rights was employed by a fare, and promptly drove away. Still further obstructions occurred on the return journey, till a policeman walked in front of the cars as they passed over the carstand.

The Manchester Tramway Scheme.—We have received from Mr. Hans Renold a pamphlet, in which his letter to the *Manchester Guardian* in favour of the conduit system in Manchester is reprinted. Mr. Renold commends greatly the report of Mr. J. A. Baker to the London County Council. He considers that if the Manchester experts had visited New York and Washington to see the conduit lines at work in those towns, they would not have recommended the overhead system. In support of his views he quotes from Mr. Harold Brown and Mr. Knudson to show how badly metallic pipes in the roadway may be affected where the trolley system with earth returns is used. He does not, we think, quite appreciate the great difference in the effects produced in consequence of the lower voltage drop allowed in this country. Mr. Renold refers to the dangers from wires breaking in the overhead system, and is strongly of opinion that in the main streets of Manchester such dangers are a fatal objection to its introduction. At the end of the letter a note from Mr. Baker himself is included, but in this the fault appears of comparing the cost of the trolley lines at Glasgow with that of the conduit at New York. The comparison is in favour of the conduit, with cost 5d. per car mile as against 6½d. in Glasgow. But the conclusion that the conduit lines are 1½d. cheaper to work is quite fallacious. The Glasgow trams only run on a short line, and the financial results of the first few months cannot be considered any gauge as to the ultimate cost when the whole system has been converted. Apart from this, we think that Mr. Hans Renold's letter comes at an opportune time, and that it should be seriously considered before the present trams are converted for electric driving.

Glasgow Telephones.—Mr. A. R. Bennett, the telephone specialist, has submitted a report to the Glasgow Corporation, in which he states that the estimate prepared by him for the Glasgow telephone enquiry, which amounted to £100,000 for 5,200 subscribers and call offices actually working, besides 1,200 spare unfinished lines and 587 junction lines, may still be taken as correct. It was based on the same type and quality of material used by the National Telephone Company, but in practice he would not recommend such a close adherence to the National Telephone Company's practice as was assumed in the estimate for the purpose of comparison. As soon as the municipal exchange had 2,000 or 3,000 subscribers successfully talking, which stage should be reached within 12 months, he would expect that new orders would flow in very rapidly, and that by the end of three years the orders already executed and in hand would number 10,000, or perhaps 12,000. He would, therefore, recommend the adoption of double the number of lines contemplated, or 10,400 completed and 2,400 spares—12,800 in all—as a basis for the initial scheme, which he estimates at £200,000, or a rental of £6. 17s. 1d. per line. He estimates, however, that all the rental necessary would be £6. 1s., instead of £5. 5s. originally proposed. This 16s. on 10,400 lines would, in 12 years, produce £99,840, which, added to the £72,000 of sinking fund, would, apart from other accumulations, amount to £171,840 in 1912. Thus only £28,160 would remain to be recovered by sale to the Post Office or sale of assets. The 16s., he suggests, should be a precautionary contribution to a sinking fund which may or may not be ultimately required, and could be made returnable to the subscriber in 1912 should the license be extended, or should sale to the Post Office or realisation of assets render the sinking fund superfluous.

Railways v. Tramways.—The competition between electric tramways and suburban railways has ended disastrously for the latter in the case of the Dublin Southern Tramways. This is not an isolated case. The last annual report of the Manhattan Elevated Railroad Company, of New York, shows the effect of improved street surface transit upon the business of the elevated road. The gross earnings (the report covers the year ended Sept. 30 last) as compared with those for the previous year, show a loss of £31,200, and the net earnings decreased £18,800. Apart from the financial aspect of the report the most significant feature is the decrease in the number of passengers carried, the loss being 3,556,500. This, however, probably does not represent the actual loss, because the aggregate number of passengers carried on all lines is rapidly increasing from year to year, and if the company had held its own against the competing surface roads, the number of passengers carried would not have been the number carried in 1897, plus the 3,556,500 lost this year, but an increase over this sum, representing the company's share of the increased business. Of course, the surface lines got all of the additional business, besides that lost by the elevated road. The latter concern has been showing negative results ever since the underground system was laid down on the surface roads, and there is no reason to doubt that the losses will continue in an increasing ratio as the new electric lines are opened up. It is evident, says the *Electrical World*, that radical improvements over existing methods of operation will have to be introduced in order to meet the advantages offered by the surface lines in convenience of access

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to the cars and speed. The adoption of electric power on the elevated road and quicker transit between stations would partially at least retrieve the lost business.

Vibrations.—Mr. F. W. Branson, F.I.C., read a paper recently before the Leeds Naturalists' Club and Scientific Association on "Some Recent Discoveries in Physical Science." Attention was first directed to the dissimilarity of radiations transmited by the atmosphere and by the ethereal medium which pervades all space. Experiments were made with sound waves to illustrate the former, and with the Hertzian waves the latter. The gradations which may be observed between sound, light, heat, and electrical waves were demonstrated by means of models and diagrams, and a table showing the number of vibrations per second of various radiations was given as follows:

Vibrations per second.	
288,224,000,000,000,000	Röntgen rays.
1,125,899,906,842,624	Photographic limit of solar spectrum.
562,949,953,421,312	Green light.
281,474,976,710,656	Infra red (photographic limit).
70,368,744,177,664	Heat rays of solar spectrum, lowest direct measurement.
67,108,864	Electric oscillations in Hertz resonator, 70 cm. diameter.
32,768	Audible vibrations, extreme upper limit.
4,096	Music, highest note.
32	Music, lowest note.
16	Water surface waves of minimum velocity.

The system of wireless telegraphy used by Marconi was then demonstrated by means of Hertzian waves emitted from a Hertz radiator. A number of experiments with phosphorescent bodies, etc., and the Röntgen rays, were then shown, and, by means of a Tesla coil, so arranged as to give a rapidly alternating field, tubes of high vacua were illuminated without the intervention of conducting wires. The experiments were very numerous and of the greatest interest, and a large attendance of members testified to the appreciation of the labour which their preparation must have entailed. It is amusing to note the large number of significant figures in the above values. Half of them, at least, are guesswork.

Alternator Armature Windings.—The *Electrical World* has in its recent issue the following useful dissertation on the arrangement of the wires in the armatures of alternators: "The distribution of the armature winding of alternators into two or more slots per pole and per phase has become quite common in the case of multiphase machines, in which its advantages are greater and more obvious than in the single-phase type. The pole-wound or unitooth single-phase machine is still that more generally built, although a full comprehension of the advantages of the other would undoubtedly induce a more general demand for the multi-tooth machine. The improved working of the latter is, however, gradually forcing it into more general use, single-phase machines now being built in this country with the winding distributed n as many as eight slots per pole. The advantages of the multi-tooth or distributed winding are several. It gives a more nearly sinusoidal form to the impressed E.M.F. wave; it reduces the self-induction of the windings and consequently the internal drop, and particularly the drop on reactive load; it distributes the armature distortion, which, with the unitooth construction, causes a heavy bunching of the lines of force immediately ahead of the slot, increasing the iron loss in the pole-pieces even if the latter are laminated, and it eliminates the pulsating variation of the reluctance of the magnetic circuit which is inherent with the unitooth type, and which increases the iron losses. These advantages are obtained at the cost of a greater expense in construction and a far greater necessary care in the insulation and a somewhat reduced E.M.F. per turn, since the distribution of the windings renders the E.M.F. waves on the different slots somewhat out of phase with each other. In case of a uniform distribution over the whole pole angle the effective E.M.F. per turn is reduced by the distribution in the ratio of 1 to the average cosine of all angles between $\pi/2$ and $-\pi/2$, and since this average cosine is $2/\pi$, which is equal to about 0·637, the E.M.F. in case of a uniform distribution is diminished about 35 per cent. The advantages, however, in case of a machine built to give satisfactory service as against one built to sell, outweigh the disadvantages."

Tesla's Views on his Critic.—The *Electrical Engineer* of New York in a recent issue printed the full text of a lecture by Mr. Nikola Tesla before the American Electro-Therapeutic Association. This course, and their leader on the subject, has drawn forth the following letter from this noted inventor: "Sir,—By publishing in your columns of Nov. 17 my recent contribution to the Electro-Therapeutic Society you have finally succeeded—after many vain attemp made during a number of years—in causing me a serious injury. It has cost me great pains to write that paper, and I have expected to see it appear among other dignified contributions of its kind, and I confess the wound is deep. But you will have no opportunity for inflicting a similar one, as I propose to take better care of my papers in the future. In what manner you have secured this one in advance of other electrical periodicals who had an equal right to the same, rests with the secretary of the society to explain. Your editorial comment would not concern me in the least were it not my duty to take note of it. On more than one occasion you have offended me, but in my qualities both as Christian and philospher I have always forgiven you, and have only pitied you for your errors. This time, though, your offence is graver than the previous ones, for you have dared to cast a shadow on my honour. No doubt you must have in your possession, from the illustrious men whom you quote, tangible proofs in support of your statement reflecting on my honesty. Being a bearer of great honours from a number of American universities, it is my duty, in view of the slur thus cast upon them, to exact from you that in your next issue you produce these, together with this letter, which, in justice to myself, I am forwarding to other electrical journals. In the absence of such proofs, which would put me in the position to seek redress elsewhere, I require that, together with the preceding, you publish instead a complete and humble apology for your insulting remark, which reflects on me as well as those who honour me. On this condition I will again forgive you, but I would advise you to limit yourself in your future attacks to statements for which you are not liable to be punished by law.—N. TESLA." Our contemporary's leader in question does not, in our opinion, warrant the tone of Mr. Tesla's letter, and the justification both for publishing the lecture and for criticising Mr. Tesla's statements in the American Sunday papers are ample.

Low-Tension Accidents.—The safety rules of the Verband Deutscher Electrotechniker, which have already been accepted by most of the German Governments, have now also been accepted by the Prussian Government. The Minister, in his letter to Mr. Gisbert Kapp, the secretary of that society, asks to be informed what steps are intended to be taken with regard to voltages between 250 and 1,000, those up to 250 and over 1,000 alone having been dealt with in the above-mentioned regulations. The *Electrotechnische Zeitschrift* reproduces the communication made

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by the society to the Government on accidents caused in chemical and other factories. It is accentuated that the danger lies, not in the pressure itself, but in the strength of current produced by it. The current is in direct proportion to the pressure, and in inverse ratio to the resistance of the human body to earth. From experiments made by Messrs. Siemens and Halske with their own workmen and those engaged in a sugar refinery, it appears that the average insulation resistance of the human body may be from 2,000 to 3,000 ohms under abnormal conditions, whereas it is as high as 100,000 ohms normally. This was ascertained in the following manner: Each workman was called from his work and made to grip one electrode (representing the line), while the other electrode was placed on the ground. The range of the apparatus was from a few hundred ohms to 150,000. Other tests were made from hand to hand. The result was that out of 25 men in 17 cases the resistance was 150,000 ohms or more, in seven cases it varied from 50,000 to 150,000, and in the other test it varied from 4,000 to 17,000. All the workmen wore wooden shoes with leather toecaps. These results refer to normal trades. For workmen in certain factories the figures are very much lower. In one room in a sugar factory they ranged from 1,700 to 900 ohms. In the cooling-room, where the salt centrifugals are placed, it was from 2,400 to 1,100 ohms; in the boiling-room the resistance of the workmen was found to be from 3,000 to 1,200 ohms. Evidently much depended upon the dryness of the shoes. In the repairing shed, where the average resistance of the operators was 7,000 to 1,300 ohms, one man with new wooden slippers topped the list at over 150,000 ohms. In the sugar centrifugal room the limits were between 50,000 to 3,000 ohms—a wide range, indeed. Amongst nine men measured in the engine-room, six gave a resistance of over 50,000, two over 20,000, and one over 10,000 ohms. These figures are equally applicable to continuous as well as to alternating current.

The Ventilation of Tunnels.—Mr. Francis Fox read a paper last Tuesday before the Institution of Civil Engineers on "The Ventilation of Tunnels and Buildings." The whole of the paper is of interest to electrical engineers, but the first part, dealing with tunnel ventilation, is specially valuable at the present time. The author enunciated the proposition that if the amount of carbon dioxide in the air of a railway tunnel did not exceed 20 parts in 10,000, then the ventilation might be deemed satisfactory. On this basis, and allowing 29 cubic feet of poisonous gas for each pound of coal consumed in a locomotive, the number of pounds of fuel consumed per mile, multiplied by 29, multiplied by 500, and divided by the number of minutes' interval between the trains, would give the volume of air which must be introduced into the tunnel per minute. The ventilation of the Severn and Mersey tunnels had been determined by this rule, and had been referred to as satisfactory in the report of the Departmental Committee of the Board of Trade on the Ventilation of the Metropolitan Railway Tunnels, 1897. In regard to the Mersey tunnel, it was, however, to be regretted that owing to the poverty of the company inferior coal was being used, and the fans were run at a lower speed than was intended. Even with these drawbacks, however, the purity of the air in the Mersey tunnel was well within the limits proposed by the author. The case of the Metropolitan Railway tunnels having been the result of recent investigation, was not mentioned otherwise than to recall the fact that the amount of carbon dioxide in the air had been shown to be as much as 86 parts per 10,000. The great Alpine tunnels were next referred to. In the case of that under Mont Cenis, 8½ miles long and 26ft. wide, the higher altitude of the middle of the tunnel above its entrances was inimical to good ventilation, and at times great difficulty was experienced in carrying on the traffic. The antiquated system at present employed was merely palliative, consisting in the injection of only 70 cubic metres per minute of air compressed to 75lb. per square inch, discharged at points 1 km. apart throughout the tunnel. Owing to the bad ventilation, not only were the men working in the tunnel subjected to great discomfort, but the corrosion of the rails was excessive, about 300 tons having to be relaid every year. As regards the ventilation of buildings, the author expressed the opinion that no large building could be successfully ventilated without some mechanical force furnished by steam, electricity, falling water, or other such agency. Then, fans could be worked with certain results, whereas automatic extractors not infrequently became inlets, thus reversing the whole system.

Galvanic Deposits on Non-Conductors.—The following is an abstract from Mr. Carl Hering's digest of an article by Knothe, in the *Elektrotechnischer Anzegier*, on the best process for coating objects that are non-conductors: It is hopeless to try and form a metallic coating by chemical means, and the only satisfactory methods are to use graphite or a coating obtained by a solution of silver. The graphite method is briefly described, but is considered inferior to the silver solution method. For the latter a solution of nitrate of silver in alcohol is used, the body being dipped into it or coated with it; it is then placed in the vapour of phosphor or sulphide of hydrogen, which converts the coating into a conductor; the sulphur method is preferred because the coating adheres better and the process may be repeated if not successful at first, while that is not the case when phosphorus is used. The silver solution should be made neutral with ammonia, as it will then adhere better to greasy surfaces and hastens the sulphiding process. With such a coating the first deposit is formed a little more rapidly than with graphite. The object should have one or more copper conductors attached to it to start the deposit; these starting points are best placed in the deeper portions of the object. The object should first be treated so that all pores are filled and that it becomes waterproof; this is done with wax, tallow, or a mixture of the two and collodium; wood is best boiled in linseed oil. The silver solution is made of two parts by weight of silver nitrate, four parts water, five parts ammonia of 0·9 specific gravity, and six parts of absolute alcohol; when the ammonia is added a brown precipitate is first formed, but is redissolved. After being coated with this it should be completely dried and freely exposed to the air for some time; it is then subjected to the action of the hydrogen sulphide; this process may be repeated as often as is necessary. The current for depositing the copper should be only 0·5 to 1 ampere per square decimetre of surface, and at 0·75 to a maximum of 1·5 volts. The copper solution should consist of 3 to 4 parts of water to 1 part of the sulphate and 2 to 8 per cent. of sulphuric acid. The hydrogen sulphide is obtained by pouring dilute sulphuric acid on iron sulphide. A metallic deposit on glass, porcelain, etc., is best obtained by coating it first with gold paint and then firing, after which the deposit can be made. Or the objects may be covered with a coating of wax or resin, which is then coated with a silver solution as above described. Celluloid may be coated in the same way. Collodium or celluloid may also be coated with a solution of phosphorus in ether-alcohol added to a solution of concentrated silver nitrate; the object is then painted with the creamy precipitate which is formed. It is found that copper salts in place of the silver salts do not give such good results.

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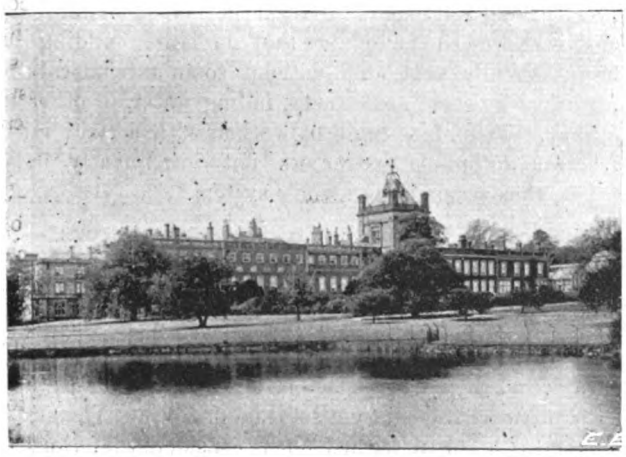
THE ELECTRIC LIGHTING EQUIPMENT AT KNOWSLEY HALL.

We were privileged some little time ago in having an opportunity afforded us of seeing the recently completed electric light installation at Knowsley Hall, the Lancashire seat of the Earls of Derby. Arriving at Huyton Station, which is the nearer, although the Hall is in Prescot, we were met by Mr. Alec Robinson, the electrical engineer-in-charge of the installation. During our drive up from the



View of Knowsley Hall from the East.

station we were able to learn a few particulars of historic and general interest before tackling the technical matters that we had come more especially to see. We understand that Knowsley has been the seat of the Earls of Derby since 1385. The park is some 2,000 acres in extent, and is entered by four lodge gates. The greater portion of the mansion was built by the ninth earl about the time of George II., from designs by Forster. The handsome dining-room, however, which is seen in the south view of the Hall in the centre, with the two turrets at either corner, is quite recent, having been built by the late earl, while the central or Jubilee tower was built to commemorate the fiftieth jubilee of her Majesty. The present earl has also just completed some additions round about the engine-room, which itself is, of course, new.

Knowsley Hall was fitted for the electric light in 1892, the wiring being undertaken by the Liverpool Electric Supply Company, for whom Mr. Alec H. Robinson, the present resident engineer, superintended the work. At that time an alternating current was supplied by the British Insulated Wire Company, who hold the provisional order for Prescot, and for the carrying out of which they have equipped a central station in their works. However, when the present Lord Derby succeeded to the estate it was decided to put down a private installation solely for the house, gardens, and stables which would be in closer proximity to the work than the generating station at Prescot, which is some $2\frac{1}{2}$ miles off. Upon this decision being arrived at, arrangements were immediately made with a view of having a private plant ready to take up the load. Seeing that the original wiring of the Hall was in the hands of Mr. A. Bromley Holmes, M.I.C.E., etc., it was only natural that he should be asked to draw up the specifications in the present case. So satisfactorily was this done, that we have absolutely no hesitation in saying that Knowsley possesses one of the finest private installations of electric light to be found in the kingdom. We cannot do better than take the various sections of the installation in order, and give a description of same; and naturally we start with the buildings.

The Buildings.

The buildings devoted to the electric light are situated at one end of the Hall, and consist of separate engine, boiler, and accumulator rooms, with the necessary storerooms, workshops, etc. These buildings are of red brick, with stone quoins, battlements, and copings. The chimney, 90ft. high, forms one corner of a large square tower, to which the station is connected, and is quite unnoticeable. The photograph (Fig. 1) gives a good idea of the general appearance of the station buildings and chimney, the latter being in the right-hand corner of the tower. In view of the fact that the engine-room is actually adjoining the main building, as will be seen from the general plan (Fig. 2), although, it is true, on the side remote from the principal rooms, it was of paramount importance that there should be an entire absence of any vibration whatever. To effectively secure this object the whole of the buildings and foundation are set on the solid rock, the ground having been excavated till the rock was exposed, and then levelled up with concrete. In some parts, it may be mentioned, it was necessary to lay 15ft. of concrete. On the solid foundation thus obtained, the boiler-house, battery-room, and engine-house were built. The plan and elevations (Figs. 2 and 3) show the arrangement of the different rooms. It will be noticed that as regards the accumulator house there are three storeys, but at present only one, the middle one, which is on the ground-level, is in use, the others being provided to cope with any necessary extensions. The boiler-house occupies the centre bay, the boilers being placed with their tops on about the ground-level, and open to the roof with the exception of a gallery running along the back. The engines and dynamos are placed on the ground level on massive

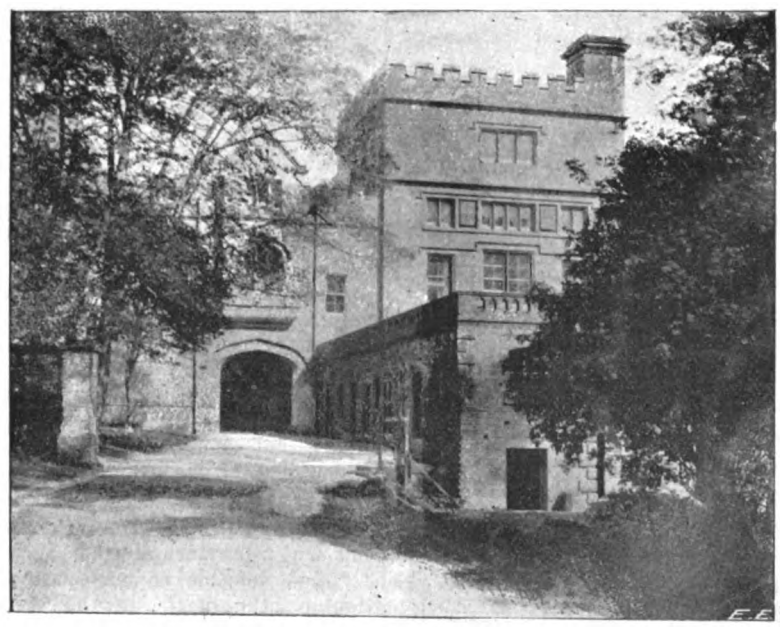


Fig. 1.—Engine-Room Buildings at Knowsley Hall.

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concrete beds, the spaces between the beds and the walls, etc., being covered in with an iron girder and cement floor, thus leaving the space round the foundations free for the ready inspection of exhaust pipes, conductors, etc., an entrance being obtained to it from the boiler-room floor. The storeroom, etc., is at the back, entered from the back of the boiler-house, to which access is obtained from a door under the stairs leading to the gallery over the switchboard.

THE GENERATING PLANT.

The boiler-house (Fig. 4) is 40ft. by 20ft., and is provided with ample means of ventilation. The boilers, two in

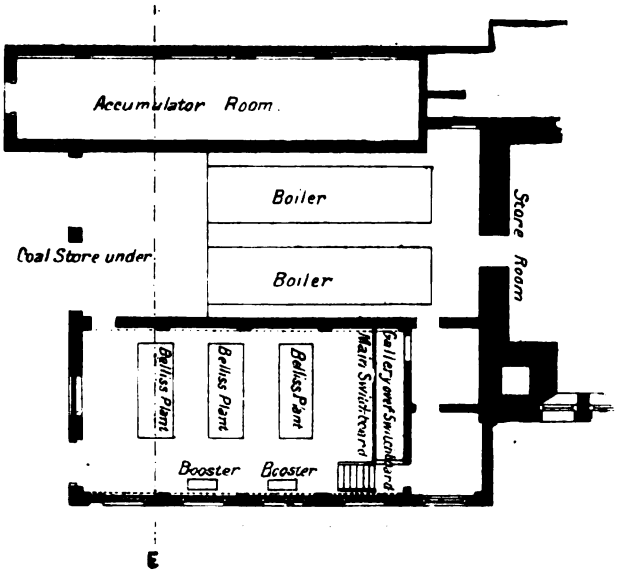

FIG. 2.—Plan of the Electric Plant.

number, were made by Joseph Adamson and Co., of Hyde, near Manchester, and are of the Lancashire type, 28ft long by 7ft. diameter, with two internal flues, each being 2ft. 9in. diameter, and tapered down at the back end to 2ft. 4in. diameter. They are calculated to sustain a working pressure of 120lb. per square inch, and were tested by hydraulic pressure up to 220lb. by the inspector of the insurance company before leaving the makers' works. The grate area in each boiler is 33 square feet, and the heating surface 830 square feet, giving a proportion of 25 to 1. The material used in the construction of the boilers was supplied by the Butterley Company, of Derby, and was made by the Siemens-Martin acid process. The tensile strength is between 20 and 30 tons per square inch, and the

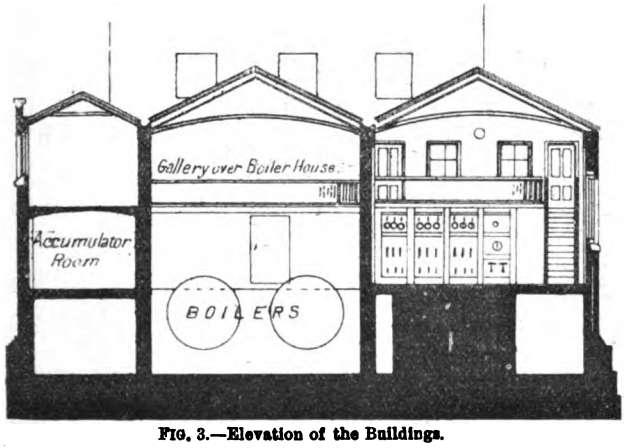

FIG. 3.—Elevation of the Buildings.

elongation in a length of 10in. is from 20 to 25 per cent. Most of the fittings are of Hopkinson's make, but in addition to their high-steam and low-water valve, there is a spring safety valve to each boiler. The boilers are supplied with water from two tanks each of 1,000 gallons capacity, by means either of a Worthington pump 4½in. by 3¾in. by 4in., in which case the water passes through a specially-designed feed-water heater, or else by the injectors of Holden and Brooks's make. It might be mentioned that there are two exactly similar Worthington pumps, the other being used to pump water up to a large tank in the Hall for fire extinction and other purposes. This pump could also, upon emergency, be used for boiler-feed purposes if necessary. The two pumps are placed below the engine-room floor, on a level with the boiler-firing floor, from which they are easily accessible. Either of the water-tanks can be shut off for examination, or both arranged to supply either injector or pump, or both together. The dampers are operated from the front of the boilers by means of counterweights and pulleys, and this arrangement has been found to be of very great convenience.

The two boilers feed into a common steam-pipe, with a Hopkinson valve dividing it, so that in case of breakdown

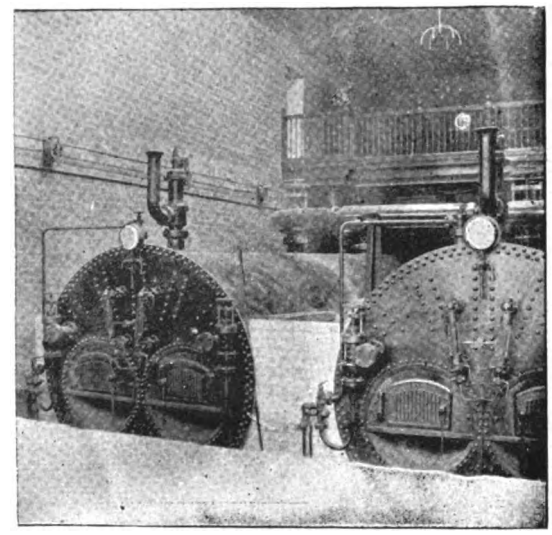

FIG. 4.—The Boiler-Room.

either of the boilers and either one or two of the engines can be examined without stopping the supply. The steam-pipe is 6in. bore cast iron, with copper pipes from boilers and to engines. Each end of the steam-pipe is connected through a steam-trap to a drain. The exhaust pipe is of 8in. bore cast iron, and is connected to a feed-water heater of Fawcett and Preston's make, and from the feed-water heater a pipe is taken into, and partly up, the centre of the chimney. All the steam and part of the exhaust pipes and the boilers are covered with Leroy's special composition, which is found to answer well.

The engine-house, of which the photograph (Fig. 5) gives a good idea, is a lofty room, 40ft. by 20ft. 6in., with a polished pitch-pine roof, iron principals, and a concrete floor. It is faced to a height of 6ft. with chocolate glazed bricks, and above the brick with Parian cement. A six-ton overhead traveller runs the full length of the engine-room.

Engines.—The plant consists of three sets of dynamo engines of Belliss-Siemens type direct coupled on the same bed-plate. The engines are of the ordinary two-crank side-by-side compound type of Messrs. G. E. Belliss's well-known type, in which there is a casing surrounding the working parts. This permits of the forced system of lubrication being adopted without waste of oil. The oil is supplied by means of a neatly-contrived pump, requiring neither valves nor packing. It is worked off the eccentric and draws the oil from a well in the framing, and discharging it at a pressure of from 10lb. to 20lb. per square foot through suitable channels into the working parts. The double action of the engine permits the film of oil at this pressure to enter thoroughly between the working journals and brasses, keeping them apart and preventing any wear or liability of knocking taking place with any load. There is a hinged door at the back of the engine to allow of free access for inspection and adjustment, and the entire front of the casing can be removed in a few minutes if necessary to overhaul the working parts. From the fact that the cranks are never immersed in oil there is no splash, as is the case with other closed-in machinery; in fact, so clean is it in work that the door may be left open and the engine examined while at work. In point of economy the inappreciable wear of these engines was a great point in their favour, Mr. Holmes having set special stress upon

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this point. The engines are controlled by the centrifugal governor, working an equilibrium throttle valve, and adjustable by hand while the engine is running. The governor is of the Belliss standard type; the centrifugal force of the governor balls is mainly met by springs directly applied to them, but a part is also carried by the adjusting spring, by means of which the revolutions can be varied, whilst the engine is running, through a considerable range. Each of the three sets of plant is adapted for an output of 80 b.h.p. at a speed of 450 revolutions per minute, and at a steam pressure of 100lb. per square inch, non-condensing.

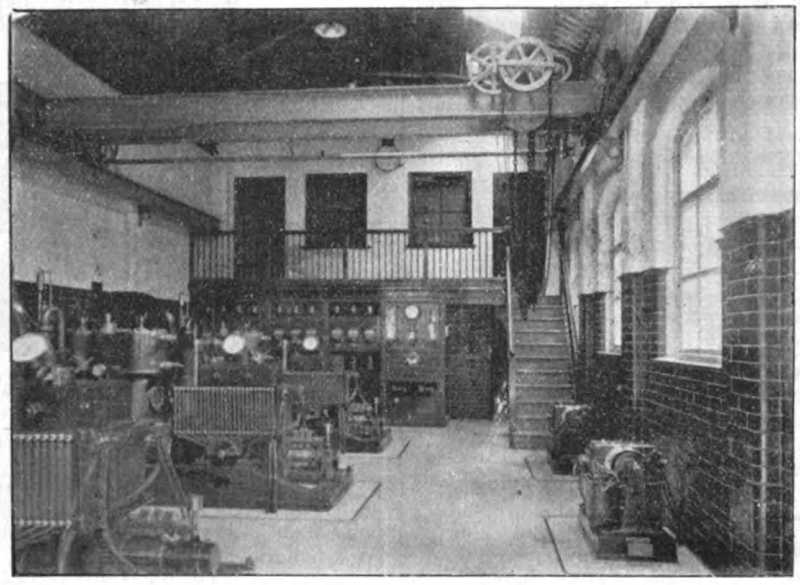

FIG. 5.—Interior of the Engine-Room.

Dynamos.—The three dynamos are of Messrs. Siemens Bros.' make, each coupled on to its respective engine. They are of this firm's well-known type of double-pole inverted machines, with wrought-iron magnets and drum-wound bar armatures. They are wound as shunt machines for an output of 480 amperes at 110 volts when running at 450 revolutions per minute. As will be seen from the photograph, there is an adjustable shunt resistance attached to the fields of each machine. Each dynamo has a tachometer mounted on it. Against the wall (Fig. 5), facing the dynamos, are placed two motor-generators, which are used for charging the cells. These were made by the Electric Construction Corporation, of Wolverhampton. The secondary is arranged to add 33 volts to the station pressure, and is wound to carry 100 amperes.

Switch Gear.—The switchboard arrangements have been very carefully thought out. At the far end of the engine-room are the feeder panels, accumulator switches, and the motor-generator and testing panels, and close to the stop valve of each engine a dynamo switchboard is placed. A large-dial Kelvin voltmeter is fixed high up at the end of the engine-room, so that it is a very easy matter to parallel the machines, and it is a great convenience having the shunt resistance and dynamo switchboard, with its main switch and instruments, so handy to the engine. All the ammeters, both on the dynamo switchboards and also on the feeder panels, are of the Weston type, which work by the drop in potential in a resistance strip of large cross-section. This does away with the trouble and inconvenience of fixing heavy leads to the instruments, as in most other makers'. The resistance strips are fixed in a convenient position in the line of run of the main the current through which it is required to measure. In the present case they are attached to the wall at the back of the feeder panels. The dynamo switchboards are provided with a main fuse on the positive pole, and a very heavy main switch on the negative pole with Weston voltmeter and ammeter. Each feeder is provided with double-pole fusible cut-out and

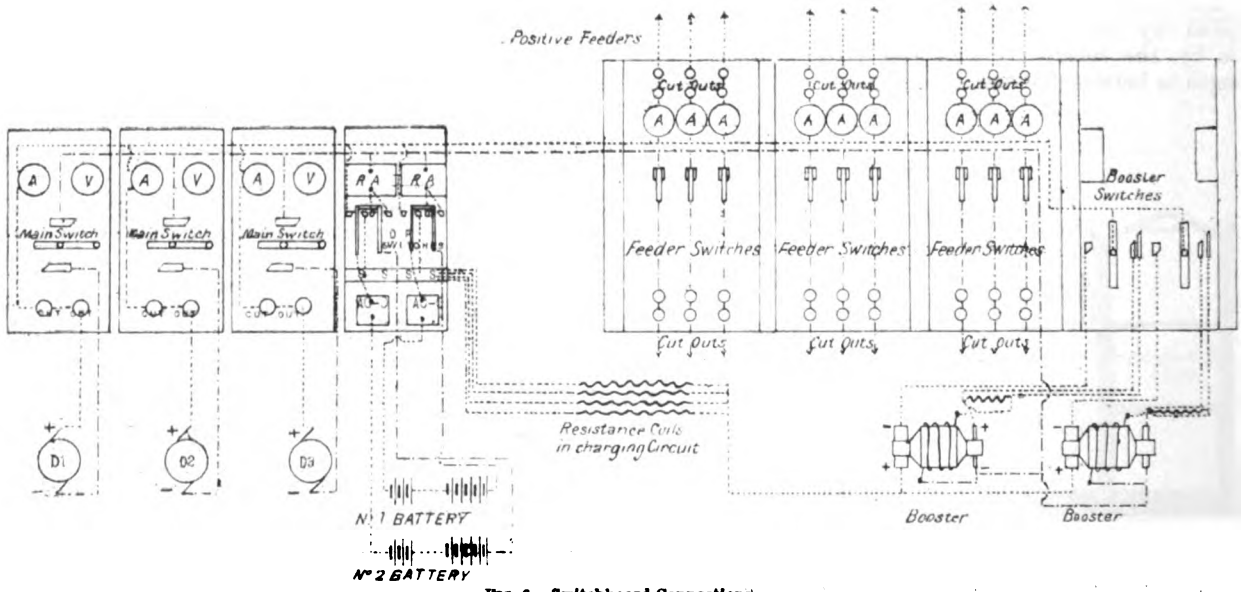

FIG. 6.—Switchboard Connections.

Weston ammeter. The accumulator board is fitted with double-pole switches, automatic cut-outs, and Richard recording ammeters, and also small switches for cutting out or putting in resistance in the charging circuit. The remaining panel of the switchboard proper contains two recording voltmeters for reading the voltage at the ends of the principal feeders, a leak-testing arrangement, and two three-way switches to start the motor-generators. The whole of the switchboards, resistances, etc., were made by the Corporation of Liverpool Electric Supply Works, and the

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lacquered metal work and enamelled slate present a very handsome appearance. The principal switchboards are arranged with a passage at the back, so as to allow of the connections being easily got at. The arrangement of the connections will be seen from diagram (Fig. 6).

Accumulators.—The accumulators now provided consist of two complete batteries of the K-33 type made by the Electrical Power Storage Company, Limited. The arrangement of these cells in the battery-room is shown in Fig. 7. These batteries are used to supply the light from about 12 midnight till the load comes on in the afternoon. The method of charging the batteries is the same as Mr. Holmes uses at the Liverpool Corporation station, and is rather a departure from ordinary private installation practice. As has already been mentioned, they are charged from the main circuit by

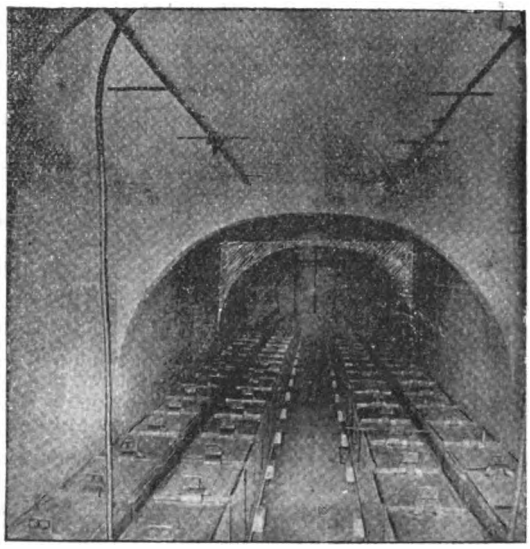

FIG 7.—The Accumulator-Room.

means of boosters, of which there are two, although one is sufficient to charge both batteries. These boosters are put on to the circuit by means of a special triple-pole switch so as to permit of their coming on gently. The arrangements for this will be seen on reference to the

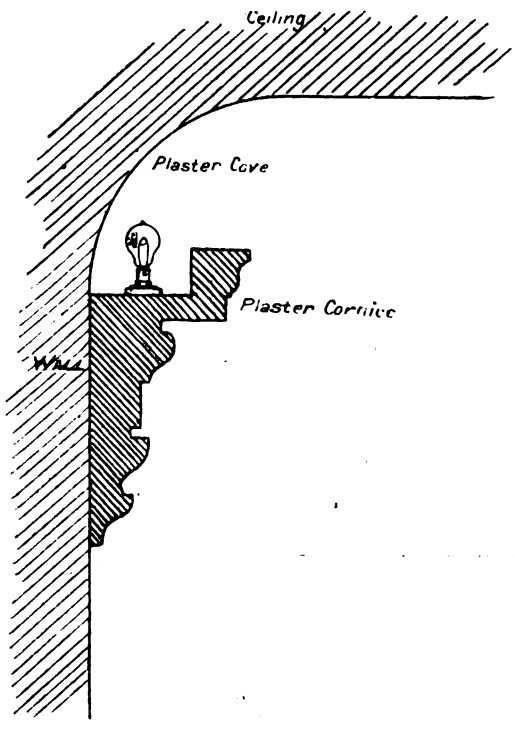

FIG. 8.—The System of Lighting the Picture Gallery.

switchboard connections (Fig. 6). The current is then passed through a series of resistances before passing on to the cells, the amount of resistance being adjusted according to the state of charge of the battery by means of the small switches shown on the accumulator panel.

THE DISTRIBUTING NETWORK.

There are nine feeding circuits on the switchboard. One of these is at present a spare one, from which it is proposed to run a main to the laundry, some three-

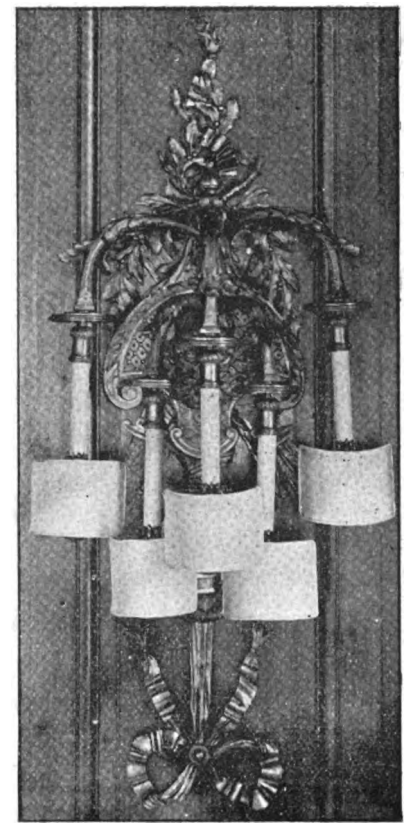

FIG. 9.—The Walnut Room Fittings.

quarter mile away, and which at present has a small 18-h.p. gas-engine plant for working the laundry machinery and doing the lighting. A second circuit runs across to the stables, the other seven supplying the Hall itself. As regards the other circuits, one runs to a position in the basement under the library, and another under the dining-room, each of which supply the reception and public rooms round about them. A third circuit runs to a board in the old passage for the lighting of that section of the premises,

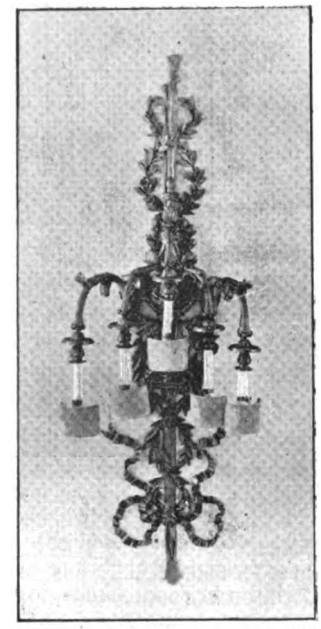

FIG. 10.—The White Drawing Room Fittings.

another to the kitchen. Of the other three, one sub-divides in the engine room for the lighting of that portion of the buildings, while the other two run to switchboards supplying lights for the principal bedrooms in the main portion of the Hall. The feeders are all of ·5 square inch section, are

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concentric paper insulated and lead covered, and were manufactured by the British Insulated Wire Company, of Prescot. The general principle of the wiring consists of running each feeder to a main distributing switchboard; the current is there again sub-divided, each circuit running to a sub-distributing switchboard, from these again to local fuse boards. In the older portions of the buildings there are some five or six lights on each circuit, but in the new portions Mr. Robinson has only been putting one lamp on each fuse; this makes a very satisfactory although naturally

FIG. 11.—The Dining Room, Knowsley Hall.

rather an expensive job. The method of carrying the conductors is, in the old portions of the buildings, in ordinary wood casing, but in the new portions the interior conduit system has been employed, and from all accounts it seems to be very satisfactory.

A short description of the method of lighting and the fittings in the various rooms will doubtless not be without interest. To commence with the library, which is a very fine room with its six small rooms leading off. The fittings at present consist of eight five-light ceiling clusters, the lamps being arranged under an obscured glass bowl. As regards the half-dozen small rooms leading off, some of these have only socket connections, and the others have ordinary two-light brackets of a French make, with imitation candles. Passing from the library we come to the picture gallery, where there is installed one of the most novel and also most successful methods of lighting employed in the Hall. The gallery contains some very fine paintings by Rubens, Van de Vilde, Rembrandt, Teniers, Claude Lorraine, and others, so it was a great advantage when, with the introduction of the electric light, it was possible to introduce a system of illumination both harmless to the pictures, but, nevertheless, one that would show out all their beauties. As we have remarked, this result has been achieved in an eminently satisfactory manner. There are in all 86 16-c.p. lamps arranged round the cornice in such a manner that they cannot be seen at all from the floor. The arrangement will be best understood by a reference to Fig. 8, which shows a section of the cornice. It will be noticed that a recess is formed at the back of the cornice in which the lamps are placed, the light is reflected from the cove of the ceiling on to the whitened ceiling itself, and this has the effect of giving a light almost the exact counterpart of daylight. Besides these cornice lights there are 30 sockets round the room for portable lamps.

From the picture gallery we enter the walnut drawing-room, so called from the fact of its being panelled with a rich dark walnut. There the lighting consists of brackets and sockets. The brackets, of which there are 12, are of a very old and valuable French pattern, two of them being originals and the other 10 copies from them. From what was told us, these fittings alone must have cost a small fortune to get made. The general design of the brackets will be seen from Fig. 9; the five branches of which the bracket consists being fitted with imitation candles and silk shades.

Before entering the dining-room we are taken through the white or stucco drawing-room, so called from the colour and style of the decorations. The lighting here, again, is very similar to the walnut drawing-room, it consisting of eight five-light brackets of something similar design, with 20 sockets for portable lamps. A bracket is shown in Fig. 10.

We now pass on to the fine dining-room, which, from an architectural point of view, is the finest room in the house. A view of it is shown in Figs. 11 and 12. As will be seen, besides the large window at the end of the room, it is lighted from the top by means of a skylight supported by a series of very finely-carved brackets. The walls of the room are covered with a collection of very interesting family portraits, some by noted painters. The electric lighting is effected by means of one of the finest examples of the brassworker's art that it has been our fortune to see adapted for the electric light. The photographs give a very poor idea of its massiveness, there being none of the flimsy modern day work about it. From the centre of the skylight is hung a massive brass eagle with wings outspread, holding in its beak a chain, from the end of which hangs the electrolier. There are 36 lamps in the fitting, arranged in three rows of 12 lamps each; each lamp is fitted with an imitation candle and white silk shade. A special point that we noticed in connection with the shades was that not only had they the ordinary conical-shaped shade at the top, but they had in addition a circular disc that fits round

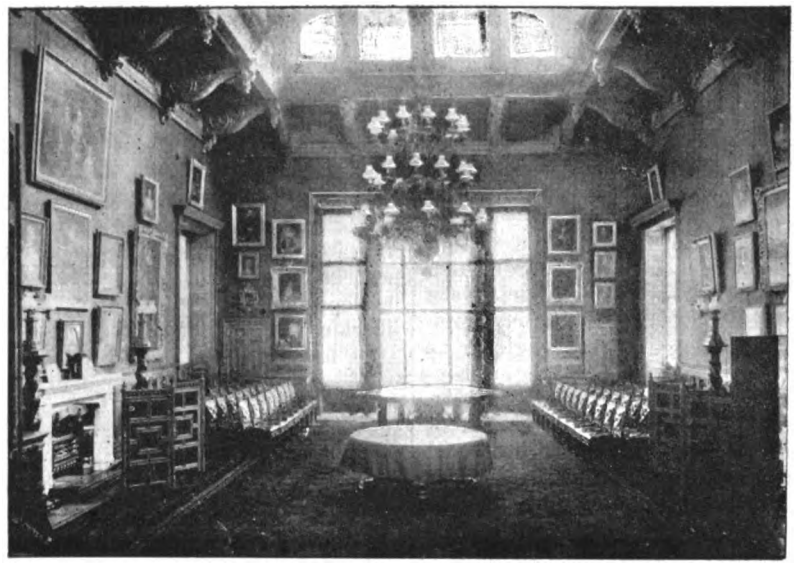

FIG. 12.—The Dining Room.

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the candle below the lamp, which shades the lamp from underneath, as from the position of the lamps so high up the ordinary shades by themselves would have been of little use. Besides this centre fitting, there are some 20 other lamps in the room. It might be mentioned that this centre fitting has been in Knowsley dining-room for a very long time, and we were told that before the introduction of the electric light ladders and trestles had to be brought in every night before dinner to light the wax candles, and the same performance the following morning to clean off the wax that had dropped about the fitting and to put new candles in. Now all that is needed is the simple turning of a switch. There is no need to give details of the fittings in the other rooms, as they are all of ordinary kinds. One point might be mentioned, however, and that is the entire absence of the commonly accepted concentric or two-pin type of wall plug; all through the house Mr. Robinson has used in their place bayonet-joint lampholders, with ordinary bayonet-joint adaptors; thus any of the portable lamps could, if desired, be attached to the nearest lamp point, be it pendant, bracket, or anything else. This must often be a great convenience, and it is astonishing that the practice is not of more frequent occurrence. As regards the switches, all those for the reception rooms are placed in the servants' quarters, those for the bedrooms, of course, being placed by the bed or the door.

The station was started at the beginning of last October, 1897, and notwithstanding the short time it has been at work the works costs up to the end of last year, the figures for which Mr. Robinson was good enough to place at our disposal, must be considered highly satisfactory, even taking into account the fact that they are for the most favourable months of the year. As will be seen from the attached table these costs come out at a fraction over 1½d. per unit, although only the best Welsh coal is used. The station is worked with one shift of two men.

Table of works costs from Oct. 4 to Dec. 31, 1897. Total number of units generated, 21,945:

	Total amounts.			Amounts per unit.
Wages	£34	14	0	0·37d.
Coal	92	13	1	1·01d.
Oil, waste, etc.	6	9	0	0·07d.
Maintenance and repairs	13	0	4	0·14d.
Total works costs	146	16	5	1·59d.

During this period some 93 tons of coal were used, which is about 9lb. per unit generated.

As mentioned above, the whole of the plant was designed and specified for by Mr. A. Bromley Holmes, M.I.C.E., the Liverpool Corporation electrical engineer, etc., with the able assistance of Mr. R. S. Downe, A.I.E.E. All the necessary building work was carried out by Mr. J. Leslie, the surveyor of buildings to the Knowsley estate.

We cannot conclude our account of this interesting installation without a special word of praise to Mr. Alec H. Robinson, A.I.E.E. Mr. Robinson superintended the wiring of the Hall for the Liverpool Electric Supply Company in 1892, and has been resident electrical engineer at Knowsley for the past four years, and is now engineer-in-charge of the station. Since the time, too, when Mr. Robinson took charge of the installation, with the aid of the estate workmen he has completed all additions and alterations, and Lord Derby himself told us that anyone outside the estate had little idea what this meant, and the satisfactory manner in which the work had been carried out. Personally we can only judge by results, and for these we must offer Mr. Robinson our heartiest congratulations.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXXVIII.

Misapprehensions and misapplications have arisen, and may arise, in relation to the value of the ampere-hour equivalent and the monad-gramme equivalent of peroxide of lead (LIX.). In my paper "On Reversible Lead Batteries"* this is given as—

$$62{\cdot}137 \text{ (the a.-h. equiv. of Ag)} \times \frac{239 \text{ (\textit{i.e.}, mol. wt. of } PbO_2)}{216 \text{ (\textit{i.e.}, twice at. wt. of Ag)}} = 68{\cdot}75 \text{ grains};$$

which is 4·455 grm. Planté is said to have estimated the value as 4·48 grm.† The figures given in the section above mentioned are 4·442, *and also half that value*—viz., 2·221 grm. The small discrepancies are dependent upon the values taken as the atomic weights.

An experimenter writes to say in effect that, having passed a current of five amperes for 10 hours through a lead anode in dilute sulphuric acid, he expected, "according to my formula," to obtain 3,437 grains = 7·85oz. av. of peroxide, whereas he obtained "considerably less than half that quantity."

Now it should be explained that PbO_2, the molecular weight of which is 239 (? 238·4), is usually regarded as a dyad because only half its oxygen—*i.e.*, one dyad atom—is utilised or involved in its reaction, the compound being decomposed according to the equation $PbO_2 = PbO + O$. But when the whole of its oxygen is utilised, or when it is decomposed according to the equation $PbO_2 = Pb + 2O$, the compound must be regarded as a tetrad, since two dyad atoms of oxygen are involved in the reaction. The monad equivalent, being one-half of the dyad and one-quarter of the tetrad, will be $\frac{239}{2}$ or $\frac{239}{4}$, according to the number of atoms of oxygen involved, and the ampere-hour gramme equivalent would be $\frac{239}{2 \times 26{\cdot}8} = 4{\cdot}45$ or half that value—viz., 2·22 grm. (nearly). Conversely, if PbO_2 be dyad, the ampere-hour would yield 4·45 grm. of the compound, but if it be tetrad it would produce only 2·22 grm. And when PbO_2 is generated from metallic lead the compound must be regarded as tetrad, since two dyad atoms of oxygen are required, according to the equation $Pb + 2O = PbO_2$; whereas if PbO_2 is produced from litharge only one dyad atom of oxygen is required, according to the equation $PbO + O = PbO_2$. Moreover, it must be borne in mind that if oxygen be evolved in waste from a *lead* anode—and, practically, some oxygen is always evolved in waste—the quantity of PbO_2 generated by the passage of the ampere-hour quantity of electricity may be "considerably less than half" the monad-gramme equivalent "obtained by halving the atomic weight of PbO_2 (dyad)—*i.e.*, considerably less than one-fourth of the atomic weight of PbO_2 (tetrad). The above will explain the meaning of the two values for PbO_2 given under the two headings of the table in Section LIX.

In depositing peroxide of lead upon a lead anode from an alkaline solution of the protoxide of the metal, theory indicates that about 69 grains of PbO_2 should be obtained per ampere-hour. An ampere-hour equivalent of Pb is deposited at the cathode, and an equivalent of O liberated at the anode may be supposed to combine with PbO in solution to produce an ampere-hour equivalent of PbO_2, such equivalent being $\frac{\text{half the atomic weight}}{26{\cdot}83}$, since the compound is here dyad. On commencing to carry out this deposition process at an accumulator factory near London, my assistant reported that the results obtained were apparently in contradiction to the theory, and that, instead of obtaining 69 grains per ampere-hour, he had deposited an average of only 20 grains. The explanation of this result is to be found in the facts that peroxide of lead is not deposited from an alkaline solution unless this is *saturated* with protoxide; that, in the contrary case, lead is dissolved at the anode—the liberated oxygen combining with the metal; that oxygen may be evolved in waste from a peroxidised anode in a solution that is not saturated with protoxide; that the simultaneous deposition of spongy lead on one electrode and of lead peroxide on the other rapidly exhausts the protoxide in solution unless means for its supply, involving a very active circulation of the electro-

* *Journal* of the Society of Telegraph Engineers and Electricians, vol. xvi., No. 66, 1887.

† Treadwell, "The Storage Battery," p. 111.

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lyte, be adopted; and, finally, that the method of deposition, as hitherto carried out, is unpractical, and the construction of the tank—especially in regard to the means for obtaining the circulation of the electrolyte—is open to great improvement. In this case, as in all others, the aggregate of the electro-chemical effects at the anode are necessarily equivalent to those at the cathode, although the former are not wholly exhibited in the form of lead peroxide, even under the most favourable conditions.

CXXIX.

The charging of accumulators may be effected according to at least three different systems—viz., under constant *current*, constant *potential*, or constant *power*. It is impossible to say which of these systems is the best, because that depends upon circumstances. Moreover, when the conditions are defined, a combination or compound system may be found more suitable than any one of the systems *per se*. Whatever system be adopted, precautions should be taken to obviate the reversal of the charging current (a fatal mishap); whereby the accumulator, its E.M.F. no longer opposed to that of the dynamo, is discharged through it, tending to work it as a motor. Thus, in the first place, a series-wound dynamo should never be used. With this machine an increase of resistance in the external circuit diminishes the current passing in the coils of the field magnets; and thus the E.M.F. is diminished when it is most necessary that it should augment. If at any given moment this should become less than the E.M.F. of the accumulator to be charged, the direction of the current and the polarity of the magnetic field become reversed; and even after the cause which has produced this change is removed, the current continues to pass in the direction opposite to that which is necessary to charge the battery. With a dynamo separately or independently excited, comprising two machines, which may be driven upon one axis, this cannot happen. In the case of a shunt machine the E.M.F. increases when, from any cause, the resistance in the external circuit is augmented, but it decreases when the resistance is diminished. In compound-wound machines the E.M.F. is adjusted to the varying resistance of the external circuit, the current traversing which passes through coils surrounding the field magnets, in addition to and distinct from the shunt coils.

The independent excitation of the dynamo field magnets has successfully been obtained by means of a current from the accumulator which is being charged.

In addition to a fuse, which becomes "blown," and thus arrests the charging current when from any cause the latter is in excess of the safe maximum, various automatic arrangements may often be advantageously employed to break the circuit whenever the E.M.F. of charge approaches too nearly that of the battery which is being charged—such as the "Mouse-Trap" switch of the E.P.S. Company, and the polarised *disjoncteur* of M. Leroy. Apparatus for automatically breaking the circuit when there is danger of reversal, and for re-establishing it when the faulty conditions have been remedied, are also obtainable, and are known in France under the name of *conjoncteur-disjoncteur*. Automatic alarums (current alarms) are also employed for giving warning that the cells with which they are connected are discharging above their normal rate.

CXXX.

At the outset, the system of charging by constant current was almost exclusively adopted—was, indeed, the only one known or recognised. At the present day, the "normal" and "maximum" rates of charge are given in accumulator price-lists without any reference to the percentage of the total charge absorbed by the battery, and on the supposition that the charging current is the same in the final as in the initial period of charge. We now know, however, that the given "maximum" current may generally be very greatly exceeded without risk of damage during the initial period; whilst, on the other hand, it may seriously damage the cell if continued up to the final period of charge. With a view to be on the safe side, the "maximum" current of charge specified usually corresponds to a current density (LXXXVI.) which—however dangerous it might be in the case of an accumulator with specially porous active material and already fully charged, or nearly so—is actually too low to produce the best results during the initial period of charge. And this expression "best results" refers not only to economy of time, but also to the quality of the active material energised by the charge. For experiment has, I think, rendered it indubitable that the active material peroxidised or reduced under the action of a current of high density differs in quality from that produced by the action of a current of comparatively low density. The former appears to be more conductive, and to possess a higher specific capacity—both qualities being dependent upon a lower percentage of lead sulphate. The current densities corresponding to the maximum rates of charge which have, until latterly, usually been specified, vary from $\Delta = \cdot042$ to $\Delta = \cdot066$.

The "time of charging," or duration of the charging process, is:

$$\theta = \frac{\tau}{\Delta};$$

i.e., it varies directly as the thickness (or weight per square inch) of the entire material on, say, the peroxide plate, and inversely as the density of the charging current.* The usual duration of the charging process with constant current, has been from five to ten hours.

In his recent work on "The Storage Battery"—from which the two following diagrams of charge are taken—Mr. A. Treadwell quotes the following in relation to charging current: "Sir David Salomons† has formulated the following very convenient rule for calculating the best charging current: 'Multiply the total number of plates in a section by 2. The result will be the best charging current for that section.'" The rule as stated appears to be quite independent of the *size* of the plates; it may be useful, therefore, to point out that it applies only to the E.P.S. Company's L plates. Sir David states that "the proper charging rate is 5·3 amperes per square foot of positive plate." Assuming that positive *surface* is meant, this corresponds to $\Delta = \cdot04$, which is one which has very generally been adopted. Taking the statement literally, the density would be unusually low. Sir David further states that: "If a much larger current is passed, the cells boil as if they were fully charged, showing that the surface of the plates is insufficient for the current to act upon; and the excess of current does its work by simply decomposing the water of the electrolyte, creating volumes of gas, and heating the liquid." I do not think that this is applicable to the whole period of charge, even in the case of an E.P.S. plate, where metallic lead is directly in contact with the electrolyte, so that there is a path for the current from lead to lead without traversing the active material. It certainly is not applicable to the initial period of charge in the case of some modern plates with embedded supports. It may here be observed that the charging rate of 6·5 milliamperes per square centimetre, corresponding to $\Delta = \cdot042$, was "found by Messrs. Gladstone and Tribe to be the best," not in the case of a well-formed plate, but in peroxidising and reducing layers of minium (red lead) applied to two strips of lead.

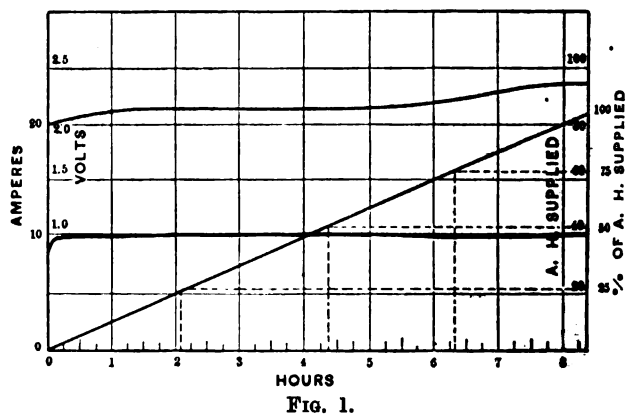

FIG. 1.

The above diagram of charge, and that which follows, apply to a Gadot (double-grid) cell, containing 9·35 kilos

* See Section LXXXVII. In the equation under this section, "I + 0" should be I θ.

† "Electric Light Installations," vol. i., p. 98.

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(20·57lb.) of plates. The former represents the conditions of charge with constant current; the latter those of charge with constant potential.

Referring to the above, it will be seen that a constant current of 10 amperes is continued for rather more than 8¼ hours, the ampere-hours supplied thus being about 83. The voltage, commencing at 2, rises to 2·32 at the end of the charge. The watt-hours supplied amount to about 180. The second line of figures to the right of the diagram shews the percentages of the total ampere-hours supplied corresponding to various periods of the charge; thus in a little over two hours the horizontal dotted line shows us that 25 per cent. of the total charge has been delivered; in about 4 hours 22 minutes, 50 per cent.; and in 6 hours 20 minutes, 75 per cent. of the charge has been effected.

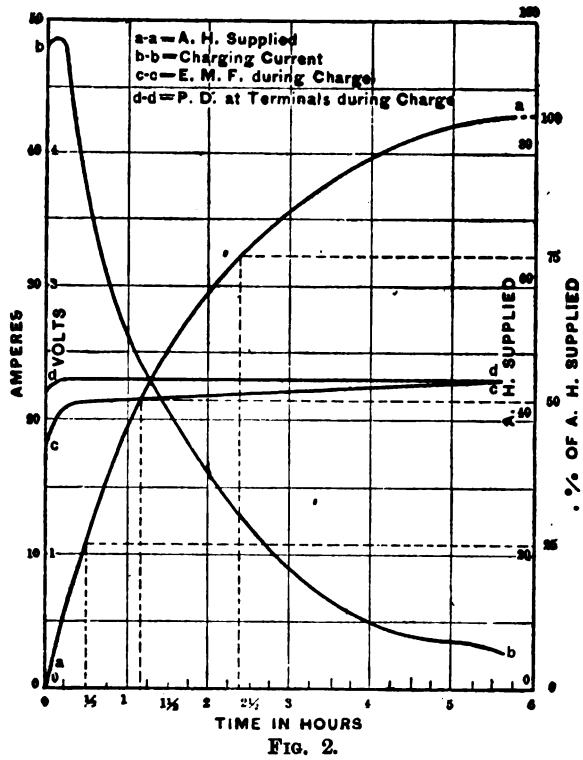

FIG. 2.

Fig. 2 shows that the same number of ampere-hours—viz., 83—are delivered under constant potential in 5¾ hours, instead of 8 hours and 20 minutes. Note that the initial current of charge is 48 amperes, whilst the final current is only about three amperes. Note, also, that 25 per cent. of the total ampere-hours to be supplied has been delivered in half an hour; 50 per cent. in 1 hour and 10 minutes; and 75 per cent. in 2 hours and 22 minutes. The total watt-hours, representing the supply of energy, are, as before, about 180. A comparison of the two diagrams would appear to be strongly in favour of the system of charging under constant potential. But this system is open to one great objection, which is dependent upon the fact that a steam-engine works under great disadvantage when the load is subject to great variation—viz., that the power (watts) required at different periods during the charge varies within wide limits. This is shown by the curve *b b*, which—potential difference being constant—indicates the variation of watts as well as of amperes.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

122. For starting single-phase alternating-current motors, what method would you recommend so that motors may be run on public supply lighting mains without causing disturbance to same?—W. B.

123. In designing a rotary converter to change a direct current into a single-phase alternating current, or *vice versâ*, how is the current density per square inch of cross-sectional area in the armature conductors calculated? Considering the characteristics of such a machine, would 2,000 amperes per square inch be too high a density?—H. B. S.

ANSWERS.

Question No. 116.—What is the relative efficiency of belt driving as compared with rope driving? Compare three kinds of belts—viz., solid, link, and balata—with three kinds of ropes—viz., cotton, manilla, and solid leather (square).

Best Answer to No. 116 *(awarded* 10*s.)*.—The relative efficiency of rope and belt driving is a matter demanding very careful attention. There are also other important points, such as cost, weight, etc., which have to be considered before deciding which system shall be adopted for any particular case.

Taking first the *efficiency*. It is usually contended that more power is absorbed by ropes than by belts. Recent experiments, however, show that there is little to choose between them upon this head. As a matter of fact, according to figures taken from some tests made at Lille in 1895, ropes are shown as being equally efficient with belts. As it is a very difficult matter to compare two cases exactly similar under practical conditions of working, these figures cannot be taken as being absolutely correct, but they are sufficiently reliable to prove that there is very little, if any, difference between their relative efficiency. A cause of loss of power with ropes which does not apply to belts, is that the ropes require to be pulled out of their grooves in the pulley. This loss is counterbalanced to a considerable extent by the greater tendency of belts to slip.

Weight.—For a fixed power the weight of rope and belt gear will be about equal.

Cost.—The cost of ropes to transmit a given power will be about 40 per cent. less than the cost of belts for the same power.

A great disadvantage of belt driving is that, if the belt breaks, the plant will be at a standstill until the belt is either repaired or replaced by a new one. This fact causes great inconvenience if it occurs in a central lighting station, as the other machines are overloaded, with consequent drop in volts, until a new belt is procured, or a fresh dynamo, if one is available, is brought into use. In the case of a main factory drive, it would enforce the entire stoppage of machinery until the defect could be remedied.

The advantages claimed for rope driving are: (1) first cost is considerably less, and this also applies to renewals; (2) it is not necessary, although, of course, desirable, that the driving and driven pulleys should be absolutely parallel; (3) positive drive; (4) as it is very improbable that more than one rope will break at once, the others will continue to do the work until such a time as the rope can be conveniently repaired; (5) they can be used for very long drives.

A disadvantage of rope driving is that owing to the difficulty of splicing ropes to equal tension some ropes will be doing harder work than others. This objection is avoided by using one continuous rope. There are several objections, however, to this. For example, if the rope breaks there will be a complete stoppage of plant precisely the same as if belting had been employed. Moreover, the system involves the use of guide pulleys, which means more friction, and consequently increased loss of power, besides greater wear on the rope. For very short drives, ropes cannot be economically employed.

Reviewing the above, it will be seen that ropes can safely be recommended as being more economical where the power transmitted is large, unless a very short drive or other exceptional condition prohibits their use.

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Comparing different kinds of belting: Leather is the most extensively used, and although it is more expensive in first cost, and is not quite so strong, it wears longer (when the best quality is employed) than either cotton, balata, or canvas. Leather link belting is rapidly coming into favour, especially for dynamo driving. Owing to the ease with which it bends round the pulley it gets a much better grip on and can be used with much smaller pulleys. It is easily and quickly repaired. It is more expensive than solid leather, and is heavier. The weight prohibits its use where very high belt speed is necessary, as the centrifugal force would be excessive. Balata belts are cheaper, and, being more pliable than leather, get a better grip upon and can be used upon smaller pulleys. There is a tendency to slip, especially in damp places. Specially prepared canvas and cotton belts are now extensively employed for main drives in factories, and give every satisfaction.

As regards material for ropes. The action which wears out a rope is the alternate bending and straightening as it passes over and leaves the pulleys. Cotton has been found to withstand this action most effectively, and is for this and other advantages used far more extensively than either hemp or manilla. The superiority of cotton is due to its flexibility, its resistance to stretch, and the ease with which it is spliced. Leather ropes were exclusively used in the early days of rope driving, but have now been entirely superseded by cotton, hemp, and manilla. Great difficulty is experienced in cutting them to a uniform strength throughout.—F. A.

Answer to No. 116 (*awarded* 5*s.*).—In 1895 the Société Industrielle du Nord de la France conducted some tests for obtaining the relative efficiency of belt and rope driving. The conclusion arrived at was that ropes and belts are equally efficient organs of transmission of power, the difference between the best and the worst being so small that the order might be reversed from local or accidental causes. The slip in rope driving is, however, much less than that of belt driving, as V grooves are cut in the pulley, and the rope is wedged in the V so that frictional resistance to slipping is very great. A belt is dependent entirely on surface friction, and as a cushion of air is formed between the belt and the pulley which increases with high speeds, the slip is very considerable. On the other hand, rope driving absorbs as much as 7 per cent. of the power, while the power absorbed by belting varies between 5 and 5½ per cent. A belt to drive with minimum slip must be very tight, and this causes a strain on the bearings. On the other hand, ropes may be quite slack, as the pull is caused by wedging in the groove, and not by any friction between surfaces. For high speeds and great power transmitted between distant shafts rope driving is preferable on account of its flexibility, lightness, quiet smooth working, small first cost, and the facility with which the slack can be taken up and the tension regulated by a tightening pulley. With belts the pulley can be made of smaller diameter, as, owing to the thinness of belt compared with a rope, the power required to bend the former round a small pulley is not so great as that required to bend the latter. Ropes are more often used to drive generators of electricity, as several are used in the place of one belt, and as they very rarely give way without due warning in the shape of fraying at one or more strands, accidents and stoppages of the supply of current are reduced to a minimum. The working stress is also a very small fraction of the breaking stress, and if any individual rope shows signs of breaking the remaining ropes can be relied on to accomplish the work while the damaged rope is under repair, and when mended can be replaced at a convenient time.

In conclusion, the modern practice is to use belts for small power transmission and ropes for large. Ordinary leather belts have a joint about every 5ft., which makes the strength very variable throughout their lengths. In link belts, however, this is not the case, as theoretically, at least, they have the same strength throughout. Balata belts are leather belts covered with balata the softness of which gives a better grip to the pulley, but it is doubtful if any real saving is effected by their use. Flat belts of the leather and balata type fail to take a proper grip of the pulley, due to their retaining a cushion of air between them and their pulleys. It is not so, however, in the link system, as this form of belt permits the escape of air through the spaces between the links, and thus enables the leather to bear uniformly over the face of the pulley. These belts are more flexible, as they consist of short leather links fastened together by steel pins and washers. They further possess the advantage of being easily tightened when slack, as a sectional series of leather links can be detached and then the pin inserted through the links on either side. Manilla ropes are preferred to cotton, as they are softer, cheaper, and stronger, and last nearly as long. Square leather belts are very little used, except in the case where only a fraction of a horse-power is transmitted.—W. H. P.

Question No. 117.—Compare the efficiencies and life of incandescent lamps of large and small candle-powers respectively.

Best Answer to No. 117 (*awarded* 10*s.*).—In a paper read by Mr. W. H. Preece, F.R.S., before the British Association at Liverpool in 1896, details of a large number of experiments on the efficiencies and lives of incandescent lamps of various candle-powers are given. These lamps were supplied by about 20 makers, and certain general characteristics were found common to all of them. From the results, Mr. Preece drew up a provisional specification which is used by the Post Office when ordering lamps, and in which are embodied the results of his experiments. The watts per candle-power are intended to be given for lamps having an average life of 1,000 hours, and show the relative efficiencies of the various lamps:

C.P.	Volts.	Max. C.P.	Min. C.P.	Max. watts per C.P.
8	100 or 105	8·5	7·5	3·9
16	,, ,,	17	15	3·75
25	,, ,,	26·5	23·5	3·5
32	,, ,,	34	30	3·4
50	100 ,,	53	47	3·3
100	105	106	94	2·9

In this table the candle-power given is the horizontal candle-power, and we see, for example, that this candle-power for an 8-c.p. lamp must lie between 8·5 and 7·5. It varies, of course, depending on the position of the filament relatively to the eye, and so the superior and inferior limits have been given. From the Post Office table we see that there is a saving of about 15 per cent. in the meter bill when we replace 8-c.p. lamps by the equivalent number of 32-c.p. lamps. Similarly, if we replaced them by 100-c.p. lamps, there would be a saving of nearly 33 per cent. This saving, however, can only be realised in practice in a few cases, as with the smaller lamps we can distribute the light better and only use it where it is wanted.

Another point also that has to be borne in mind when comparing their relative efficiencies is that the glass bulbs of the various lamps should be proportional to their candle-powers. For example, the surface of the glass bulb of a 16-c.p. lamp ought to be twice as great as the surface of an 8-c.p. lamps, otherwise the blackening of the bulb and the consequent deterioration of the lamp will proceed more rapidly in the lamp which has the smaller surface per candle-power. If the watts per candle-power of the various lamps be the same, then the higher the candle-power of the lamp the longer will be its life. If a 16-c.p. lamp which takes 3·5 watts per candle has a life of 1,000 hours, then a 100-c.p. lamp which took 3·5 watts per candle would have a life of 2,000 hours or more. It would also maintain its candle-power much more steadily than the smaller lamp. Larger lamps are far more dazzling than smaller lamps, and hence the illumination produced is not so pleasing. Also with large lamps the illumination produced cannot be so well regulated as when smaller lamps are used, and hence this leads sometimes to a waste of light and consequent waste of current, which largely reduces the saving effected by their use.—J. C. R.

Answer to No. 117 (*awarded* 5*s.*).—Respecting the life and efficiency of incandescent lamps, it is not correct to say that one lamp has a greater efficiency than another, for a high state of efficiency simply means that the filament is

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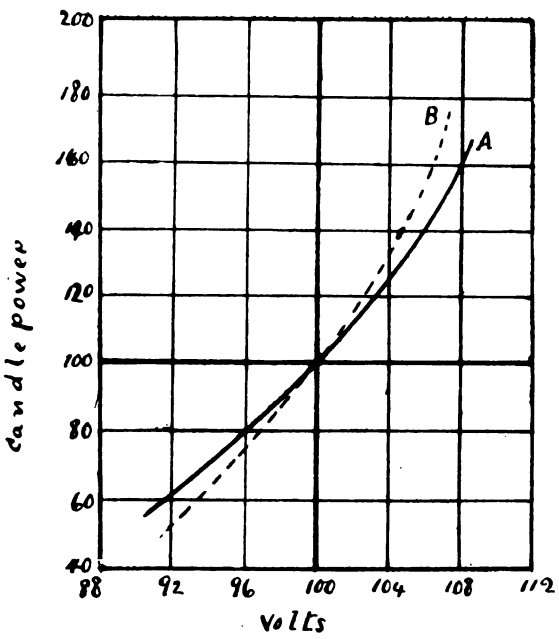
at a higher temperature, so that any lamp may be run at any efficiency or temperature up to its breaking point. With incandescent carbon a certain temperature means a certain colour of light and definite efficiency either in watts per candle-power or in proportion of luminous radiation to total radiation. All lamps fall off in candle-power when supplied with a constant number of watts, and this falling off is usually at the commencement of their active life. But the length of time taken by lamps of the same make to deteriorate in candle-power by a certain percentage depends very much upon their treatment; if the pressure is maintained constant within 2 per cent. on either side of the normal, the useful life of the lamp will be longer than if the pressure is allowed to vary as much as 5 per cent. The pressure at which electricity is supplied is anything but constant, therefore the amount of deterioration will vary almost with every supply. The following curve shows approximately the percentage variation in candle-power for a given percentage variation in volts over a range of 10 per cent.: the Curve A is the result when the filament remains constant in resistance over the



range of 10 per cent. variations in volts; the Curve B gives the result if the filament falls off in resistance by 5 per cent. for an increase of 10 per cent. in volts. Thus it is seen that a slight increase in the pressure causes the candle-power to rise greatly, while a slight decrease means a great falling off in light.

The following table shows the average life in hours at constant E.M.F., also on an E.M.F. of percentage variation:

Watts per candle-power.	Life on constant E.M.F.	Rise in volts						
		1 %	2 %	3 %	4 %	5 %	6 %	7 %
4·5	2,200	1,900	1,700	1,400	1,300	1,100	950	820
4	1,550	1,400	1,150	950	850	750	660	600
3·5	1,000	850	750	660	600	530	470	440
3	600	520	470	440	380	330	290	250
2·5	300	270	250	220	200	180	150	130
2	150	130	120	110	95	85	70	57

From the above table it will be seen that a 4 per cent. variation in pressure sacrifices almost one-half of the life of the lamp, while a 7 per cent. increase reduces the life nearly by two-thirds. A lamp may be considered to have passed its useful life when it has lost 20 per cent. of its candle-power, which in the case of a 16-c.p. lamp would only be 12·8 after the loss. The useful life is the period during which it suffers this loss. The falling off in candle-power is due to particles of carbon being thrown off the filament, and this action reduces the life of the lamp in three ways: (1) the particles of carbon form a coating on the glass of the lamp, and therefore obscure the light given by the filament; (2) the nature of the surface of the filament is thereby altered, and its emissivity is increased, so that it is now at a lower temperature; (3) the resistance of the filament is increased, so that it now takes less current, and is on that account at a lower temperature. Thus not only does the filament give less light, but a great proportion of what it does give is prevented from getting outside the bulb.

Now, all the above effects are proportional to the temperature, and it has been shown an increase in candle-power means an increase in temperature; so, if we increase the candle-power, we increase the bad effects, and the efficiency of a lamp is the number of hours it will give its stated candle-power. Low candle-power lamps being at a lower temperature, they therefore have a longer life at their stated candle-power than lamps of large candle-power having filaments of the same ratio of surface.—BAGOT.

N.B.—In this last answer, which is otherwise excellent, the real point of the question is not answered.—ED. *E. E.*

FORTHCOMING EVENTS.

FRIDAY, DEC. 9.

Physical Society.—At Burlington House, at 5 p.m., (1) "Longitudinal Vibrations in Solid and Hollow Cylinders," by C. Chree, Sc.D., LL.D., F.R.S.; (2) "On the Thermal Properties of Normal Pentane," by J. Rose-Innes, M.A., B.Sc., and Sydney Young, D.Sc., F.R.S.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 8 p.m., "British Cable Tramways and their Construction," by Mr. E. A. Heath.

North-East Coast Institution.—Annual dinner at the Westgate Assembly Room, Newcastle-on-Tyne.

MONDAY, DEC. 12.

Society of Arts.—At 8 p.m., Cantor Lecture on Acetylene, by Prof. Vivian B. Lewes. Last lecture of series.

TUESDAY, DEC. 13.

Institution of Civil Engineers.—At 8 p.m., discussion on "The Ventilation of Tunnels and Buildings," by Francis Fox, M.I.C.E.

Liverpool Self-Propelled Traffic Association.—At Royal Institution, Liverpool, at 8 p.m., discussion on the "Judge's Report on the 1898 Trials, and the Conditions for the 1899 Trials."

WEDNESDAY, DEC. 14.

Institution of Electrical Engineers.—Students' meeting, at 7.30 p.m., at 28, Victoria-street, "Notes on Electric Light Installations," by F. W. Purse.

Liverpool Engineering Society.—At Royal Institution, Liverpool, at 8 p.m., "Further Experiments on the Character of Fluid Motion" (illustrated by means of the lantern), by Prof. H. S. Hele-Shaw.

City of London Tradesmen's Club.—At Albion Hotel, Ludgate-circus. A paper on the "Purchasing of the Electric Lighting Undertaking by the Corporation," by Mr. T. H. Brooke-Hitchings, president.

FRIDAY, DEC. 16.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Kentish Town Widening, Midland Railway," by Walter Daniel, Stud.Inst.C.E.

SATURDAY, DEC. 17.

Institution of Junior Engineers.—At 11 a.m., visit to Messrs. Yarrow's works at Poplar.

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 8.

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Members.—C. Bright, 14, Copthall-avenue, E.C.; V. A. Fynn, 13, Bexley-road, Erith, Kent; H. A. Humphrey, Winnington, Northwich, Cheshire; W. S. Robertson, Western and Brazilian Telegraph Company, Limited, Para, Brazil; A. H. Unwin, Casilla, No. 137, Rosario, Argentine Republic.

Associates.—H. O. F. Bindemann, Espon y Mina, Madrid, Spain; J. W. Garside, Electricity Works, Brighouse; E. V. Graham, Royal Arsenal, Woolwich; W. H. Grimsdale, Ferry House, Twickenham; J. Hall, 11, Perrymead-street, S.W.; S. E. Hall, 48, Godwin-road, Forest Gate; J. E. Hutton, Northallerton, Yorks; W. T. Le Feuvre, 10, Almorah-crescent, Jersey; F. V. L. Mathias, Amberley House, 12, Norfolk-street, W.C.; H. E. Moul, 8, Hythe-road, Willesden Junction, N.W.; D. Owen, B.A., B.Sc., Technical School, Birmingham; W. B. Pinching, 50, Great Percy-street, W.C.; G. Porter, 29, Kingdon-road, West Hampstead, N.W.; W. Thom, Madras Electric Tramways Company.

Students.—W. J. Cooper, 3, Bisham-gardens, Highgate, N.; T. C. Cunningham, 36, Lexham-gardens, S.W.; J. Eustace, 158, Osborne-road, Forest Gate; H. J. Jones, 7, Helix-gardens, Brixton, S.W.; L. R. Lester, 65, Philbeach-gardens, S.W.; R. P. Russell, Faraday House, Charing Cross-road, W.C.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XXI. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ELECTRICAL CABS.

At the ordinary meeting of the London Electrical Cab Company on Monday last the directors had to face the shareholders with the statement of a loss upon the year's working of upwards of six thousand pounds. The loss was, perhaps, not all incurred from the actual working of the cabs, but, none the less, it had to be faced. A loss is always an unpalatable fact, but circumstances often minimise the effect of a loss, and in this particular case the shareholders should bear the loss with equanimity. It will be cold comfort to say that the future depends very much upon the amount of capital available. From the practical side of the question, the directors were able to promise less expensive working in various directions, some of the promises being far more positive than others. Thus the cost of electrical energy is to be lessened by obtaining it from the company's own installation. Then a number of minor defects which became evident in the actual working have been more or less remedied, and the very expensive item of tyres is said to be in a fair way of solution. But for the moment let us turn to another point of the question, which, so far as we are aware, has not been sufficiently considered. The Commissioner of Police says: "The hackney carriages propelled by electricity which have been placed on the streets appear to have given general satisfaction. The vehicles are roomy, the interiors well fitted, and the mechanism is well under the control of the driver. Should electrical carriages come generally into use, the effect on the traffic of the Metropolis will be marked, as such vehicles occupy but a little over half the space as that of a similar vehicle drawn by one horse. From a sanitary point of view, also, the diminution in the number of horses in the streets is a desideratum." This is very good and very true, yet a close study of the balance-sheet shows a lesser daily patronage for these better vehicles than there is for the competing vehicles. According to all preconceived notions, the better equipped, more roomy, and more comfortable vehicle should gather unto itself the greater patronage. We assume that the vehicles are running, say, for three hundred days in the year and no large percentage in the hospital. It is too often forgotten that there are two ways of making a concern pay, and that in the majority of cases unduly reducing the expenses spells ruin. The two ways, it is almost unnecessary to say, are reducing the expenses and increasing the receipts. The *rôle* of the reformer is almost always directed to the cutting down of expenses, and not to the increase of the receipts. The directors of the cab company seem to realise the one; have they realised the other, and is it possible to act both ways at the same time? If so, there would be a double joy to the shareholders, for a pound less of expenses and a pound more of receipts really means two pounds on the proper side of the balance-sheet.

Thus far the balance-sheet and the condition of affairs it shows, but what of the future. Is there a good prospect of ultimate success? Assume proper organisation, proper working, and, in fact, business methods prevailing everywhere, we see no

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reason why an electrical cab company should not ultimately prove a triumphant success. Some of our remedies would be drastic enough, but these are details which cannot satisfactorily be discussed in the columns of a newspaper. There is no scientific nor any practical reason why electrically-driven cabs should not be paying concerns, and we trust that the shareholders will have sufficient faith in the future of this class of vehicle to provide the necessary capital to carry on till all the difficulties are overcome and success ensured.

SCIENCE TEACHING.

At its meeting on Tuesday the London County Council passed the resolution, "That the Council do approve of the Technical Education Board notifying to the Department of Science and Art its willingness to be responsible for the science and art instruction within the county of London." The divided responsibilities now existing are against the best possible organisation existing for the teaching of science and art in the Metropolis. It is somewhat curious, however, that the energy to improve this teaching comes from the Council and not from the School Board. But the reason is not far to seek. County councils receive certain moneys from local taxation, and since the receipt of this money have generally used it for the spread of science education. Hence the London County Council, and not the School Board, is *the* authority in the Metropolis on matters of technical education. The chief of the department, Prof. Garnett, is probably the best man that could have been selected for the position. An able educationist, full of energy, holding to the watchword "thorough," he will undoubtedly revolutionise the chaos of science teaching and put it upon a firm basis. He will not, however, fall into the error of placing too many red-tape rules about the teachers, but leave them in a large measure to follow their own methods, providing the result is satisfactory. It is not often we agree with the London County Council, but in this instance we wish this new departure all success.

THE INSTITUTION DINNER.

The annual dinner of the Institution of Electrical Engineers was held last Wednesday, and again the Hotel Cecil was chosen as the meeting place. Mr. J. W. Swan, F.R.S., the president of the Institution, was in the chair, and amongst the invited guests we noticed the Attorney-General (Sir Richard E. Webster, G.C.M.G., Q.C., M.P.), Lord Monkswell, the Earl of Dundonald, the Earl of Lichfield, the Right Hon. G. Shaw-Lefevre, Sir Courtenay Boyle, K.C.B., Mr. W. H. M. Christie, C.B., F.R.S. (the Astronomer Royal), and Sir Albert K. Rollit. We do not know if Mr. W. H. Preece, C.B., F.R.S., was a guest, but all were pleased to welcome him and to see one of our own members representing the Institution of Civil Engineers.

After the dinner, the PRESIDENT having proposed the usual loyal toast, Sir RICHARD WEBSTER commenced the longer speeches by proposing "The Institution of Electrical Engineers." He regretted that the dinner had taken place that night, and that in consequence he was unable to derive benefit from Prof. Lodges's system of telegraphy. When he found he had to propose this toast he immediately put himself in telephonic communication with Mr. Preece, who said "Hello." He replied "Are you there?" Mr. Preece said, "What do you want?" He said that he had been put down to propose this toast. Preece said, "I am very sorry." He replied, "So am I." "Oh," said Preece, "I meant I was sorry for the audience." "You are not so sorry for them as I am," he replied. "Well," said Preece, "I am engaged in a conversation with Marconi on wireless telegraphy. What is your wave-length? I will make your speech for you, and you can indicate the proper gestures." He replied, "Forty-eight inches in the most prominent part." Then there was a pause, after which Mr. Preece said, "Did you hear or feel anything?" "No," he replied. "Then," said Mr. Preece, "You are wound up the wrong way; cut yourself out." Having got his audience into good humour, Sir Richard Webster proceeded to review the benefits conferred by the electrical engineering profession. The practical applications of electricity commenced with her Majesty's reign by the introduction of telegraphs, and afterwards of submarine telegraphy. He was pleased that he had to couple with the toast a name—and, without adulation, he knew of no name more worthy than that of John Wilson Swan to represent the Institution. Mr. Swan combined with a capacity for genuine hard work an extraordinary inventive genius, and a modesty which found universal respect.

Mr. J. W. SWAN said that electrical engineering dated further back than Sir Richard Webster had stated. He well remembered a rhyme learnt when he was a boy, which he quoted as follows:

> With a spark that he got from the skies
> He displayed an unparalleled wonder,
> And showed with delight and surprise
> That a rod could protect us from thunder.

He learnt that rhyme nearly 60 years ago, when he was 12 years of age, from an old sailor. That rhyme contained all that was known then of what they now called electrical engineering, and that knowledge was rather of a negative character. Proceeding, the President referred to the past work of the Institution, and to the vast interests now bound up in electricity. Thus, from Garcke's excellent manual on electrical undertakings, it was seen that nearly 100 million pounds were invested in English electrical works. As to the future prospects, he could not say whether Prof. W. Crookes's idea of enriching our cornfields with electrically-produced nitrates would be one of the new developments, or whether we should eventually use the upper region of the atmosphere for transmitting power, but we might be sure that applications of electricity at present unsuspected would be made. In conclusion, the President referred to the loss the Institution had sustained by the deaths of Mr. Latimer Clark and Dr. John Hopkinson.

The toast of "The Navy, the Army, and the Reserve Forces" was then proposed by the PRESIDENT, who said that no one had more horror than he of the suffering caused by war. He believed that an efficient defensive and offensive force did much to prevent misunderstandings between nations passing beyond the limits of elasticity.

Rear-Admiral Sir W. J. L. WHARTON, K.C.B., R.N., F.R.S., the hydrographer to the Admiralty, replied for the navy, and paid an eloquent testimony to the service rendered by electricity on board ship. The last decade had done much to put the navy on a really efficient footing.

General Sir RICHARD HARRISON, K.C.B., C.M.G., R.E., replying for the army, spoke of the excellent work our young soldiers had done against such enemies as the Afridis and the Arabs. He had hoped that the Sirdar might have been there to reply to the toast, but his presence in Egypt was required to complete the work he had begun. There was no better civiliser than the telegraph, and the British army was very well equipped in this respect. General Harrison explained how with a small staff of regulars and a large staff on reserve duty, or helping the Post Office in some districts, the telegraph department of the Royal Engineers was kept always well up to date and of ample strength. He hoped that the Electrical Engineers Volunteer Corps would do good work in the future, and he should be glad to hear that they were up to strength.

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Captain R. E. CROMPTON said that mournful circumstances had made him head of the Electrical Engineers (R E.) Volunteers, and he could not agree with the last speaker as to the urgency of bringing the corps up to strength. They could fill the ranks to-morrow, but they wished to have in the corps the supreme electrical intelligence of the profession. They might in the future have to carry warfare into the upper regions if Tesla's ideas came to anything, but at present they were engaged on the necessary work of the defence of our coast. They might not always have to be on the defensive side, however, and should occasion arise would be prepared to render service in attacking invading squadrons.

Sir JAMES CRICHTON-BROWNE, F.R.S., gave the toast of "Science," coupled with the names of W. H. Preece, Esq., C.B., F.R.S., the president of the Institution of Civil Engineers, and Prof. W. Ramsay, Ph.D., F.R.S.

Mr. W. H. PREECE acknowledged the kind way he had been referred to in his position as president of the Institution of Civil Engineers, and said he was surprised that such a prodigal as himself should have to reply for science. Still, he had attained the blue ribbon of engineering, in spite of the fact that he had been classed as a "monopoly defender." At Edinburgh recently the Sirdar had told him that the two greatest civilisers in the world were, first, the telegraph and then the railway. He also referred to the humorous remarks of the Attorney-General, and capped them by others as extravagant.

Major-General C. E. WEBBER, C.B., R.E., then proposed "Our Guests," to which the Right Hon. G. J. SHAW LEFEVRE and the Hon. W. P. REEVES, Agent-General for New Zealand, replied.

The following is a full list of those present:

Mr. Acres, Mr. Addenbrooke, Mr. Alabaster, Mr. Allen, Mr. J. D. F. Andrews, Mr. L. Andrews, Mr. Anson, Mr. Appleby, Prof. Armstrong, Mr. Atherton, Mr. Bagley, Mr. Barber, Mr. Barker, Mr. Bayly, Mr. Beaumont, Mr. Benedict, Mr. A. Bergtheil, Mr. E. Bergtheil, Mr. Bevis, Mr. Bidwell, Mr. Biggs, Mr. Billington, Mr. Blenkarn, the Rev. C. W. Bourne, Sir C. Boyle, Mr. Braithwaite, Mr. Bristow, Mr. Bristow, jun., Mr. Brown, Sir J. C. Browne, Mr. Bush, Mr. Butterworth, Mr. Byng, Mr. Cardin, Colonel Cardin, Prof. Carus-Wilson, Mr. Chatterton, Mr. Chattock, Mr. Christie, Mr. Cluer, Mr. Cole, Dr. Common, Mr. Copland, Mr. Cooper, Mr. Cottam, Mr. Courtenay, Mr. Cowper-Coles, Lieut.-Colonel Craig, Mr. Crawter, Captain Creak, Mr. Crisp, Mr. Crompton, Mr. Cunynghame, Mr. Cushing, Mr. D'Alton, Mr. Davies, Mr. A. Dennis, Mr. F. W. Dennis, Mr. Dent, Mr. Dieselhorst, Hon. C. Dillon, Mr. Down, Earl of Dundonald, Mr. Dymond, Mr. Eck, Mr. Edmunds, Alderman Ellis, Mr. A. D. Ellis, Mr. Erskine, Mr. Epstein, Mr. Esson, Mr. Everett, Mr. Fairfax, Mr. Fawcus, Mr. Feetham, Mr. Ferranti, Sir H. C. Fischer, Mr. Fladgate, Sir E. Frankland, Major-General Fraser, Mr. Freund, Mr. Fuller, Mr. J. de Gallindez, Mr. Gamlen, Dr. W. J. Garnett, Mr. Gaster, Mr. E. Giepel, Mr. Gibbings, Mr. Gorham, Mr. J. Gray, Mr. R. K. Gray, Lord Greenock, Mr. Grindle, Mr. Groves, Mr. Gunz, Mr. Haig, Mr. Hall, Mr. Hammond, Mr. A. Harrison, Mr. H. E. Harrison, Mr. H. T. Harrison, General Sir R. Harrison, Mr. Hay, Mr. Heaphy, Mr. Heaviside, Mr. H. F. Hesse, Mr. F. E. Hesse, Mr. Hill, Mr. Hirst, Mr. Holden, Mr. Holmes, Mr. Hooper, Mr. Howard, Prof. Hughes, Mr. Hughes, Mr. Hurrell, Mr. Inrig, Mr. Inrig, jun., Mr. Jacob, Mr. Jenkin, Mr. Jenkinson, Mr. Kershaw, Mr. Kingsbury, Mr. Knight, Mr. C. Kolle, Mr. H. W. Kolle, Mr. Krugelberg, Mr. Lamb, Mr. Lawrence, Mr. Leadbeater, Colonel Leese, Mr. Leyshon, Earl of Lichfield, Mr. Lloyd, Mr. Lord, Mr. Luke, Mr. McDougall, Sir J. Mackay, Mr. Mackrow, Mr. McMahon, Mr. McMillan, Mr. Madgen, Sir H. Mance, Mr. Mance, Mr. Manville, Signor Marconi, Mr. H. Marsh, Mr. H. W. Marsh, Mr. Martineau, Mr. Martin, Mr. A. E. Mavor, Mr. Sam Mavor, Mr. May, Mr. Mead, Mr. Medhurst, Prof. Meldola, Mr. Miller, Mr. Mitchell, Mr. Moat, Dr. L. Mond, Lord Monkswell, Mr. Mordey, Mr. Morse, Mr. Mott, Mr. Mountain, Mr. Nalder, Mr. Nisbett, Sir H. Oakley, Mr. O'Briern, Mr. Offor, Mr. O'Gorman, Mr. Oxenham, Major Flood Page, Mr. A. Flood Page, Mr. Partridge, Alderman Paxman, Mr. Pearce, Mr. Peake, Colonel J. Pennycuick, Mr. D. Penton, Mr. E. Penton, Dr. Perkin, Prof. Perry, Mr. Phillips, Dr. Pounds, Mr. Powles, Mr. A. H. Preece, Mr. L. Preece, Mr. W. H. Preece, Mr. Railing, Prof. Ramsay, Mr. J. Rawlings, Mr. W. R. Rawlings, Mr. Raworth, Mr. Read, Mr. Reason, the Hon. W. P. Reeves, Mr. Reid, Mr. Reynolds, Mr. Ritchie, Mr. Roan, Captain Rogers, Sir A. K. Rollit, Mr. J. Rowell, Prof. Rücker, Mr. Rumbold, Mr. C. N. Russell, Mr. H. Russell, Mr. Ryder, Mr. Samuelson, Mr. Saul, Mr E. K. Scott, Mr. S. Scott, Mr. Seviet, Mr. Seymour, Right Hon. G. Shaw-Lefevre, Mr. J. V. Sherrin, Mr. T. Sherrin, Mr. Shoolbred, Mr. Sinclair, Dr. F. Smith, Mr. F. Smith, Mr. R. A. Smith, Prof. R. H. Smith, Mr. Snell, Mr. C. E. Spagnoletti, Mr. J. E. Spagnoletti, Mr. C. P. Sparks, Mr. H. C. Sparks, Mr. Stanley, Mr. Stearn, Mr. Stebbing, Mr. Still, Mr. Stöttner, Mr. Stothert, Mr. Stroh, Major Stuart, Mr. Sunderland, Mr. C. Swan, Mr. J. W. Swan, Mr. Swinburne, Mr. Swinton, Mr. G. E. Taylor, Mr. H. A. Taylor, Mr. Thomas, Prof. Thompson, Mr. Thomson, Dr. Thorpe, Prof. Tilden, Mr. Tree, Mr. Trotman, Mr. Verity, Colonel Villiers, Mr. Wadley, Mr. Wallace, Mr. Wallis-Jones, Dr. Walmsley, Mr. Walton, Mr. Ward, Mr. Watson, Mr. Webb, Major-General Webber, Sir R. Webster, Admiral Wharton, the Rev. J. White, Mr. Wigan, Captain Wood, Major Woodley, Mr. Woodley, Mr. Woods, Mr. Wordingham, Mr. Wright, Mr. Young.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

Several years ago an investigation of the conditions and requirements incident to the use of high voltages was undertaken by the engineering department of the Westinghouse Electric and Manufacturing Company. In this experimental investigation the size of the apparatus and the conditions of the tests were as far as practicable such as would prevail in actual work.

The transformer, the *sine qua non* of high-voltage working, received first consideration. A design suitable for large sizes was worked out and tested; then high-voltage windings were made. Attention was next directed to the line insulator.

New phenomena were liable to be presented at higher voltages, and it was necessary to determine what they were, also how to meet the requirements which they impose. New forms and sizes of insulators were designed, made and tested to determine the losses which would occur and the limit at which they would break down.

The luminosity and the hissing sound emitted by the connecting wires of high voltage suggested a loss which might be an appreciable addition to that over the surface of the insulators. It was found that a very considerable loss of energy took place between the wires—a loss which at high voltages was much in excess of that across the surface of the insulators.

Mr. L. L. Nunn visited Pittsburg at this time and became much interested in this work. He was a pioneer in power transmission, having put in the first large alternating-current transmission plant in this country—namely, that at Telluride, Colorado, which was designed by the writer and described by him at the general meeting of this institute in 1892. It was proposed that this work be taken up conjointly by the Westinghouse Company and Mr. Nunn, and prosecuted on a much enlarged scale, by operating the original motor over a high-voltage line. In a report to the vice-president and general manager of the electric company, dated April 2, 1895, the writer said: "The transformers would be arranged to give a line pressure of 10,000, which is to be increased by suitable steps to possibly 50,000 volts. . . I regard this as an excellent opportunity to make a thorough and extremely important and valuable test of high-tension working under difficult practical conditions, which our company should take up and carry out as fully as possible." Raising and lowering transformers were made and sent to Telluride, and power for the 100-h.p. synchronous motor was transmitted at voltages far exceeding any which had been previously used anywhere. Exceptional facilities were afforded for observing the practical operation of high-tension working under severe climatic conditions, and for making measurements. The results of the work were so assuring that the Telluride Power Transmission Company has lately installed a plant which is in commercial operation at 40,000 volts, and is now making an increase in the plant. This work has been continued on experimental circuits at East Pittsburg, and some measurements have been made at Niagara.

The work which has just been briefly described was an investigation into an unknown field. It has been pro-

* Paper read before the American Institute of Electrical Engineers.

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gressively and systematically carried out, and it has determined results which were unforeseen, and which are of both theoretical interest and practical importance.

This present paper describes the more interesting and important parts of this work, and gives the methods by which measurements have been made and the results which have been reached. A number of points of interest and importance are given with regard to long-distance transmission plants now in operation.

High-Tension Transformers.

In 1891 the Westinghouse Company furnished transformers for the 10,000-volt transmission to San Bernardino and Pomona. Twenty transformers were used in a set, each giving a pressure of 500 volts, and the 20 in series 10,000 volts. This arrangement made the insulation within the individual coils a matter of comparative ease. The insulation between the coils of the high-tension circuit and other parts of the transformer was secured by allowing a space, which was filled with oil.

The first arrangement of transformers for giving from 30,000 to 50,000 volts was made by using a number of transformers, each giving 10,000 or 15,000 volts. The low-tension circuits of the several transformers received current from an insulating transformer in which there were a number of separate coils, each one supplying a separate raising transformer. An arrangement of this kind was used for obtaining the high voltages in the exhibit of the Westinghouse Company at the World's Fair. A large transformer was designed in January, 1894. The output of 200 kw. was many times greater than that of any transformers which had been made by the Westinghouse Company. The transformer was oil insulated and was cooled by water flowing through a pipe immersed in the oil. This transformer was pronounced a success, and the type was adopted and has been followed ever since as a standard, except that the water cooling is employed only on the largest sizes.

The transformer was then rewound for 40,000 volts and a somewhat reduced output. It was operating at this voltage for a short time when it was found that through an oversight the insulation between layers was insufficient. In October the high-tension coils were rewound for 60,000 volts, and the transformer is still in use after many months of varied service and a considerable period of inactivity.

The making of a single large transformer for a very high voltage naturally involved new difficulties. Above 10,000 or 20,000 volts there was an unexplored and uncertain field in the matter of insulation. Materials which were commonly used at ordinary voltages might have very different characteristics under the new conditions. Tests were made on materials before the first high-voltage transformers were made, and it has been continued. The large high-tension transformer as made to-day was not designed in a week or a month, but it has been an evolution based upon experimental tests and experience in continued operation.

High-Tension Insulators.

After a high-voltage transformer was constructed, the insulator naturally presented itself as a fundamental factor in transmission. The requisites of an insulator for high-voltage work are, that it shall have a dielectric strength sufficient to prevent the current passing directly through the material, that its dimensions shall be large enough to prevent the passage of current over the outside of the insulator to its support, and that the resistance, both of the material and its surface, shall be sufficiently high to prevent undue loss of energy. In addition to these fundamental electrical requirements are those of a mechanical nature involving strength and convenience. These properties must, of course, be permanent, and not liable to deterioration while in service.

Up to this time very little attention had been given to the manufacture and design of high-tension insulators. There were available for our laboratory tests the glass insulators which we had designed for the 10,000-volt transmission line at San Bernardino and Pomona, California. (See paper of Mr. G. H. Winslow before the general meeting of the institute in 1895.)

A much larger glass insulator was made having the so-called "helmet" form, which was probably the beginning of a type which is now quite common. The large glass insulator presented mechanical difficulties in manufacture, and recourse was had to porcelain. An insulator was designed to be under-hung, the top of the insulator being supported in an inverted cup, which was to be bolted to the underside of the cross-arm. From the bottom of the insulator a pin extended, which was anchored in a hole in the insulator and held the wire several inches below the porcelain. The object was to place the wire below the cross-arm, so that the snow which might pile up on the cross-arm would not come near the insulator. The wire, moreover, instead of being supported upon the top of the insulator, where it is in connection with an extended wet surface, would be supported from the part of the insulator which is most protected and the driest.

An interesting evolution then began to take place in the manufacture of porcelain. There were eight or ten steps in this history in which insulators which were presumed by the manufacturer to be satisfactory were broken down on high-voltage test. Porcelain which presented a beautiful smooth glazed surface was often found to contain internal cracks or cavities which were soon traversed by the current. In other cases bits of pebbles or other impurities were found. In still other cases the porcelain was not homogeneous and was not compact, or the material was porous and absorbed a drop of ink almost as readily as a lump of sugar would do. The effect of this work is seen in the improved quality of material now made by certain porcelain manufacturers who benefited by this experience. It may also be remarked that some of the unpleasant experiences with porcelain insulators might have been prevented if similar preliminary tests had been made instead of employing the more expensive and inconvenient method of testing them in commercial service.

(To be continued.)

LONG-DISTANCE TRANSMISSION OF ELECTRIC POWER.*

BY PROF. GEORGE FORBES, F.R.S., M.I.C.E.

(Concluded from page 723.)

In transmission schemes the cost of copper becomes so all-important, when dealing with long distances, that it helps more than I can tell you to have simple means for estimating even roughly the cost and efficiency under various conditions. I feel some diffidence in laying before you these methods because there is nothing new in the results, and all the results can be obtained by the ordinary methods. They have, however, been invaluable to myself. These methods are particularly useful for getting out preliminary estimates quickly. Here let me say that in all preliminary work on the cost of long conductor lines, I never take notice of the resistance of the conductor, nor of the value of the current. I deal only with the current density, and loss of volts. It is the same thing under a different name. But it is what you want. Again, I never use, in calculations for my own use, the efficiency of the conductor system. It is far more convenient to use the inefficiency, or the reciprocal of the efficiency, which is also the horse-power put into the generating end of the line to deliver 1 h.p. at the other end. I give you these suggestions, for what they may be worth, as the result of long experience.

I suppose everyone present is aware of the fact that if you had a case where the power cost absolutely nothing, you would use the least copper and have the cheapest arrangement, with an inefficiency of 2—*i.e.*, an efficiency of 50 per cent., or 2 h.p. generated for each horse-power delivered. If you make the current density either greater or less than what is required to produce this inefficiency, then you have to use more copper to deliver the same quantity of power. This is a point which, in a general way, is appreciated by the business man who is not an electrician, as has been already stated. Fig. 1 shows this very well, and a study of it is interesting. We see that the copper required to transmit 1 h.p. 100 miles, at an initial pressure of 10,000 volts, with continuous current, falls with the increase of density until the efficiency is 50 per cent., and then rises. This figure shows the weight of copper required per horse-power delivered at a distance

* Paper read before the Society of Arts, Nov. 23, 1898.

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of 100 miles at 10,000 volts, or 150 miles with 15,000 volts, or 200 miles with 20,000 volts. It is drawn for the simplest case of continuous current, to which corrections only for temperature and sag have to be made. It is equally applicable to a single-phase or two-phase alternating transmission to 100 miles at 10,000 effective volts; or at 5,000 effective

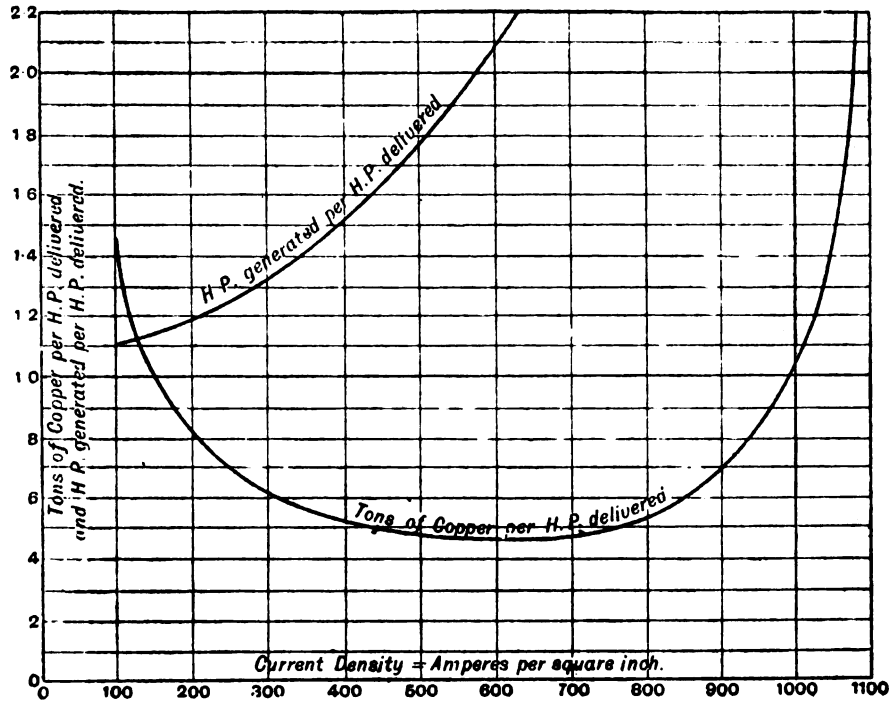

FIG. 1.—Electric Transmission Curve for 100 Miles at 10,000 Volts Continuous Current.

volts from any wire to the middle of the electric system, or to three-phase transmission to 100 miles at 5,000 effective volts from any wire to the middle of the electric system. But with alternating current corrections must be made for self-induction and capacity. The same remarks apply to the meaning of the voltage of the line in all the curves and tables referred to. They are worked out for continuous current, and for any other system the engineer must add the usual corrections. Another curve may be drawn showing the inefficiency at each current density. This curve constantly rises—*i.e.*, the greater the current density the greater is the inefficiency. Now, from these two curves we can deduce a third curve, which is the one which I find gives one in a few minutes all the main facts one wants for any horse-power to be delivered to any distance at any initial volts. This curve gives the tons of copper per horse-power delivered at 100 miles with 10,000 volts, continuous current, in terms of the horse-power generated per horse-power delivered. Measuring along a horizontal line you get the inefficiency—*i.e.*, the horse-power generated for each horse-power delivered—and measuring vertically you get the corresponding tons of copper required for each horse-power delivered at a distance of 100 miles. The curve is also marked with figures to show the current density in amperes per square inch section of copper. I never travel a day without this curve in my pocket. This curve is correct for 100 miles and 10,000 volts, or for any other case where the volts = 100 times the miles. The curve shows you, for example, that for an inefficiency of 1½ you require a current density of 387 amperes per square inch and ·55 ton of copper. And thus current density and weight of copper per horse-power is the same, whether you use 10,000 volts at 100 miles or 100 volts at one mile. For any other volts and distance in miles, V and M, you divide the volts by the miles and get $\frac{V}{M}$; then $\frac{V}{100\,M}=D$, the multiplier for the current density, and $\left[\frac{V}{100\,M}\right]^2=T$, the divisor for the tons of copper per horse-power. As an example, 15,000 volts and 300 miles. Here $D=\frac{15,000}{100\times003}=\frac{1}{2}$. Hence for an inefficiency as above of 1½, the current density will be ½ × 387 = 198. The tons of copper per horse-power will be $\frac{\cdot55}{(\frac{1}{2})^2}=2{\cdot}20$ tons.

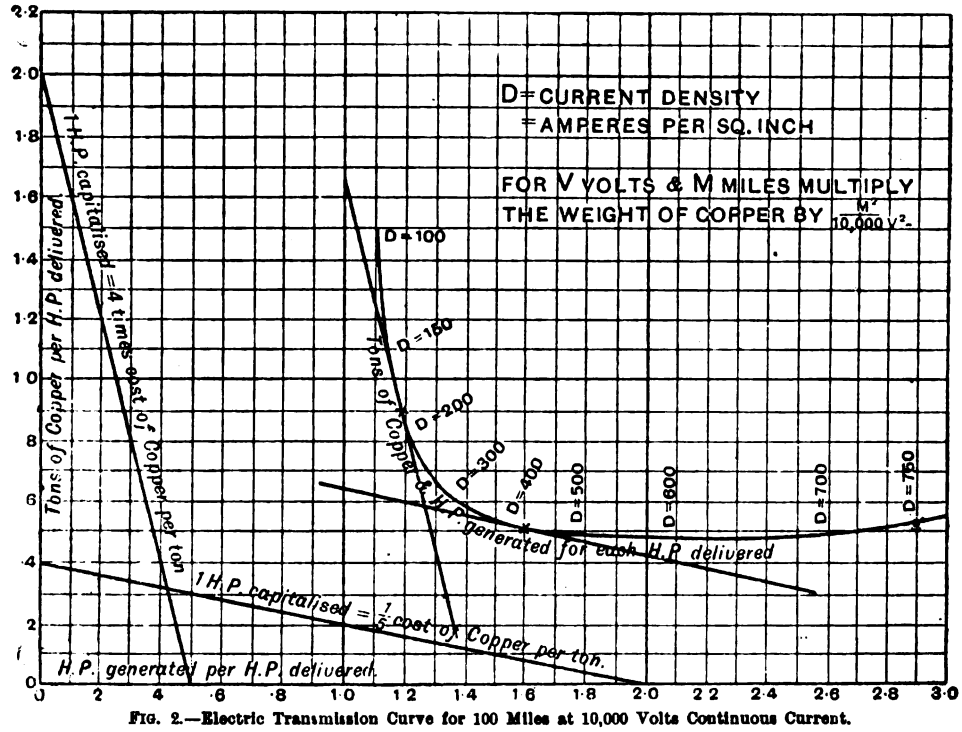

FIG. 2.—Electric Transmission Curve for 100 Miles at 10,000 Volts Continuous Current.

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Now let me show another use of the curve. Suppose we capitalise the cost of running the generating station, and add to it the cost of the generating works, and divide by the horse-power, we have then the capitalised value of 1 h.p. generated; I will call it for short the value of 1 h.p. generated. We also know the cost of one ton of copper. Divide the value of the horse-power by the value of the ton of copper, and draw a line across the axes so that it cuts the axes in that ratio. Draw a line parallel to this and touching the curve. This gives you, according to Lord Kelvin's law (as modified by Ayrton and Perry), the point of maximum economy giving directly the inefficiency, the tons of copper per horse-power, and the current density. Thus on the curve two examples are shown, one where the value of 1 h.p. is four times that of a ton of copper. In this case the greatest economy is got by an inefficiency of 1·18, a current density of 180 amperes per square inch and 0·91 ton of copper per horse-power delivered at 100 miles distance, the initial pressure being 10,000 volts.

Another example is shown on the curve where the horse-power is one-fifth of the cost of a ton of copper. The resulting values are seen directly to be: inefficiency = 1·58; current density = 420; copper = 0·51 ton.

To do this for other values of T $\left[T = \left\{ \frac{100\ M}{V} \right\}^2 \right]$ you must divide the value of the horse-power by T. Measure this distance vertically by the unit on the vertical scale or by fractions of these units, and measure the cost of a ton of copper horizontally by the unit on the horizontal scale or by the same fraction as before of that unit. Join the two points by a line and draw a parallel line touching the curve at the point of maximum economy. You will see now how valuable such a curve must be for obtaining the very information that an engineer requires in his first examination of any project. But we can do more than this. Divide the tons of copper per horse-power by 18 times the distance in miles, and you get the sectional area in square inches of the conductors (go and return) per horse-power. Multiply this by the total horse-power to be delivered, and you get the size of your conductors. N.B.—Remember that this is all worked out for continuous current, and must be corrected for other systems as well as for temperature and sag. Some people prefer to work by tables instead of by curves, so I will put down the readings of the curve which we have just been discussing. For ordinary work the following is sufficient:

Inefficiency.	Tons copper per horse-power.	Current density.
1·20	·86	190
1·30	·66	266
1·40	·58	330
1·50	·55	387
1·60	·51	432
1·70	·49	475
1·80	·48	510
1·90	·472	545
2·00	·470	574

In most practical cases, however, the economical inefficiency for long-distance transmission lies between 1·20 and 1·50. The following table gives closer values over this range:

Inefficiency.	Tons.	Density.
1·20	0·86	190
1·22	0·80	207
1·24	0·76	221
1·26	0·72	236
1·28	0·69	250
1·30	0·66	266
1·32	0·64	279
1·34	0·62	292
1·36	0·60	306
1·38	0·59	319
1·40	0·58	330
1·42	0·57	342
1·44	0·56	354
1·46	0·55	365
1·48	0·54	376
1·50	0·53	387

From either of these tables, having given the efficiency, to get the density for any volts and distance, multiply the above value by $\frac{V}{100\ M}$, and to get the tons of copper, divide the above value by $\left[\frac{V}{100\ M} \right]^2$. This little table enables us, then, with a very simple piece of arithmetic, to get the result for any case that may arise sufficiently closely. But in actual practice I find it far more useful to have the table extended in such a way that an approximate result may be arrived at without any calculation. Three tables are here given. The first gives a reference letter for any volts and distance. In the second and third tables the results we want are found under that reference letter. The second table gives the tons of copper per horse-power delivered, and the third gives the current density for any inefficiency that we may select.

TABLE I.—Distance of Volts.

	Virtual Volts between Wires.					
1 or 2 phase	5,000	10,000	15,000	20,000	25,000	30,000
3-phase	4,325	8,650	12,975	17,300	21,625	25,950
	Distances in Miles.					
A	12·5	25	37·5	50	65·5	75
B	25	50	75	100	125	150
C	37·5	75	112·5	150	187·5	225
D	50	100	150	200	250	300
E	62·5	125	187·5	250	312	375
F	75	150	225	300	375	450
G	87 5	175	262·5	350	437·5	525
H	100	200	300	400	500	600
K	150	300	450	600	750	900

TABLE II.—Tons of Copper per Horse-Power Delivered.

Inefficiency.	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
A	·0537	·0412	·0362	·0344	·0319	·0306	·0300	·0295	·0294
B	·2150	·1650	·1450	·1375	·1275	·1225	·1200	·1180	·1175
C	·4837	·3725	·3262	·3094	·2869	·2756	·2700	·2655	·2644
D	8600	6600	·5800	·5500	·5100	·4900	·4800	·4720	·4700
E	1·344	1·031	·9062	·8594	·7969	·7656	·7500	·7375	7·344
F	1·935	1·499	1·305	1·237	1·148	1·102	1 080	1·062	1·058
G	2·634	2 020	1·776	1·684	1·562	1·504	1·470	1·446	1·439
H	3·440	2·640	2·320	2·200	2 040	1·960	1 920	1·888	1 880
K	7·740	5·940	5·220	4·950	4 590	4·410	4·320	4·248	4·230

TABLE III.—Current Density—Amperes per Square Inch.

Inefficiency.	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
A	760	904	1,320	1,448	1,728	1,900	2,040	2,180	2,296
B	380	452	660	724	864	950	1,020	1,090	1,148
C	253	301	440	515	576	633	680	727	765
D	190	226	330	387	432	475	510	545	574
E	152	181	264	310	346	380	408	437	459
F	127	151	220	258	288	317	340	363	383
G	108	129	188	221	246	271	292	311	327
H	95	113	165	193	216	237	255	272	287
K	63	75	110	129	144	158	170	182	191

RULES FOR USING THE TABLES.

Rule I. *To Find the Reference Letter.*—In Table I., in the column referring to the volts generated, find the approximate distance of transmission in miles. The capital letter at the beginning of the line in which this is found is the reference letter.

Rule II. *To Find the Tons of Copper per Horse-Power Delivered.*—Look along the row in Table II. referring to the reference number, and tons of copper are there given for each inefficiency. The inefficiency being the horse-power generated to deliver the horse-power at the distant point.

Rule III. *To Find the Current Density.*—Table III. gives this in amperes per square inch in the row corresponding to the reference number, and in the column corresponding to the inefficiency chosen.

Rule IV. *To Find the Economical Conditions of Working (Kelvin's Law).*—Divide the capitalised value of 1 h.p. by the cost of one ton of copper. Divide this by 10 and call it q. In Table II. look along the row corresponding to the reference letter until the difference between successive numbers is approximately q. The number at the head of that column is the economical inefficiency, the tons are also then given, and the current density is obtained directly in Table III.

Rule V. *To Find the Total Section (Go and Return) of all the Transmission Conductors.*—Multiply the tons per horse-power by the total horse-power, and divide by 18 times the distance in miles. This is the result in square inches. Dividing this by the number of conductors gives the sectional area of each. I trust, gentlemen, that I have not wearied you with these arithmetical conundrums. All I can say is that I have found them of the greatest use, and I shall be very pleased if some of you do so also. I trust that all here present who are not engineers realise now that the cost of transmission of electric power to a distance is a pure question of balancing expenditure and profits. By the methods now described, or by the ordinary methods, there can be no question as to the cost of the work. The only point, in fact, affecting the cost which has been left to the choice of the engineer is the electric pressure to be used, and every engineer in reporting on

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a scheme generally gives his reasons for selecting the pressure. In old days the highest pressure for which we could get a guarantee from contractors was used. But the expense of insulation increased so much with increase of pressure that now, as at Rheinfelden, we work to that pressure which is the most economical. Manufacturers will now guarantee any pressure if you will pay for it. Having now determined with sufficient accuracy the cost of the works and their maintenance, annual expenses, and interests on mortgage, the next thing is to see (or perhaps this ought to be the first matter attended to) what return can be obtained for the power delivered to a distance. It is then for the purely financial men to say whether the profits to be derived are worth the venture.

It has been my object to-night to put before engineers some useful rapid methods for arriving, on the ordinary lines of working, at the data for any special case of long-distance transmission of power. It has also been my object to show that those who carry out such schemes do not require to be handicapped by the enormous capital which has hitherto been generally considered necessary. Incidentally it would appear that whenever gold mines exist which can afford to pay 5s. or 6s. per ton of ore milled, and if there be good water power within 400 miles of the mines, it is most probable that it will pay well to transmit the power electrically. If I have convinced any doubters that simply in my limited experience I have found many cases where it will pay well to transmit power to distances of several hundred miles, then my purpose is served, and I shall be glad that I have brought this subject to your notice.

DISCUSSION.*

The **Chairman** said there were two matters of which there could be no doubt—first, that Prof. Forbes had brought forward a most suggestive and valuable paper upon a subject which was pressing on the minds of many people in all parts of the world; and secondly, that engineering was a most delightful profession. He was sure all those who belonged to it would agree with him, and those who did not belong to it, after hearing this paper, would be more envious than ever of those who did. The profession of the civil engineer had been defined as that of one who directed the great forces of nature for the use and convenience of man, and engineers were brought into contact with so many interesting subjects, localties, and people, that they were all happy to belong to such a profession. One of the matters which pressed on the mind of the engineer was the conservation of energy. It might take the form of capturing the power which existed in and came from the clouds in the form of rain, and was found in rivers or stored in reservoirs; it might harness the winds, and make them serve the use of man. Proposals had even been made to capture the force running to waste in the waves, and there was the very seductive proposal of directly capturing the electricity in the air, due to terrestrial magnetism or electricity. All these subjects were germane to the interesting question brought forward that evening, because in so many cases the conservation of energy was not of much use unless there were also the power to transmit it to the place where it could be used. For instance, in Scotland, the valley of Ben Nevis had a rainfall of 10ft. per annum, which represented an enormous force at present unused. If that could be captured at a reasonable cost for storage and transmitted to a distance, what a great future seemed to lie before future generations. It was rather startling to hear of £100 being paid per horse-power, but figures had been given showing that gold mining could afford to pay even that figure. In England one expected to get horse-power at £5 or £6 per annum by the storage of water, but he would not go into those details, nor yet into the financial question, except to suggest that the idea of a mortgage at 4 per cent. on copper which was spread over 400 miles in Central Africa seemed to him rather hypothetical. No doubt the value of the copper was there, but whether capitalists would be ready to lend money on it at 4 per cent. under those circumstances he had some doubt about it. He was not an electrician, and would not attempt to follow the figures and diagrams, but they seemed to be of the greatest possible value to those who had to deal practically with this subject, and they must all be grateful to Prof. Forbes for giving them such means of forming a judgment on the problem which was at first sight so intricate as that of the transmission of electric force for distances of 400 or 500 miles.

Colonel Geuraud said he thought the present subject had money in it, and it was a great pity the hall was not filled with capitalists and financiers.

Mr. G. L. Addenbrooke said this was a subject to which he had paid a good deal of attention during the last few years, but the form in which it was presented almost took one's breath away. He did not wish, however, to say anything derogatory of the view put forward, for which they were much indebted to Prof. Forbes. There were no doubt many large sources of water power in various parts of the world, and in time they might be utilised, but he might point out that for many purposes the cost of electric power was much the same whether generated by steam or water power. If these great waterfalls were used in this way, it might lead to an enormous shifting of population, and some of the great centres of industry at present might be destroyed. The question was whether there was any danger of this, and whether anything could be done to enable existing manufactories and populations to remain where they were. What Prof. Forbes said was perfectly feasible. He thought that Englishmen who had not travelled or specially studied the subject had little notion of what had been done in this way abroad. Nothing struck him more at Geneva and one or two other places than the confidence with which capitalists put immense sums into these water-power transmission schemes, especially considering the difference between them and steam-power installations. In the latter case you could start on a small scale; put down, say, 1,000 h.p. and see if there was likely to be a return; but in the case of water power it was essential to begin on a large scale. At Rheinfelden they put down a plant and obtained 22,000 h.p., of which perhaps not more than one-fourth was as yet utilised. But they erected immense works, brought in sidings, built a bridge over the Rhine, bought up all the land in the neighbourhood, and advertised that they would sell sites to manufacturers; so that there was an immense amount of capital locked up which could not be immediately remunerative; but they had sufficient confidence in the thing to wait until it was. What had been done there could no doubt be carried out in other places, such as Prof. Forbes had mentioned. The only one with which he had any acquaintance was Western Australia, for while Prof. Forbes was considering the scheme to which he had referred, he (Mr. Addenbrooke) was acting for some people who had a concession for lighting Coolgardie, and had to consider what they should do with it, and whether they would not be swamped by power transmitted from the coast. He came to the conclusion that there was not very much risk of it. Having spent some time in the country, he was fairly conversant with the local circumstances, and ascertained from some large shipping people at what price they could land coal at the nearest port. He also found there were coalfields within 500 miles which the Government were developing, and which had since been placed in communication by rail. The railways were in the hands of the Government, who were willing to carry coal at ½d. per ton per mile, and he found that they could get coal delivered in Coolgardie at 45s. a ton or less, and at that price he did not think it would pay to generate power on the coast and transmit it. It would be better to generate it on the spot as they were doing on the Rand, and distributing it up to distances of 20 miles. There the price charged per horse-power was about £45. He mentioned that to show that one of the elements which capitalists would have to consider was the chance of coal being found in the neighbourhood, which might alter the whole of the conditions. At the same time there would be many places where this method of transmitting power would be valuable.

Mr. L. Gaster said that he had visited some institutions in Switzerland, and had seen a steam-engine factory where a current of 5,000 volts was transmitted from a river 12½ miles away with an efficiency of 77 per cent., and it was used for all the purposes of the factory. Some time ago Mr. Wallace read a paper at the Society of Chemical Industry on the utilisation of water power, in which he said that by that means power could be supplied at a profit for £4 per annum per horse-power, which was cheaper than steam. The one requisite was to have a very large central station, as in that way it was produced more economically. For long distances the way to reduce the charge for copper was to increase the voltage. From Lauffen to Frankfort, a distance of 108 miles, a high-voltage transmission (although double transformation was used) gave an efficiency at Frankfort of 73 per cent. Large works always produced power more cheaply than small ones, and small manufacturers did better by obtaining their power from such sources than by working independently. Prof. Forbes had shown that long distances were no obstacle, and there was every reason to believe that the time was not far off when this method would be very largely adopted. If England had no great amount of water power she had cheap coal, and if large central stations were established near the coalpits it would be a great benefit to the people at large.

Mr. W. M. Mordey emphasised the very great technical advances of recent years which justified the reader of the paper in treating these bold engineering proposals entirely from the commercial standpoint. What will it cost to transmit the power? And what can be got for it? The chairman had given them two propositions. He ventured to give them a third. If you can make the mouths of capitalists water by showing how to make big profits, you produce a water power of the greatest value. He congratulated Prof. Forbes on having done much to start that power.

Prof. Forbes said he had very little to reply to; and perhaps what he had put forward would be like seed sown in the ground, which in due time might yield a valuable return. He did not think the objections raised were really very serious, not even what the chairman had been good enough to point out, for all the places referred to were not in Central Africa. That question had been fully discussed by himself and the business men before whom he had put the proposition. It was perfectly obvious that something must be laid by for the removal of the copper, and there were many other points which he might have mentioned; for instance, it would be essential that those who held the bonds should have some representative on the spot to see how much copper was put down, and that the value remained, and many other precautions would have to be taken, but these were matters of detail, with which he did not think it necessary to burden the paper. He trusted the view put forward by Mr. Mordey would be generally adopted, that they really had no differences to settle in this matter; at any rate, none worth talking about. The estimates which could be made were like those for building a bridge or any other work; it was purely a question for business men whether it was worth venturing. He thought the scheme of dividing the

* From the *Journal* of the Society of Arts.

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capital into a speculative and a solid investment was a sound proposition. He should be glad to be able to get 4 per cent. on such a safe investment as this seemed to him to be, and as for the speculative side, he thought 40 per cent. ought to make even a large capitalist's mouth water.

LONDON COUNTY COUNCIL.

REPORT ON TECHNICAL EDUCATION.

The following is the report of the Technical Education Board on the proposed application to the Department of Science and Art:

The Department of Science and Art receives annually from the Treasury a sum of money to be employed in aiding the teaching of various branches of science and art in the schools and classes throughout the country which are associated with the Department and conducted in accordance with the Department's regulations. The grants made under this arrangement have, as far as London is concerned, been largely increased since part of the Local Taxation (Customs and Excise) money placed at our disposal by the Council has been applied in aiding the scientific and artistic education of the Metropolis and making it more thorough and efficient. The grants are usually paid by the Department in December on account of the school year which ended the previous July, so that under the present system the grants are not receivable until 15 months after the commencement of the work on account of which they are paid, and this has necessarily been the source of great inconvenience to poor schools.

In 1896 a departmental committee was appointed by the Lord-President of the Council to consider what changes, if any, should be introduced into the Science and Art Directory. The committee comprised Sir John Gorst (chairman), Sir John Donnelly, Mrs. Sidgwick, Lord Balfour of Burleigh, Sir Henry Roscoe, Mr. G. L. Ryder, Prof. Jebb, and Mr. W. Armstrong, with Captain Abney as secretary. As one result of the deliberations of that committee a clause was introduced into the directory of 1897 enabling the work of the Department to be partly decentralised by delegating to the local authorities certain of the functions of the Department, this course having become possible in consequence of the educational experience gained by the several technical instruction committees of county councils. The clause in question, which appears as Clause VII. in the directory, is the following: "In counties and county boroughs in England which possess an organisation for the promotion of secondary education, such organisation, if recognised by the Department, may notify its willingness to be responsible to the Department for science and art instruction within its area. In such case grants will in general be made to the managers of new schools and classes only if they are acting in unison with such organisation. The rights of the managers of existing schools and classes will not be interfered with, and town councils and school boards which are managers of schools receiving Science and Art grants will not be debarred from establishing in their districts additional schools where necessary."

The principal effects of this clause will be as follows: (1) any schools may, if they wish, enter an organisation to be established by the local authority; (2) existing schools and classes which prefer to remain outside the organisation may continue, as at present, under the direct control of the Department, no change whatever being made in connection with them; (3) the right will be reserved to the School Board not only to carry on existing schools and classes under the Department, but to establish new schools and classes—in fact, the powers of the School Board will not be affected in any respect; (4) the local authority will have power to prevent unnecessary competition and overlapping by the opening of new schools under management other than that of the School Board; (5) inasmuch as the local authority will become entitled to receive the grants payable by the Department, it will be possible for that authority to pay the grants to the schools in quarterly instalments without waiting for the actual payment by the Department; (6) all attendance registers and other important forms will pass through the office of the education committee of the local authority, and the committee will thus secure the opportunity of inspecting all registers before forwarding them to the Department for the payment of the grant, and will also have control over the subjects taught in all the schools within the organisation; (7) all the schools within the organisation being federated under one local authority, it would be possible for that authority to employ specialists as travelling teachers, who would give courses of instruction at several schools on different days of the week, and would thus enable the schools to secure the services of much more highly qualified specialists than is possible under the present organisation; (8) the London schools federated under the local authority in conjunction with that authority might make representations to the Department respecting any matter in which the regulations of the Department are found to interfere with the efficiency of the schools, and upon such representation it would be easier for the Department to make any changes which the special conditions of London might require than if recommendations were submitted by individual schools.

Already the councils or technical education committees of over 30 administrative counties and county boroughs have been recognised by the Department as responsible for the conduct of science and art instruction within their county areas. Communications have been received from the secretaries of several of these local authorities with regard to the working of the new arrangement, and from their replies it appears that it would not be necessary to increase our present office staff in order to provide for such additional work as may be occasioned by the adoption of responsibility under Clause VII.

The total amount of annual grant at present being paid by the Department to schools and institutions within the administrative county, other than those connected with the School Board for London, is about £21,000, of which almost exactly half is received by the polytechnics, and the remainder by other technical institutions, schools of art, science and art classes, and schools of science forming parts of ordinary secondary schools.

We have very fully considered the various questions which arise out of the proposal to ask the Department of Science and Art for recognition under Clause VII., and have concluded that such recognition would conduce greatly to better organisation and improvement of the teaching in the schools receiving aid from this Board. The matter, however, is one of considerable importance, and we have come to the conclusion that we ought not to proceed without acquainting the Council with our intention, and asking its sanction to the step proposed. We therefore report that we have passed the following resolution: "That the Board notify to the Department of Science and Art its willingness to be responsible for the science and art instruction within the county of London, subject, however, to a report on the matter being submitted to the Council, and the Council's approval of the proposed notification being obtained," and we recommend that the Council do approve of the Technical Education Board notifying to the Department of Science and Art its willingness to be responsible for the science and art instruction within the county of London."

EDWARD BOND, Chairman.

Mr. ORGAN moved that the consideration of the question be postponed until the meeting of the Council to be held on Dec. 20, and that in the meanwhile the School Board for London be invited to nominate representatives to confer with representatives of the Council as to the proposed application to the Science and Art Department.

The report was approved by the Council.

PROVISIONAL ORDERS.

Advertisements have been issued *re* provisional orders by the following corporations, councils, and companies in addition to the list already published by us:

Burslem—electric lighting.
Camborne, Redruth, and District—light railways.
Carshalton—electric supply.
Clayton—tramways.
Carringham—light railways.
Crystal Palace—light railways.
Didcot and Wallington—light railways.
Dudley and Wolverhampton—tramways.
Economic Railways Company—light railways, Cornwall.
Guildford—extension of electric lighting.
Hampstead and Edgware—light railways.
Hendon—electric lighting.
Ilford—tramways.
Middlesbrough, Stockton, and Thornaby—extension of tramways.
Nevins, Thomas—light railway near Lansdowne Castle.
North Lindsey—light railways.
North Staffordshire Tramways.
North-West London Railway—work by electricity.
Oldham—tramways.
Queensbury—tramways.
Railway Corporation of Great Britain (3)—light railways.
St. Helens, Leigh, and Bolton—light railways.
Swansea—light railways.
Waltham Cross and Enfield—light railways.
West Metropolitan Railway—railways in London and Middlesex.

This completes the list for 1899. It includes 114 applications for electric lighting, not counting applications for electric supply in various large centres. There are 32 light railways proposed to be worked by electricity.

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LEGAL INTELLIGENCE.

OVERHEAD TELEPHONE WIRES.

Christoffer and Others v. The National Telephone Company, Limited.

The plaintiffs in this case, which was heard in the Queen's Bench Division before Mr. Justice Lawrance and a special jury, were interested in the house, 15, Assam-street, Church-lane, Whitechapel, and they claimed damages in respect of injury said to have been caused to the house through the erection near it of two great telephone poles, which carried a very large number of wires over the house.

Mr. Moyses and Mr. Chamier were for the plaintiffs, and Mr. Roskill for the defendants.

The poles were not upon the land of the plaintiffs, but they were within some 10in. of their house; one of the poles was 13in. and the other 15in. in diameter, and they were sunk 6ft. or 7ft. into the ground. The first pole was put up some 13 years ago, and the second one at a later date; and the case for the plaintiffs was that the vibrations of the poles in high winds moved the earth under the foundations and caused a sinking in the building. There were two cracks in the building, one in the front part of the house, and one between the main building and the back addition, with the result that the back addition should be rebuilt. There were other complaints as to annoyance of noise, darkness, and so on, from the overhead wires, which were said to be 546 in number, most of which were in cables. Evidence was given upon the one side and the other, as to whether any damage suffered by the house arose from the movement of the poles, or from the house having a faulty foundation. It was said that no earlier complaint than this had been made because it was supposed that the defendants had statutable authority for what they did when they put up the poles, which, it was said, had been removed.

The Jury gave a verdict for the plaintiffs for £50.—*Standard.*

SAVORY v. EDWARD LLOYD, LIMITED.

This action was tried on Wednesday in the Queen's Bench Division before Mr. Justice Day and a special jury, and was brought by Sir Joseph Savory, of 33, Upper Brook-street, W., against Messrs. Edward Lloyd, Limited, of 12, Salisbury-square, E.C., and Mr. W. J. Richardson, of 4 and 5, Great Queen-street, Lincoln's-inn-fields, claiming damages for libel. The defendants are respectively the proprietors and printers of a newspaper called *London*, and the plaintiff complained that in the issue of that newspaper for June 30, 1898, the defendants falsely and maliciously printed and published of and concerning the plaintiff and of him in relation to his official position as an alderman of the City of London and as Lord Mayor of London from November, 1890, to November, 1891, the following libel: "How the City sold its Municipal Birthright.—An electric lighting transaction which enriched members of the Corporation and created a monopoly—the Lord Mayor, Sir Joseph Savory, concerned.—In proposing at the last meeting of the Common Council that the Corporation should acquire the undertaking of the City Electric Lighting Company, Mr. Brooke-Hitching incidentally referred to the circumstances under which the enterprise was established. We have investigated this subject and will lift the veil from a very discreditable transaction. The action was a clumsy and barefaced one, but combined the characteristics of Hooleyism and Tammanyism. Some members of the Corporation were interested in a promoting company formed for the purpose of buying out monopolistic rights which several of them assisted to create. We will describe the sordid story as we have gathered it from unimpeachable records. It is one of the worst jobs which tarnish the municipal history of the City of London. Initial Experiments.—The City began experimenting with the electric light in 1879, but nothing serious was done till 1890, when the Commission of Sewers, the lighting authority, decided to divide the City into three districts and invite tenders for lighting for 21 years. This looked well, as it cut down the period of monopoly and created competition. The Brush Company secured two districts, and Messrs. Laing, Wharton, and Down the third. This was towards the end of 1890, and one would have thought that the competing companies would at once have got to work vieing with each other in the excellence and cheapness of their service. Nothing apparently was done, however, until Jan. 27, 1891, when the City Commissioners of Sewers were invited to attend a luncheon to inaugurate new underground works. A Promoting Company.—Even then the companies did not go ahead with their work, but in the meantime a concern was being hatched with the help of members of the Commission; and here, as we are on serious ground, we may at once say that all our information on the subject is gained from records in Somerset House and the minutes of the Commission of Sewers. On Feb. 5, 1891, the City of London Pioneer Electric Lighting Company was registered. This company was promoted by the General Electrical and General Investment Company, 1, Great Winchester-street, for the purpose of promoting another company, as, indeed, it candidly admitted. It was not to be a working company, but a promoting syndicate to buy up the two competing companies and to create a monopoly. The objects which it avowed were: '(1) to carry into effect the agreements with the Brush Company and Messrs. Laing, Wharton, and Down; (2) to take such steps as may be necessary towards the formation of a larger company and towards securing the subscriptions to its capital and to pay all expenses incidental thereto; (3) to carry on in the City the business of an electric lighting company in all its branches.' The objects of the company were also described in a letter sent to the Board of Trade in February by Messrs. Laing, Wharton, and Down, stating that a 'company had been formed under the auspices of, and assisted by, the Electrical and General Investment Company, Limited, 1, Great Winchester-street, and was registered under the name of the City of London Electric Lighting Pioneer Company, Limited.' The objects in this letter were described as being 'initiating works by the Brush Company and Messrs. Laing, Wharton, and Down, and for financing them up to a certain stage of the same,' 'with the intention of forming a strong company with a large capital.' The Board of Trade was unable to express itself satisfied as to the financial position of the undertaking, and it was not until March 10 that the Streets Committee were able to report that the Board of Trade had given the necessary consent. Evidently the Board suspected the transaction. Lord Mayor Savory's Interest.—There was a regular cycle of Hooleyism. First, the Streets Committee of the Commission of Sewers granted concessions to the Brush Company and Messrs. Laing, Wharton, and Down; the Exploration Company helped the Electrical and General Investment Company, Limited, which promoted the City of London Pioneer Electric Lighting Company, Limited, which in turn promoted the present City of London Electric Lighting Company. Some people are concerned in all the transactions, including the decisions of the Streets Committee of the Commission of Sewers. The nominal capital of the Pioneer Company was £100,000, divided into 2,000 shares of £50 each. The chief promoters of the company were the Lord Mayor (Sir Joseph Savory), a member of the Streets Committee—to which committee the whole subject had been delegated—and Mr. Cecil Braithwaite, a stockbrocker. There was a call of £25 per share, and the following were among the shareholders: the Lord Mayor (Sir Joseph Savory), 25 shares, £1 250; Alicia Savory, eight shares, £400; Isobel Savory, 10 shares, £500; A. H Savory, five shares, £250; Rev. E. L. Savory, five shares, £250; R. H. Savory, five shares, £250; the Rev. A. Savory, not stated. The Lord Mayor was also a shareholder (holding 100 ordinary and one founders' shares) in the Electrical and General Investment Company, which promoted the Pioneer Syndicate, and pays 30 per cent. The following members of the Commission of Sewers were shareholders: Edward Lee, 10 shares, £500; J. F. Hepburn, 20 shares, £1,000; Walter Brown, five shares, £250; B. S. F. MacGeagh, one share, £50; A. Purssell, one share, £50; C. E. Smith, no information given. Several other members of the Commission were shareholders, but in the names of firms with which they were connected. Mr. Nathan Rothschild held £5,000. This syndicate, having acquired the rights of the companies which the Streets Committee created, negotiations, of course, went on very smoothly. The Streets Committee, on June 3, 1891, reported that they 'offered no objection to the transfer of the electric lighting orders to the new company,' in which some of the members were to hold shares. There was, however, some suspicion that things were not right, and an amendment was moved that the Commissioners should disapprove of the transfer in the absence of any details or duly certified information as to the value of building, plant, etc., and of the value of work in hand or to be completed, and further objection to any payments being made to the promoters as purchase-money for the agreements with the Commission. This amendment was rejected by 21 votes to 17. None of the members who had shares in the syndicate voted against the amendment, but it was opposed by the chairman of the Streets Committee, Mr. Sayer, and Mr. W. H. Pannell, of whom we shall have more to say. No time was lost by the Pioneer Company in getting rid of its agreement and in promoting the City of London Electric Lighting Company. The Pioneer Company did not last more than six months, and at the end of that time sold the undertakings to the present City of London Company, which started with a capital of £1,300,000. The Lord Mayor and the other shareholders in the syndicate received all their capital back (though they appear to have only paid up half the amount) and a 50 per cent. bonus in addition. This means that the new company paid the Pioneer Syndicate £150,000. The net benefit of the interested shareholders was the amount set against their names, which means that the Savory family had £2,900 and the members £1,850. This does not represent the full extent of their benefit, as we shall show, most of them became shareholders in the present company. It was a very profitable transaction. They were all small Hooleys in their way, and made their money quite as easily as he did in his promotions and with less anxiety. Company Drafting Corporation Resolutions.—One little incident shows how the affair was 'engineered.' On Feb. 24 a letter was received from the Board of Trade enclosing communications from the Laing, Wharton, and Down Syndicate, intimating that the Pioneer Company was to be formed to take over the orders. That letter contained the following significant paragraph: 'I enclose . . . copy of a resolution passed at a meeting of the Streets Committee of the Commissioners of Sewers on Feb. 13 (who by a resolution passed at a meeting of the Commissioners of Sewers on the 10th inst. were specially authorised to deal with this matter) by which it will be observed that the Commissioners are satisfied that the syndicate has complied with the requirements of the Commissioners, and is in a position to fully and effectively carry out the contracts.' The 'reference to the Streets Committee of the 10th inst.' referred to by Laing, Wharton, and Down, was merely an intimation that the company had deposited the necessary £1,000, and were prepared to proceed with the work, and only waited the permission of the Board of Trade. Anxious to 'facilitate' matters, the company took the extraordinary course of drafting a resolution for the Com-

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missioners, setting forth these simple facts, which certainly looks as though they desired to 'rush' the matter through. 'Impanelled.'—When the letter from the syndicate announcing the Pioneer Company was read before the Commissioners of Sewers several members professed not to understand the subject. Mr. Pannell enlightened them; he explained that the Pioneer Company was formed to promote a larger company and that the provisional order had nothing to do with the transfer of the contract. Mr. Sly asked whether this company was the one advertised in which the Lord Mayor was chairman and of which Mr. Pannell was the accountant. Mr. Pannell was anxious further to explain, and said that the Pioneer Company had nothing to do with the Commissioners in any way. He might have added that the Commissioners had a good deal to do with it, which was still worse and more to the point. Mr. Sayer said that the Commissioners 'were most of them aware that these electric lighting companies must be financed by someone'—a piece of financial wisdom which did him credit. Mr. Sly drew attention to the standing order of the Court, which prohibited a member from voting upon a question of this sort in which he was interested. This again brought Mr. Pannell to his feet. He said: 'I am not a shareholder in this company; I have never been a shareholder in any company. I ask whether my position as a public accountant forbids my being associated with this Commission?' Mr. Pannell was beside the point. The Solicitor said that the standing order did not affect him. As accountant of the promoting company Mr. Pannell took an active part in the Pioneer scheme. At this meeting Mr. Sayer said that the Commissioners were much indebted to Mr. Pannell (who had been specially added to the committee to help) for the assistance he had rendered to them in this matter, and at the inaugural ceremony of the works Mr. Deputy Green congratulated Mr. Pannell on the zeal he had displayed in getting the electric light for the City. He had attended the whole of the meetings. Mr. Pannell has been well paid for his zeal and got a good deal for himself. If he got the electric light for the City, as Mr. Green says, the citizens will not now congratulate him for his civic zeal. He was the accountant of the Pioneer Company, promoted by the Lord Mayor and others, and became the accountant of the City of London Electric Lighting Company, one of the best-paid posts of the kind in the City. Mr. Pannell is in a better and more independent and profitable position than if he had been a shareholder. The effect of the intervention of this promoting company was the 'watering' of the capital of the present City of London Electric Lighting Company, from which the citizens still continue to suffer through high charges to pay the dividends of a huge capital, and if Mr. Brooke-Hitching's scheme go through, the 'deal' which we are exposing will have cost the citizens over half a million. Shareholders in Present Company.—Some of the members who helped to finance the Pioneer Syndicate, and who benefited from selling interests which the Commission of Sewers had created, were in the swim again. The following were among the shareholders of the City of London Electric Lighting Company. The shares were £10: Edward Lee, 75 shares; J. F. Hepburn, 150 shares; Alfred Purssell, 58 shares (these members have now sold out); B. S. F. MacGeagh, 28 shares. The Savory family were also in it as follows: Ronald Savory, 45 shares; Rev. E. L. Savory, 88 shares; A. H. Savory, 38 shares; Mrs. E. A. Savory, 60 shares. A Tight Monopoly.—The mischief was not yet complete. What seemed to the public to be a competitive system with a limited monopoly has turned out to be an absolute monopoly, and the City of London is the only place where there can be no competition in electric lighting either by a company or the municipality. We have seen that there were never three competitors as intended, but only two, and the two soon became one. The clause in the agreement with regard to public lighting which restricts the monopoly of the company to 21 years for the completion of the side-street lighting is inoperative, as no serious attempt has been made to complete the side-street lighting, nor is there likely to be. The company has had many privileges granted to it, such as the use of subways, which it did not construct, and put down mains under the three City bridges without making any payment for the privilege. The terms of the agreement with the company in the opinion of the five law officers of the Corporation prevent the Corporation from doing what Marylebone has done—promoting a provisional order itself—and it compels the Corporation to oppose the attempt of any rival company to enter the field in competition with the favoured monopoly. The whole spirit and letter of legislation on electric lighting has been undermined, and it was the duty of the law officers at the time to stop the exceptional privileges being granted. The City Company is in a unique position—absolutely free from competition within the area of the City, it is still able to compete with other companies outside the City, as it does in Southwark. The story we have told is taken, as we have said, from official records. It speaks for itself. If Sir Joseph Savory and the others have anything to say for themselves, we shall be glad to publish their statements. If Mr. Pannell can show that he was actuated by a high sense of public duty in 'getting the electric light for the City and the position of accountant for himself, his explanation should be interesting. Is Municipalisation Possible?—We admire the courage which Mr. Brooke-Hitching is showing in this matter. He thinks the City should follow the example of Liverpool, Sheffield, and Birmingham and buy the undertaking at a profit. It would be the most expensive purchase of the kind yet carried out, for the City would not only have to pay the ordinary premium on the shares, but pay also for the exclusive monopoly which the Commission of Sewers granted and for the watered stock which the promoting company created. Still he hopes that there would be economies, particularly if the City were to follow the example of Shoreditch and utilise its dust and refuse as fuel. We are not quite so sanguine on the subject. The 'unholy influences,' as Mr. Moreton called them, which fastened this monopoly on the City are still at work. Weighted with an enormous capital—far in excess of the net value of the undertaking—it would be difficult to make it pay and at the same time reduce the charges. It could be done by competent management, such as we find in Birmingham and Southampton. But in the City the engineer's department, which would naturally have charge of the work, has too many jobbing traditions to be able to manage competently such a huge undertaking. We have no confidence in the engineer's department, and the Corporation shows no desire to improve its administration. If things go on as they are, the citizens, who are now paying twice as much as Brighton, Edinburgh, and other towns for electric lighting, will in 20 or 30 years' time be paying about 10 times as much. Tammany in the City.—The exposure which we make this week of the way in which the electric lighting undertaking in the City was established explains why in the centre, where electricity could be supplied for less than any other place in London or in the country, the charges are the highest. It also throws a light on the shameful transactions which go on behind the scenes at the Guildhall. While the City ratepayers, eager for the sake of health and cleanliness, thought that the most envied area in the whole country for electrical enterprise was to be given to competitors, who would vie with each other in providing light cheaply, a scheme was being hatched within the body whose duty it was to protect public interests for floating a company to create a monopoly. The Lord Mayor for the time being, Sir Joseph Savory, was chairman of the promoting company. He was also a member of the Streets Committee who executed the electric lighting contracts for the Commission of Sewers Several other members were also shareholders in the company. Lord Mayor Savory was interested in the company which financed the promoting company—started solely for the purpose of making money out of the interest which the Commissioners of Sewers created and of the contracts which it had granted, presumably in the public interest. When the new company, with its inflated capital, was created, members of the Commission again appear amongst the shareholders. It was a cycle of petty Hooleyism, the effect of which was to fasten a lighting monopoly with a watered capital on the City, which uses the special privileges it obtained to impose excessive charges on the citizens. What would be thought of such a transaction on the part of members of public authorities were it done in Birmingham, Glasgow, or Liverpool? What would be thought of members of the County Council were they to degrade themselves to such sordid financial scheming for their own enrichment and the public loss? What would be said if the members of the Highways Committee of the County Council promoted a little syndicate to acquire a valuable tramway concession, which in a public capacity they had granted, and then sold to another company, pocketing handsome premiums for their services? Why, anyone who did such things outside the City of London, whether in Manchester, Birmingham, or at Spring-gardens, would be hounded out of public life and despised by his fellow-citizens. But in the City of London, that home of model government and great traditions, the standard of municipal ethics has sunk so low that the men who participated in the deals we expose still stalk about in public life with unsullied reputations, respected as worthy members of the Corporation and examples of civic virtue. Not in New York, even in the worst days of Tammanyism, could such a transaction have been carried out without exposure, and, once exposed, so impudent and barefaced was the scheme that it would have immediately collapsed. The worst feature of the whole business is that one of the chief persons concerned was the Lord Mayor, Sir Joseph Savory, whose official position is fully described in the share lists of the companies. His influence and his name must have been of enormous value to the promoters, and his connection with the two promoting companies was not unprofitable to himself. The Mansion House, from which radiate so many elevating influences, the home of hospitality and the national centre of charity, should be free from the influences of company promoting. What do the citizens, who all suffer now from the transactions, by excessive electric lighting charges, think of these doings? Are they satisfied with the system of government under which such things can be done? Where were the men in the Corporation who believe in honest and good government? Where are they now, if they do not purge their body of the 'unholy influences' which are still at work? Not many members of the Corporation would stoop to such transactions. Few of them, we are willing to believe, are ready to do so. Many, we gladly admit, have high ideals of civic duty, and seek only to promote the good government of the City. But if they are content to stand aside and permit members to benefit financially from their connection with the Corporation, if they refuse to recognise any standard of municipal ethics and honesty, they share in the blame for the wrongs that are committed. These dealings which we have exposed may be said to be past history, but it has a very vital bearing on the present problem. We consider that the effect of these 'deals' was the 'watering' of the present company's stock—that is to say, its capital does not represent real assets—and the creation of an absolute monopoly. Unlike Marylebone, or any other place in the country, the City cannot use the threat of competition as a lever to lower the purchase price. On the contrary, the Corporation is committed to protect the company against competition, while that company is able to enter the field of rivals in Southwark from its protected centre in the City. Were purchase proposed, the stock of the company would immediately rise in value. At present, while the nominal capital of the company is £1,400,000, the Stock Exchange value is about twice that amount. Were the Corporation to propose purchase, the price would rise and

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purchase would only be possible at the Stock Exchange value, plus 10 per cent. for compulsory purchase. There would be little scope for lowering charges. But, on the other hand, if the company is allowed to continue, we may be sure that the price for electricity in the City will remain higher than anywhere else in London, and that in about 20 years from now, by which time the municipalities will be supplying current at 1d. and 2d. per unit, the City consumers will still have to pay exorbitant charges. Administrative reform, as we point out elsewhere, would be necessary before we could have any confidence in the City's capacity to manage a municipal undertaking with efficiency and profit." The plaintiff alleged that the defendants meant thereby that the plaintiff had abused his said official position and had sacrificed the public interests for the purpose of making private gain, and had been guilty of discreditable, corrupt, and dishonest conduct, and of conduct which rendered him unfit to hold any official position in the City of London, and for which he ought to be shunned by all respectable persons. The defendants pleaded that the words did not mean what was alleged by the plaintiff, and that they were incapable of any defamatory meaning. They further pleaded that, in so far as the words consisted of allegations of fact, they were true in substance and in fact; in so far as they consisted of expressions of opinion, that they were fair comments made in good faith and without malice upon the said facts, which were matters of public interest.

Sir E. Clarke, Q.C., Mr. J. Eldon Bankes, and Mr. R. V. Bankes appeared for the plaintiff; Mr. Carson, Q.C., Mr. J. Alderson Foote, Q.C., and Mr. Dunlop Hill for the defendants; Mr. W. de B. Herbert and Mr. W. E. Harrison held watching briefs for persons interested.

Sir E. Clarke, Q.C., in opening the case for the plaintiff, said that Sir Joseph Savory was an alderman, and had been long connected with the City. He was sheriff in 1882, and became an alderman in 1884. He was Lord Mayor in 1890, and was made a baronet in 1891. In 1892 he became member of Parliament for the Appleby Division of Westmorland. Prior to becoming Lord Mayor he was not a member of the Common Council, nor was he prior to that time connected with the Commissioners of Sewers. He had been associated with public life in an honourable way. The justification pleaded by the defendants was founded upon mis-statements of facts relating to the plaintiff's position. From 1878 to 1890 the Commissioners of Sewers were the lighting body in the City. The plaintiff had nothing to do with the electric lighting in the City. The contracts for that purpose were made in 1890, before the plaintiff was appointed Lord Mayor. The Lord Mayor never took part in the proceedings of the Commissioners of Sewers, and, with the exception of attending a meeting on Feb. 10, 1891, he never had any connection with the Commissioners. At night there was practically no consumption of electric light in the City, and the consumption of electric light there was irregular. When elected Lord Mayor the plaintiff made a statement as to the companies with which he was connected. In consequence of representations made to the plaintiff, and under great pressure, the plaintiff joined the City of London Pioneer Electric Lighting Company. This was done publicly and under public pressure. He took shares in the company as a matter of duty to the extent of £1,250. The Pioneer Company having fulfilled its duty was wound up, and the plaintiff made a profit on his shares to the extent of £625. That was all that the plaintiff had to do with electric lighting. The article headed "Tammany in the City" was as defamatory as it could be. All that the plaintiff did was in the public interest and to promote the electric light.

Sir J. Savory was then examined by Mr. J. E. Bankes, and said that he was member of Parliament for the Appleby Division of Westmorland. Between 1882 and 1890 the Commissioners of Sewers and the Streets Committee regulated the electric lighting of the City. He was not a member of either, and had nothing to do with the electric lighting. He had nothing to do with the contracts entered into with the Brush Company or the Laing Company. In 1892 the Baring crisis took place. In 1891 he was approached by a deputation, and he was asked whether he would join a company to carry out the work. He at first declined, but ultimately on great pressure consented. He agreed to become chairman of the Pioneer Company, which was to carry out the work. He thought it his duty to do so as Lord Mayor. One of the objects of the company was to tide over the period until a larger company could be formed. The City of London Electric Lighting Company was formed, and as the Pioneer Company had performed its duty it was voluntarily wound up. The capital of the City Electric Company was £800,000. He did not become chairman of the new company, though he was asked to. The Lord Mayor used to be chairman of the Commissioners of Sewers. He took no part in their action with regard to electric lighting.

Cross-examined by Mr. Carson, Q.C.: He became Lord Mayor in 1890. He did not know that whenever he desired to attend the Commission of Sewers he was entitled to take the chair. The Commissioners of Sewers entered into a contract with the Brush Company and Laing, Wharton, and Down. The Electric and General Investment Company promoted the City of London Electric Lighting Pioneer Company. He did not know that everyone of the companies made a profit. At one time he had shares in the Brush Company. The chairman of the company, Mr. J. B. Braithwaite, was his cousin. When he became chairman of the Pioneer Company he did not investigate the contracts. As to the Electric and General Investment Company, he got one founder's share and 100 ordinary. He held them for about a year. He got £129 for the founder's share, and for the ordinary shares £198. 14s. 6d. The reason of the promotion of the Pioneer Company was that during the Baring crisis the Brush and the Laing Companies had a great difficulty in finding the necessary capital by Feb. 17, 1891, and if they had failed in this, the contracts with the Commissioners would have lapsed. The Pioneer Company was not really the Electric and General Investment Company in another form. The total capital of the Pioneer Company was £100,000, £50,000 only being called up. Mr. Pannell was appointed auditor. The secretary of the Electric and General Company was also the secretary of the Pioneer Company. Every shareholder in the Pioneer Company got 50 per cent. profit for the few months it was in existence. It was an advantageous thing for the City that a virtual monopoly should be granted to one company. He did not know that it was in the teeth of the Electric Lighting Act, 1880. He did not know that before the prospectus of the City of London Electric Lighting Company was brought out the Pioneer Company had entered into contracts with the Brush and Laing Companies to give them the work in their districts for £300,000 and £200,000 respectively. There was an agreement between the Pioneer Company and the Brush Company, but he could not say how the figures in that contract were fixed. He denied that a considerable sum of money was given to the Brush and Laing Companies to transfer the monopolies created by the Commissioners of Sewers. If he had known it, he should, as Lord Mayor, have thought it a discreditable thing. He did not believe a penny was given. He did not know whether a detailed specification was made out before the sums to be paid for transferring the monopolies were fixed. He did not know that the Laing Company paid the Electric and General Investment Company £10,000 He could not say why the Laing Syndicate was to pay the Investment Company £9,000. He did not know why the Brush Company was to pay to the Investment Company the sums of £1,000, £9,000, and £5,000. It was not the share of the "swag" of the Investment Company. He could not say why it was paid. He did not think that every company connected with electric lighting in the City made a profit. The Pioneer Company made £25,000 profit. It only used £20,000. He had 25 shares in the Pioneer Company. He had no recollection of taking part in the allotment. His three brothers, a sister-in-law, and six cousins, also two brothers-in-law, all had shares, also the Brush Company and the Investment Company. The City of London Electric Lighting Company came out in September. Four of the directors were the same as those of the Pioneer Company; offices in the same building, the same brokers and secretary. He did not know that the capital of £1,200,000 of the City of London Electric Lighting Company was now worth £2,400,000 on the Stock Exchange. He had 200 ordinary shares and 1,000 preference. He made £200 or £300 profit on them. He thought the company might not pay. He did not object to statements in the prospectus of the City of London Electric Lighting Company that the company would have an exceptionally profitable field, although at that time he did not think electric lighting would be profitable. He could not say what a company called the Exploration Company was. As a result of the promotion he knew there was some dissatisfaction among the ratepayers in the City. He did not know Mr. Brooke-Hitching issued a circular and proposed to the Common Council that the electric lighting companies should be bought out, and that at that meeting he (the plaintiff) was referred to in somewhat uncomplimentary terms. Utilising a public position for private gain would be "Tammanyism" He was at the lunch of Jan. 27, 1891, as Lord Mayor. He objected to the expression that a concern was being "hatched." He had not ascertained whether it was true that it—*i.e.*, the Pioneer Company—was hatched with the help of the members of the Commission of Sewers. It was untrue that the Pioneer Company was a promoting company to buy up the two competing companies and create a monopoly. The Pioneer Company never carried on the business of an electric lighting company. It wound up directly its mission was accomplished.

Mr. Carson, Q.C.: Its mission was to divide its profits?

Sir J. Savory: No.

Cross-examination continued: He never enquired if the Electrical and General investment Company paid 30 per cent. He did not know that there was a division amongst the Commissioners of Sewers as to whether the Pioneer Company should be allowed to go on. He did not know that the Commission of Sewers required an undertaking that nothing should be paid to the contractors for the transfer of the monopoly. Instead of £150,000, the City of London Electric Lighting Company paid the Pioneer Company £75,000. The capital of the City of London Company was £800,000. [**Mr. Justice Day** pointed out that it appeared from the prospectus that the capital was £1,200,000.] He could not say how much the Savory family had made out of the companies. It appeared that the Laing Syndicate had sent to the Commissioners the resolution they wished them to pass. In the prospectus of the Pioneer Company it was stated that there was a virtual monopoly in electric lighting. He was not aware that the Council had been advised that they would be bound to oppose any other provisional order for electric lighting. He had not asked if the charges in the City of London were more than Brighton and Edinburgh. He chiefly had to do with the public lamps in the City of London. Mr. Braithwaite and the Duke of Marlborough were members of the deputation who called upon him in reference to his going on the Pioneer Company. [**Mr. Justice Day**: I suppose they represented the taxpayers of the City.] He could not say whether anyone in the deputation was connected with the cycle of companies.

Re-examined by Mr. J. E. Bankes: All the companies were publicly advertised. He was not personally aware that his family were shareholders. As to private contracts, the contractors were to have the monopoly for 21 years from the date of the contracts. He believed that the contracts were absolutely beneficial to the City of London. If the contracts had lapsed, electric lighting in the City would have been indefinitely postponed. He believed

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that the contract with the Brush Company provided most carefully and scrupulously for the works being properly carried out.

Major-General Webber, C.B., examined by Mr. J. E. Bankes, said that he was formerly consulting engineer to the Brush Company, and frequently consulted with the Commissioners of Sewers. Ultimately, in May, 1890, a contract was entered into for public lighting. The Pioneer Company entered into a contract with the Brush Company to do certain works at a certain price. The specification of works was prepared under his instructions. The price for doing the work in the contract of Feb. 6, 1891, was fixed by him. They were fair and proper prices. In 1890 he thought it would be better if municipalities did the work themselves, but he knew no municipality would do the work. It was considered a great risk financially, and no municipality would saddle the ratepayers with such a rate. The cost of providing London with electric light would be far greater than that of any other city.

Cross-examined by Mr. Carson, Q.C.: He had been consulting engineer to the Brush, Pioneer, and City of London Electric Lighting Company. The Brush Company could not expediently raise capital for the purpose of its contract. That was never reported to the Commissioners. He had not the least doubt the contractors could have carried out their contracts. The figures of £300,000 and £200,000 were fixed after consulting with him, but he could not refer to any document showing how they were made up. Capital cost regulated the price charged for electric light.

Mr. Carson, Q.C.: Yes, capital cost! Capital cost for works, promotion, Pioneer Companies, and Lord Mayors.

Re-examined: The extra capital cost in London explained the difference in charges between London and other places.

At this stage the Court adjourned.—*The Times.*

COMPANIES' MEETINGS AND REPORTS.

LONDON ELECTRICAL CAB COMPANY.

The ordinary general meeting of the London Electrical Cab Company, Limited, was held on Monday at the Westminster Palace Hotel, S.W., Mr. H. H. Mulliner (the chairman) presiding.

The **Chairman** explained that the holding of a meeting had been postponed so long in order to enable the directors to present the result of a full year's trading, and also to announce that the new premises were completed, and that the machinery for making the electricity was in full working order, which was now a matter accomplished successfully. It had been necessary to proceed with the greatest caution. Nothing would have been easier than to put in hand a large number of cabs, but in a new industry like that it would have probably meant that they would have found other improvements advisable, and so would have found themselves in the awkward position of having spent their capital and yet not have had perfect cabs. They had commenced by buildiug 12 cabs. Although these cabs were praised up sky-high both by the general and the scientific Press, those who were behind the scenes knew them not to be perfect for their requirements. Some of those cabs were altered and new ones were built until they had 24 in use. The public "caught on," and the cabs were in enormous demand. They were used probably much more than any hansom with two horses to work it in London. They were a great improvement, but still the directors were not satisfied. They had started a system of entering every complaint and every breakdown, however trivial, and the number of these breakdowns and complaints at the time made them all very unhappy, but they went to the bottom of each complaint, and localised the reason, and found at least nine-tenths arose from five different causes. It would not be policy to go too minutely into what these causes were; four of them were mechanical or electrical, and the fifth, which was one of the most serious, was the rubber tyres. In consequence of their energy in localising and remedying these complaints, the number of these breakdowns or troubles had been reduced to less than one-fiftieth of what it used to be. They had guaranteed their drivers to recoup themselves for any losses owing to such breakdowns, and, although the directors treated this guarantee in a most liberal spirit, it was now costing them on the average about 1½d. per vehicle per day. No hackney vehicle in London would satisfy the public unless it was fitted with indiarubber tyres. He recently heard it stated by a gentleman on the Continent (who was a large manufacturer of motor-carriages) that he was convinced the success of motor-carriages in the future depended, not on the accumulators nor the motors, but on the possibility of obtaining a rubber tyre which would stand the severe strain. Now, his experience was confined to oil carriages, which were much lighter and consequently less harmful to the tyres than those propelled by electricity. To a large extent he agreed with that opinion, and he must admit that a large part of their loss had been in connection with rubber tyres. Shareholders might reasonably complain that that ought to have been realised when the Company was formed. Unfortunately, however, the directors had not the experience of running 50 miles a day regularly to go on, and he did not think there was a man living, whatever his knowledge of tyres might have been, who would have realised what they had since found out—viz., the enormous difference in the wear of rubber tyres on an electrical motor-carriage compared with that of a horse-driven vehicle: first, there was the wear owing to the very much increased weight; secondly, the "creeping" of the tyre caused by the vehicle being propelled by the friction between the hind tyre and the ground; and, thirdly, the question of the hardness of the rubber in order to prevent "skidding." When a carriage pulled by a horse commenced to skid, the horse, going forward, pulled it straight again, but directly a motor-carriage began to skid, its own energy, being behind, tended to send it right round. However, provided the tyre was sufficiently hard, there was no danger in the skidding, but that had to be taken into consideration in deciding on the tyres to be used. Of course, there had been plenty of motor-carriages built previous to their inauguration, including several very successful electrical carriages made under their own patents; but no motor-carriages except the Company's, either before or since, had run regularly 50 miles a day, and it was this running regularly 50 miles a day which developed the weak points, such as tyres, which no amount of foresight could have prevented. They had experimented with six or seven different sorts of tyres, with more or less success; but he thought that they had now hit upon one which would be efficient. The makers also seemed confident about it, as they proposed guaranteeing their durability for nine months. The cabs now made slightly more noise than at first, owing to a new kind of chain employed. Mr. Preece, the engineer to her Majesty's Post Office, had congratulated them in his inaugural speech particularly on the chains they were then using. However, they had found that these chains would not stand the severe regular use, and they had had to be substituted by the present ones. There had been three strikes of drivers, but things were now on a friendly footing, and he believed neither side had any grievance against the other. All the drivers were now paying the full Asquith award, without any reduction, and he thought that was more than could be said in any other cabyard in London. The intention of the directors was in future to make special efforts to develop the private hire trade, by supplying carriages by the day, week, or month. That would probably prove more profitable by saving wear and tear, saving the Scotland-yard licenses, and obtaining a slightly-increased price. He instanced Prince Henry of Orleans as one of their customers who much preferred their cabs to any form of horse-driven vehicles, and who were willing to hire them for extended periods. He asked the shareholders, before expressing dissatisfaction with their financial position, to endeavour to realise the enormous difficulties they had met with, and the fact that even if they had not succeeded as much as hoped, they had at least shown a better practical result in the motor industry than the whole of the rest of the motor companies in the world, although their own capital had been small compared to some of them. Of companies to deal with electrical carriages alone, he had heard of five or six being started, but had yet to hear of one single successful vehicle which had been built or any practical result which they had obtained. It had been pointed out to the directors many times that their cabs should have been built differently in several respects. Perhaps that was right. The Paris company, who were working practically exactly the same vehicle under the same patent, had, after an immense number of experiments and experts' opinions, decided to build their cabs absolutely and identically as their own. They had heard a great deal about the French being the pioneers of the motor industry, while, as far as electrical vehicles were concerned, they were absolutely the copyists of the Company. The electric current and the accumulators had been another source of trouble. They started with contracts from the London Electric Supply Corporation for current and with the Electrical Power Storage Company for cells, and the contracts had not proved satisfactory. They had given notice to terminate them, and had laid down an installation for manufacturing their own electricity. This plant had been in working order for the past month, and appeared extremely satisfactory. Their electricity was not costing a quarter as much now as before. In order to use electricity from the London Electric Supply Corporation, they had purchased at very large expense motor-generators, but through the good offices of their consulting engineer (Mr. Manville) these had been disposed of without any loss. After innumerable difficulties, etc., with the Electrical Power Storage Company with regard to the accumulators, they had now practically settled upon a working basis which they believed would prove satisfactory to both parties. The directors were discussing the advisability of ceasing to purchase any more accumulators, and hiring them at practically the cost as their maintenance now amounted to. That would decrease the amount standing in the balance-sheet under contingent liabilities, and would give more working capital. Referring to matters still pending, he said accumulators would not prove the impossible barrier to their success. They had acquired a piece of land adjoining their premises in Juxon-street, on which they had erected suitable buildings for the purpose. The undertaking being now a purely commercial one, a manager of considerable electrical knowledge being required, Mr. J. Grice Statter had been appointed. As regarded the balance-sheet, the stated purchase price was £50,000 The capital of the Company was £150,000, of which about £75,000 was subscribed. The vendors had therefore received about £25,000. There were few companies where the directors, under similar circumstances, had been able to make so good an arrangement with the vendors. It was a moot point whether under the agreement the vendors were entitled to receive one-third of the last issue. However, according to the opinion of two separate counsel, obtained one at the expense of the company and one at the directors' own expense, it was quite clear that this was the case. However, so that the Company should have the full benefit of any other working capital which might afterwards be subscribed, it had been arranged with the vendors that the balance of the purchase price was to be taken in deferred shares, those deferred shares to rank after the subscribed capital both as regarded capital and dividend. The premium of 2s. 6d. per share on the last issue had been justified, because at the time the issue was made there was such a demand

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for the cabs that they could have supplied 60 times the quantity, and their prospects seemed so bright that it did not seem fair that those shareholders should come in on the same footing as others who had invested their money a year previously, and still more that the old shareholders should have to bear the expense of making this issue. Probably all the cabs would be in working order and in regular use by the middle of January. As stated in the issued report, it was proposed very shortly to make an issue of debentures. Twelve thousand pounds would be amply sufficient, but, in order to be on the safe side, that £12,000 was to be part of an issue of £15,000 which remained to be issued at a future period if required. This debenture issue was amply secured by the electrical plant, machinery, new premises, etc., and other assets. As a proof of their confidence the directors themselves were prepared to take up a considerable part. The loss stated in the balance-sheet of £6,207. 15s. 6d., although stated as a trading loss, must not be looked upon quite in that light. The balance-sheet covered a period of 20 months, and all the losses which he had referred to in connection with construction, experiments, etc., had occurred during that time.

The resolution, which was seconded by the **Hon. Reginald Brougham**, was then put and carried unanimously.

The retiring directors (Mr. H. H. Mulliner and the Hon. Reginald Brougham) were re-elected.

Messrs. Monkhouse, Stoneham, and Co. were reappointed auditors, and a vote of thanks was given to the chairman and directors, and the proceedings then terminated.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Stirling.—The Commissioners of the Burgh of Stirling invite tenders for boilers, engines, dynamos, etc. Tenders by Jan. 2, 1899.

Leeds.—The City Council require tenders for the supply of (*a*) underground conductors; (*b*) switchboards, etc. Tenders by Dec. 29.

Salford.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of various plant. Tenders by Dec. 15.

Shoreditch.—The Vestry invite tenders for the supply of six direct-current rotary transformers, etc. Further particulars appear in our advertising columns. Tenders by Dec. 13.

Sunderland.—The Corporation are prepared to receive tenders for the supply of three 125-kw. direct-current high-speed steam dynamos, 460 volts. Tenders by noon on Dec. 30.

Barnsley.—The Guardians invite tenders for the supply and fixing of certain telephonic communication required at workhouse. Particulars may be obtained on application to Mr. S. J. Crawshaw, master at the workhouse. Tenders by 12th inst.

Barnsley.—The Corporation invite tenders for erection of a tall chimney, and engine, dynamo, and boiler house, storage rooms, and offices in Beckett-square, Barnsley. Specifications, etc., can be obtained on personal application to Mr. J. Henry Taylor, A.M.I.C.E., borough surveyor, St. Mary's-place, Barnsley. Tenders by 12 noon on Dec. 12.

Fleetwood (Lancs.)—The North Euston Estate Company invite tenders for the following, to be erected in the Euston Hotel, Fleetwood: (Section 1) installation of wiring, switchboards, etc., for the electric light, current from town supply; (2) electric bells. Specifications and forms of tender may be obtained from Mr. Thomas Barton, M.I.E.E., Consulting Department, Ainsworth-street, Blackburn, on payment of £2. 2s. for each section, which will be refunded on receipt of bona fide tenders. Tenders by 10th inst.

Beckenham.—The Urban District Council invite tenders for the following works in connection with their proposed electric light station—viz.: (Section A) water-tube boilers and economiser; (Section B) steam alternators, transformers, and switchboard; (Section C) pipework, feed pumps, overhead tank, feed-water heater, etc.; (Section D) arc lamps, lamp-posts, etc.; (Section E) cables, and other street work; (Section F) travelling crane. Specifications, etc., can be obtained from Messrs. Wilson and Storey, 66, Victoria-street, upon payment of £2. 2s. for each section, to be returned on receipt by the Council of a bona fide tender, together with the copy of the specification. Tenders by mid-day on Dec. 17.

Barnsley.—The Corporation invite tenders for the supply and erection of (1) Lancashire boilers and Green's economiser, and setting of same; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of electricity supply works, and engine, etc., foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and service boxes, and service connections. Specifications, etc., can be obtained on application to Mr. Thos. L. Miller, M.I.E.E., 7, Tower-buildings, N., Water-street, Liverpool, on payment of £5. 5s. (or £1. 1s. per section), which will be returned on receipt of a bona fide tender. Tenders by 12 noon on December 12.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

London.—The London County Council have accepted the tender of the National Electric Free Wiring Company for a dynamo, at £274.

York.—The following tenders have been received by the City Council for the dust destructor: Manlove, Alliott, and Co., £4,482 (accepted); the Horsfall Furnace Syndicate, £3,087; Beaman and Deas, Limited, £4,976; Goddard, Massey, and Warner, £2 960.

Liverpool.—The City Council have accepted the tender of the British Thomson-Houston Company, Limited, London, for the supply and delivery of six motorcars, for the sum of £554. 9s. 6d. each, and six motorcars for the sum of £587. 4s. 6d. each. The tender of Messrs. R. W. Blackwell and Co. has been accepted by the Council for the overhead equipment of the Aigburth-road extension line for the sum of £1,780. 12s. 1d.

Knowle.—The following tenders have been received for the supply and fixing of two engines and dynamos, equal to an output of 24,000 watts each, etc., at the County Lunatic Asylum, Knowle, near Fareham:

Bow, McLachlin, and Co., Paisley	£4,700	0	0
Brush Electrical Engineering Company, London, E.C.	4,630	0	0
Calvert and Co., Manchester	4,650	0	0
Crompton and Co., London, E.C.	5,650	0	0
Heath, Snoxell and Co., Birmingham	5,540	0	0
Joel and Potter, Limited, London, E.C.	4,700	0	0
Laing, Wharton, and Down, London, W.	4,998	0	0
Matthews and Yates, Manchester	5,385	0	0
Prestwich and Burt, Kingston-on-Thames	5,804	2	6
Sax, Slatter, and Co., London, S.W.	9,500	0	0
Scott, Anderson, and Bait, Sheffield	3,856	10	0
Scott and Mountain, Newcastle-on-Tyne	4,865	0	0
F. Shalders, Southampton (accepted)	4,300	0	0
Summerscales and Sons, Keighley (laundry machinery only)	557	15	)
Suter and Co., London, W.	3,351	10	)
Thomas and Laylor, London, W.	5,700	0	0

BUSINESS NOTES.

Leith.—The Corporation have decided in favour of electric traction for the tramways.

Blackburn.—The Town Council have increased the salary of the traffic manager of the tramways (Mr. J. H. Cowell) by £26 per annum.

Malvern.—The Board of Trade has been asked by the Urban District Council to extend the time for the lighting order granted in 1890.

Rochdale.—Colonel A. J. Hepper, R.E., has held an enquiry into an unopposed application of the Corporation to borrow £30,000 for electric lighting purposes.

Eastbourne.—The Ratepayers' Association are getting up a requisition asking the Mayor to convene a meeting of owners and ratepayers to consider the electric lighting question.

Fleetwood.—Another deputation left here on Thursday week to visit Bedford, Chelmsford, and Brighton to gather information respecting electric lighting for the public streets.

Stockton.—Application is to be made by the Corporation to the Public Works Loans Commissioners for a loan of £28 482 for purposes of electric lighting, at 2¾ per cent. over 25 years.

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Peterborough.—The Town Council have obtained a piece of land for the proposed electric lighting station.

Personal.—Mr. J. W. Swithenbank, the Leeds manager of the National Telephone Company, is about to leave Leeds in order to take up the administration of the system at Middlesbrough.

Longton.—The British Electric Traction Company have abandoned their intention to apply for a provisional order authorising them to supply electrical energy under the Electric Lighting Acts in the borough.

Aberdeen.—The Tramways Committee have had under consideration the system of traction to be adopted on the Woodside route, and intend to visit Glasgow and examine the systems in operation there.

Whitechapel.—The District Board have adopted a scheme for electric lighting for the district, and decided to borrow £60,000 for carrying out the first portion of the work, which is to be performed within two years.

Electric Works' Institute, Bushbury.—Under the auspices of the officers of the Electric Construction Works' Institute, Bushbury, an amateur evening concert was given on Monday in the messroom connected with the works.

Blackpool.—At the first monthly meeting of the Town Council, which has just been enlarged from 24 to 48 members, the question of the adoption of the overhead system of electric tram traction was introduced, and after discussion referred to the General Purposes Committee.

Wellingborough.—The report of the committee of the Urban District Council upon a visit to the Shoreditch and Leyton works has been adopted. It has been arranged with Messrs. Beaman and Deas to report as to the site, cost of destroying the refuse, and generating electrical energy.

Ipswich.—The tramways company have decided to sell their undertaking to the Drake and Gorham Electric Syndicate for £30 000. The undertaking cost £32,000 to lay down and equip, and the present system of horse trams is to be discarded for trams driven by electricity on the overhead system.

Birmingham.—At a meeting of the City Council on Tuesday a notice from the Wednesbury Electric Supply Company, who are applying for a provisional order under the Electric Lighting Act, was referred to the Gas Committee to take such steps in the interest of the gas undertaking as they might be advised.

Woking.—At a meeting of the Woking Tradesmen's Alliance a resolution was passed, in view of the recent failure of the Electric Supply Company to give a regular and constant supply, requesting the Woking Urban District Council to consider seriously the desirability of acquiring the undertaking of the Electric Supply Company.

Ramsgate.—Notice has been given by the Corporation to the Isle of Thanet Light Railways (Electric) Company, Limited, that the Corporation object to the proposed position in the road of the railway to be constructed by the company within the borough under the powers contained in the Isle of Thanet Light Railways Order, 1898.

Wednesbury.—Mr. F. J. Warden Stevens, of Victoria-street, Westminster, electrical engineer, is to be asked by the Town Council to report upon an electrical supply, giving full particulars of a scheme suitable for the borough and a statement of the capital proposed to be expended in connection with the undertaking.

Grimsby.—The Town Council have decided to petition against the Grimsby Street Tramway Bill to be introduced into Parliament next session, it being stated that the Bill asked for powers to generate electricity and to compel the Corporation, when taking over the tramways, to purchase all the plant whether in use or not, and to purchase as a going concern.

South Staffordshire Mines Drainage.—The proposal to borrow £10,000 at once for gravity works upon the surface and £10,000 for electric pumps on the surface when electricity was available has been approved, and the chairman and the general manager have been empowered to take the necessary steps with a view to the suggested arrangement being carried into effect.

Railway Diary.—We have received from Messrs. McCorquodale and Co., Limited, of Cardington-street, Euston-square. "Railway Diary and Officials' Directory," and also a "Railway Almanack" for 1899. The diary is compact, having two weeks at an opening. The reference part contains a railway directors' and officials' directory and tables of traffic returns, accounts, dividends, etc.

Enfield.—At the last meeting of the District Council the clerk of the Finchley District Council wrote to the effect that, in consequence of lack of support with reference to proposed electric lighting in North London, his committee did not see their way to call a further meeting, and he was directed to state that his Council had decided themselves to apply for a provisional order.

Penzance.—At the last meeting of the Town Council an amendment disapproving of the application of the Edmundsons' Company for an electric lighting provisional order, and pledging the Council to take early steps to obtain a provisional order themselves, was carried. It was also decided that the Highways and Lighting Committees should hold a joint meeting to prepare a scheme.

Lincoln.—At the last meeting of the City Council the Electric Lighting Committee reported that they had approved of the estimate of the engineers for the expenditure of £19,000 for extra plant, cables, etc., and Mr. Harrison said they now looked like being able shortly to turn on the current. Already they had applications for more power than they would at present be able to supply.

Middleton (Lancashire).—The Board of Trade are about to issue an order empowering the British Electric Traction Company to construct tramways between Middleton, Manchester, Rochdale, and Oldham. Application is being made to construct tramways inside the boundaries of Oldham, Rochdale, and Manchester. The same company is seeking powers to construct tramways in the Spen Valley and other parts of the country.

Dewsbury.—Plans have been deposited with the local authorities of the Spen Valley of the scheme of electric tramways, having Dewsbury as a centre, which is being promoted by the British Electric Traction Company, Limited, London. One of the proposed lines will traverse the main road through Heckmondwike and Liversedge, and terminate at the junction of Whitechapel-lane and Bradford-road at Cleckheaton.

Rotherhithe.—At the meeting of the Vestry on Tuesday last the County of London and Brush Provincial Electric Lighting Company, Limited, submitted map and *Gazette* notice of their intention to apply to the Board of Trade on or before Dec. 21 next, under the provisions of the Electric Lighting Acts 1882 and 1888, for a provisional order to authorise and empower the company to produce, store and supply electricity within the parish.

"The Scotsman."—This influential newspaper has just removed into new premises. The railway is situated in close proximity to the new buildings, and will be very convenient for the carriage of the paper required. All the most recent and up-to-date improvements in construction and machinery have been introduced throughout the buildings, and electric power has been largely made use of, telephones and pneumatic tubes connecting all departments.

Chelsea.—A special meeting of the Vestry took place on the 29th ult., in compliance with the regulations of the Board of Trade, to resolve whether application should be made to that authority under the Electric Lighting Acts of 1882 and 1888, authorising the Vestry to supply electricity for public and private purposes in the Kensal Town portion of the parish by contract or otherwise. After a discussion lasting nearly two hours, the resolution was defeated by a vote.

Cleethorpes.—The Grimsby Street Tramways Company have deposited at the offices of the Cleethorpes District Council a copy of the plan and book of reference of the proposed extension and improvement of their system, and the establishment of an electric power station at Cleethorpes. It is not thought that the Council will oppose the tramways company's Bill, with the exception of that portion referring to the supply of electric light in Cleethorpes, which the local authority will probably wish to have in their own hands.

Worthing.—At a meeting of the Town Council held last Tuesday the Electric Light Committee reported that they had conferred with Mr. Monkhouse as to the cost, advantages, and expediency of erecting a refuse destructor in connection with the electric lighting works, the cost of and most desirable method of providing the water supply which will be required for the works, and the cost and method of lighting the street lamps, and had arranged that he should furnish them with full and detailed information thereon. The report was confirmed.

Sheringham.—At a public meeting on Friday last it was decided to adopt the Lighting Act. A report from the surveyor was read dealing with gas and electricity, in which it was pointed out that the town stood in a unique position, inasmuch as it possessed a natural supply of water from various springs which could be utilised as the motive power for driving the dynamos should the electric light be adopted. The surveyor estimated the cost of installation at £4,600, and placed figures before the meeting which he considered showed that it would prove a paying concern to the parish.

Perth.—A new installation of electric light has just been completed by the Caledonian Railway Company for the goods and shunting yards at Perth South Station. The new installation consists of seven arc lamps of 2,000 c.p. each, two of which are placed on the north side of the Edinburgh-road bridge, and five on the south side. The new lights are a marked improvement on those formerly in use, the shunting yards and part of the line being brilliantly lit up, thus enabling shunters and engine drivers to pursue their somewhat dangerous calling with a minimum of risk. The work has been done entirely by the electrical staff of the company.

Wolverhampton.—The *Express and Star* publishes an interview with Mr. Shawfield, the chief engineer at the Corporation works, from which it appears that new orders are coming into the manager's office, almost daily, to such an extent that it is fully anticipated before the end of the year, or at all events during the Christmas week, that the maximum load to be put upon the generators will show an excess of at least 50 per cent. compared with that of the corresponding period 12 months ago. Mr. Herbert Kendrick, one of the staff at the town clerk's office, has reported to the Tramways Committee the result of his various visits to a large number of municipalities owning tramways.

Appointments Vacant.—The Belfast and County Down Railway Company require the services of a competent and reliable man to take charge of the electric plant, boilers, and machinery at their Slieve Donard Hotel, Newcastle, county Down. Applications, enclosing copies of recent testimonials, and stating wages required, and age, to be sent to the Locomotive Superintendent, Queen's-quay Terminus, Belfast, by 10th inst.—There is also a vacancy on the staff of the Hull Corporation for a mains superintendent, which is open until 31st inst. The salary begins at £120, rising by £10 per annum to £150. Particulars of this and of several minor vacancies will be found in our advertisement columns.

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Rotherham.—At the last meeting of the Highway Committee a letter was read from the Drake and Gorham Electric Power and Traction (Pioneer) Syndicate, Limited, with reference to establishing an electric traction scheme through Rotherham to Rawmarsh, and asking if the Corporation would sanction their obtaining powers for so doing. It was decided to reply that as the Corporation were intending to construct trams, they could therefore not entertain their application. The Gasworks Committee have appointed a sub-committee to consider and report as to an installation of electric light for the borough

Glasgow.—The Tramways Committee of the Corporation have decided that the electric tramways be extended from Glasgow Cross to Govanhill, and worked on the overhead system. An experiment with the conduit system is also to be made in some other part of the city to which electric traction has not yet been extended. At a meeting of the Electricity Committee of the Corporation on Wednesday, a report was submitted by Mr. Chamen, the engineer of the department, and Mr. Myles, architect, on the proposed new electricity works at Coplawhill, on the south side of the city. The total cost for building and plant is estimated at £59,000, of which £16,000 has already been authorised by the Corporation for the new generating station.

Camberwell.—The General Purposes Committee of the Vestry have reported the receipt of formal notice from the County of London and Brush Provincial Electric Lighting Company of their intention to lay electric conduits in College-road and High-street, Dulwich, and also to construct transformer chambers in Calton-road, Overhill-road, North Cross-road, and Fenwick-road No action has been taken by the Vestry. The Vestry have replied to a letter of the Hammersmith Vestry (similar to the one referred to in our note on Kensington) that the Vestry are in agreement with their views, and would co-operate in any way that might seem desirable to prevent legislation being passed on the lines indicated in the Parliamentary Committee's report.

Dudley.—The Railway, Tramway, and Electric Lighting Committee of the Town Council have issued a report stating that, having discussed the terms of the agreement to be entered into between the Corporation and the British Electric Traction Company, with reference to the relaying and electrically equipping the line from the railway station to the borough boundary, they have instructed the town clerk to draw up such agreement for perusal by the company. The town clerk has been instructed to take steps to oppose the application of the Midland Electric Corporation for Power Distribution to the Board of Trade for a provisional order to supply electricity for public and private purposes within, amongst other places, the county borough of Dudley.

Chelmsford.—At a recent meeting of the Town Council a report of the Lighting Committee was adopted drawing attention to the unsatisfactory way in which the Chelmsford Electric Lighting Company, Limited, were carrying out their contract for lighting the streets. The committee had received many complaints of the inefficiency of the private lighting, and therefore recommended that a strong representation should be made to the company on the subject. It was also reported that the lighting company intended to lay four new cables underground in Chelmsford, to acts as feeders to their system, and also to construct new transformer pits in various parts of the borough, the line and positions of which were indicated on plans submitted by the company. The town clerk has been directed to give the company notice that the Council disapproved of the scheme on the ground that the plans submitted did not show sufficient details.

British Electric Traction Company, Limited.—An extraordinary meeting of the members of this company was held on Monday, at Donnington House, Norfolk-street, W.C., under the presidency of Sir Charles Rivers Wilson. The chairman said they were called together to meet the requirements of the Light Railways Act, which required that the approval of the shareholders should be signified to any applications to Parliament, and for this purpose a special meeting must be called. They were met to pass a series of resolutions approving the drafts of several light railway orders which were in process of being promoted by the company; these were the light railway orders for Merthyr Tydvil, Kinver, Poole and district, South Staffordshire, Doncaster and district, Barnsley and district, Middleton extensions, Colchester, Spen Valley, and Dudley and district (extension). Resolutions approving the proposed applications were put to the meeting, and approved unanimously.

London County Council.—The Council have authorised the provision of eight additional fire-alarms to be connected with the Wandsworth station, at an estimated annual cost of £61; also that telephonic communication be established between the Greenwich station and the fireman's watch-box in Lewisham High-road, and between the Camberwell station and the fireman's watch-box in Peckham-rye, the net increased annual charges being £7 and £6. 10s. respectively. The following companies have been granted permission to extend their mains: (1) the Blackheath and Greenwich District Electric Light Company; (2) London Electric Supply Corporation; County of London and Brush Provincial Electric Lighting Company (under the Wandsworth order); and the Vestry of St. Pancras. The Vestry of Hampstead also have given notice of intention to lay certain mains, but as the Vestry is the undertaker under the order, the Council has no power of approval or disapproval of the works.

Paddington.—At the Vestry meeting on Tuesday, a letter was received from the Vestry of Hammersmith stating that in the event of legislation being brought forward on the lines indicated in the report of the Joint Committee of both Houses of Parliament upon the subject of the electrical energy (generating stations and supply), they have decided to take a strong position in opposition thereto, and asking the co-operation of Paddington. Mr. H. H. Collins moved the consideration of the letter to the Electric Lighting Committee, and trusted that the committee would go fully into the question of overhead wires, for there was no doubt that overhead wires were not only dangerous but spoilt the look of their thoroughfares. The Chairman said the question was a most important one, especially with regard to overhead wires, which ought never to be sanctioned in London especially. It was agreed that the Electric Lighting Committee consider the letter and report on the subject.

Liverpool.—At Wednesday's meeting of the City Council it was stated that the profit on the Dingle line amounted to £40 per day. The recommendation that the Tramway Committee be authorised to carry out the construction of the lines mentioned in the city engineer's report (already noted by us), other than the line from the Dingle to Aigburth Vale, which has already been authorised by the Council, at an estimated cost of street construction works of £127,400, came before the meeting. The scheme involves the construction of 8½ miles of new tramways, and the conversion of 18¼ miles of horse tramways. Of the total cost the sums of £17,426 and £37.413 are for permanent way in the form of rails, etc., and £38,300 and £55,000 for paving and repaving within the statutory limits. A further recommendation was carried to the effect that the Tramways Committee be authorised to carry out extension of the electric line of tramways from South Castle-street to Park-lane *vid* Lord-street and Paradise-street, and that from Park-lane along Paradise-street a double line be laid up to the point where Paradise-street joins Lord-street, at an estimated cost of £8,300.

Kensington.—At the last meeting of the Vestry a letter was read from the Vestry of Hammersmith, forwarding extract from the report of the Joint Committee of both Houses of Parliament upon the subject of electrical energy (generating stations and supply), expressing their concurrence in the opinion that the local authority within the area of supply should have the power of deciding the route along which the mains should be laid as well as the power of themselves breaking up and reinstating the streets in connection therewith, and intimating their intention to take up a strong position in opposition to the suggestions put forward in the report that it is not advisable, in the case of overhead wires for traction purposes, that the local authority, other than the London County Council and county boroughs, should have an absolute veto, and that the existing conditions by which the local authority in the case of an application for the granting of a provisional order, have practically a veto only to be dispensed with in special cases by the Board of Trade, should be amended and the local authority, in lieu thereof, to be heard before the Board of Trade. The letter was referred to the Special Electric Lighting Committee.

South Africa.—The additions to the electric lighting installation of Durban will include 20 arc lamps, two generators capable of supplying 2,500 incandescent lamps, and 20 transformers for directing the current from the mains by overhead wires. An electric lighting installation is in contemplation for Uitenhage, the current to be generated by water power. The Bloemfontein Town Council have decided to extend their contract with Messrs. Rennert and Lenz for the electric lighting of the borough, so as to provide for the whole town, the cost to be over £17,000, instead of £7,500. Electrically-driven ventilating fans are part of the completed equipment of the new Marine Hotel, Durban. Tenders were called last month for an electric lighting installation for Newcastle, Natal. The Johannesburg Town Council have accepted the tender, amounting to £11 100, of Messrs. Siemens, Limited, for the electric lighting of Old and New Doornfontein; the material is to be ordered in Europe. The supply of an electric lighting plant for the City Flour Mills, Capetown, has been entrusted to Messrs. George Findlay and Co., electrical engineers, Capetown. A complete electrical installation, with a 150-h.p. generator, has been fitted up at the Dunraven gold mine, Rhodesia.—*The British and South African Export Gazette.*

Swansea.—The employés of the Swansea Tramways held their annual dinner on Tuesday night. The manager (Mr. David James), who presided, having proposed "The British Electric Traction Company," which has recently taken over the Swansea undertaking, Mr. Emile Garcke, the managing director, who was present, assured his hearers that the Swansea Corporation would be the first to recognise that the advent of the company to Swansea would be of advantage to them as well as to the ratepayers. He also expressed the conviction that the municipalisation of those undertakings was not in the interests of the ratepayers, and that the public of Swansea, when they saw the character of the work the traction company were able to do, would see the value of private enterprise. If the Corporation, he added, were inclined to allow the company to deal with the electric lighting of the town, then they were perfectly willing, and would carry out the work in a way which would be impossible for the Corporation or anybody else to do satisfactorily, because they would be able to do the two things from one power station. In conclusion, he alluded to the additional advantage it would be if the company secured the working of the Mumbles Railway. Other toasts followed.—*Western Mail.*

Western Australia.—The Perth Tramways Syndicate, of London, has a concession for building a tramway in the city of Perth, Western Australia, and to Subiaco, Leaderville, and Fremantle, suburbs of Perth, which, when finished, will have a total mileage of between 30 and 40 miles. At present 10 miles are being built in the city proper, part single and part double track. A second 10 miles will be laid on completion of the first section. The road will be 3ft. 6in. gauge, operated by electricity,

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and all the equipment will be American, with the exception of the 6in. girder groove rails now being rolled in England. The power plant will be built to develop 2,300 h.p., the first installation to consist of two tandem compound engines of 350 h.p. each, now being built by the Robb Engineering Company, of Amherst, N.S. The Babcock and Wilcox Company, of New York City, will furnish the boilers. The electrical equipment, including one 225-kw. direct-connected generator, will be supplied by the General Electric Company, Schenectady, N.Y. Iron poles for carrying the overhead wires, to be extra heavy and of special design, are now being made by the Pennsylvania Tube Works. Ten American style 18ft. closed cars, with cross seats and centre aisle, have been ordered from the J. G. Brill Company, Philadelphia. *Railway News.*

Wrexham.—A meeting of the Town Council was held on the 6th inst. to meet Mr. Albright, the managing director of the company applying to the Board of Trade for a provisional order to provide electric tramways in Wrexham and district. Mr. Albright said their first undertaking would be to take in hand the present tramway from Wrexham to Johnstown, a distance of 3½ miles, and widen the gauge to 3ft. 6in., and run it up Gutterhill to Rhos. From the present terminus in Penybryn, Wrexham, they proposed to run down Penybryn, Brook-street, up Vicarage-hill, past the central station, then along High-street and Regent-street to the Great Western Railway Station and the Wrexham Racecourse. At Hill-street there would be a junction, and the trams would go down Regent, Hope, High, York, and other streets to the Wrexham Barracks The trolley system, he said, would be used. In answer to questions, Mr. Albright said he had no doubt the company would be pleased to arrange with the Corporation to utilise their standards for the purpose of carrying the electric wires of the Corporation, and that if satisfactory terms could be arranged the company would take the motive power for the trams from the Corporation electric light station. The Chairman thanked Mr. Albright for his attendance, and said a special meeting of the Council would be held to consider the matter.—*Liverpool Courier.*

Dundee.—Prof. Kennedy has declined the offer of the appointment of consulting engineer on the ground of pressure of other work. The Tramway Committee are of opinion that the overhead system is the only appropriate one for Dundee, and they have instructed the burgh engineer and Mr. Tittensor, the electrical engineer, to prepare plans and specifications (1) for the application of electric power to the Perth-road tramways, and (2) for the construction and application of electric power to tramways to be constructed on the Broughty Ferry route, and to report such plans and specifications, with estimates of costs, as early as possible. The feeling of the committee was that, so far as Britain was concerned, the conduit system was still in the experimental stage, and that, moreover, the expense of laying it down would be so great that Dundee would not be warranted in adopting it. It was also felt, however, that in the event of the conduit system ultimately proving a success little loss would be incurred in taking down the overhead wires in the centre of the town and in substituting the conduit. It was also resolved to remit to Mr. Brownlee to negotiate with the tramway company for the purchase of the plant, with a view of obviating the cost of arbitration. The Corporation are taking steps to prepare the lines for the electric cars prior to taking over the whole system in June. In reply to enquiries, the Provost said, at the last meeting of the Police Commission, he thought he was warranted in stating that, whilst they had no chance of getting the electric light this winter, he was very much misinformed if they did not have it in full swing before next winter began. The provisional order had been obtained, and all that was necessary now was the formation of a local company to carry out the provisions in that order.

Manchester.—A deputation from the Tramways Committee of the Corporation visited Glasgow lately to make enquiries and inspect the working of the Corporation tramway system in that city. The *Manchester Guardian* says the deputation were especially interested in seeing the tramcar sheds in Glasgow, the electrical equipment of a section of the Glasgow system, and the style of cars which have been adopted in lieu of the class which is known as "single deckers." Attention was given to the type of cars which the committee should recommend to the City Council for adoption in Manchester. In Glasgow experience showed that the "single deckers" did not meet with general approval, and a change was made in favour of "double deckers," or those which provide for the accommodation of passengers on the roof as well as inside. The single decker is not objected to in winter, but in summer passengers naturally prefer the outside seats. With regard to fares it was found that the halfpenny fare, which has long been in vogue in Glasgow, is exceedingly popular there. Since its introduction the weekly revenue of the whole network of tramways has risen from £4,000 to £8,000. It is not improbable that a halfpenny fare system will be recommended for adoption in Manchester. This would only apply to stages within the city boundaries. The deputation were impressed with the following facts: (1) the overhead trolley system is the only possible one for Manchester; (2) no nuisance or danger from it is experienced in Glasgow; (3) electric traction has proved so successful there that gradually it will supersede horse traction; and (4) halfpenny fares for short distances are possible and profitable. The proceedings of the Parliamentary Sub-Committee contain a letter from the secretary of the British Electric Traction Company, Limited, intimating the intention of the company to make application to the Light Railway Commissioners for an order authorising the construction and working of a light railway between Middleton and Crumpsall.

St. Helens.—At the last meeting of the St. Helens Electric Supply and Tramways Committee it was resolved to acquire certain land for a site for the electric tram depôt, and to approve of the plans for the latter. It was stated that of the St. Helens, Leigh, and Bolton light railways two were proposed to join with the authorised extensions of the Corporation tramways at Haydock and Derbyshire Hill-road. Messrs. Rothwell and Sons will carry out the construction of the depôt, the work to be commenced at once, and to be completed in three sections, the first section within seven weeks, the second within 12 months, and the whole within 24 weeks. In the prospectus of the new St. Helens and District Tramways Company, Limited, which has been formed with a capital of £150,000, it is stated that the St. Helens tramways are at present worked over about 10 miles of lines by the St. Helens and District Tramways Company, Limited. The lines belong to the St. Helens Corporation, who have also obtained from Parliament this year powers for the construction of additional lines, and have entered into an agreement with the old company to grant a new lease of the whole of them to that company, or a new company formed to acquire and carry on its business for a term of 21 years from Oct. 1, 1898. It has further been agreed between the Corporation and the old company that the whole of the lines shall be worked by electricity, and they are now being equipped for that purpose. It is expected that the first section—from St. Helens to Prescot—will be completed by March next. The Corporation agree to construct, furnish, maintain, and keep in thorough repair the whole of the lines, and the obligations of the company are merely to find the cars and working staff and pay a rent for the lines and a charge for the electric current used. The new company has been formed to acquire the whole of the assets of the old company, including the right to take up the new lease, and the cars, engines, and stock-in-trade of the business as a going concern, and to provide the necessary working capital.

Islington.—At the last meeting of the Vestry the Clerk read a letter, enclosing a resolution passed by a meeting of ratepayers, held at 314, Caledonian-road, the premises of the West Islington Liberal and Radical Association. The resolution was as follows: "That this meeting emphatically protests against the wanton waste in the proposed outlay for electric lighting plant in connection with the new infirmary, and urges the Guardian Board to obtain the necessary current from the Islington Vestry." The following notices of motion were given: (1) "That the resolution passed by the Board, agreeing to lay down their own plant for electricity at the new infirmary, be rescinded." (2) "That the Building Committee, before appointing an electrical engineer, report to the Board the probable cost of electric light; and, further, obtain an estimate from the electricity department of the Vestry as to the charges for supplying electric light to the infirmary." This led to a somewhat noisy debate, and finally it was agreed to defer the answer to the above letter for a week. At an extraordinary meeting to-day it will be proposed: "(1) That it be an instruction to the Electric Lighting Committee to report to the Vestry the cost of providing the electric light from Highbury-corner along Canonbury-road and the New North-road in order that the Islington installation may meet the electric lighting system being at present carried out by the Vestry of Shoreditch as far as the boundary of that parish; (2) that letters be sent from this Vestry to the Board of Guardians of St. Mary, Islington, and to the Local Government Board protesting against the proposed large expenditure and waste of the ratepayers' money by the Building Committee of the new Islington infirmary buildings, Highgate-hill, providing and fitting up an electric generating plant for supplying the electric current for lighting purposes in the above building, seeing that we have belonging to the parish one of the most modern and perfectly fitted up stations in the United Kingdom for generating the current for electric lighting purposes and of a much greater capacity than will be required to supply the electricity for the lighting of this building and seeing that our mains for both public and private lighting do or will pass the above building as authorised by the Vestry."

PROVISIONAL PATENTS, 1898.

NOVEMBER 28.

25051. Improvements in or relating to combined pressure or vacuum registers and electric alarms. Charles Andrew Gillespie, 96, Buchanan-street, Glasgow.

25058. The spring automatic fuse replacer for electrical cut-outs. Henry George Solomon, 193, Elgin-avenue, Maida Vale, London. (Complete specification.)

25084. Improvements in phonographs, graphophones, and the like. Louis Wolff, 6, Lord-street, Liverpool.

25087. Improvements in arc lamps. Walter Crudgington, 128, Colmore-row, Birmingham.

25095. An improved flexible conductor for submarine cables. George Gatton Melhuish Hardingham, Club House, Surrey-street, London. (The firm of Felten and Guilleaume, Germany.)

25098. Improvements in electric surface-contact tramways. Silvanus Phillips Thompson, 6, Lord street, Liverpool.

25109. Improvements in electric hoisting machinery. John Walter Brown and Archibald James Grant Simpson, 7, Kendoa-road, Clapham, London.

NOVEMBER 29.

25202. Improvements in electric alarm clocks. Léon Schott, 18, Buckingham-street, Strand, London.

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25217. Improvements in and relating to the production of electric currents. Romulo Echtermeyer, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25221. Improvements in electric arc lamps. John James Rathbone, 166, Fleet-street, London.

NOVEMBER 30.

25259. Improvements in electrical revolution indicators. Karl Obst, 15, Water-street, Liverpool. (Complete specification.)

25260. Improvements in electricity meters. Harry Nunns, South-parade, Halifax.

25314. Improvements in apparatus for transforming alternating into continuous electrical currents and conversely. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par L'Electricité, France.)

DECEMBER 1.

25327. An improved electrical terminal. Leonard Ridout, 124, Regent-street, London.

25410. Improvements in batteries or apparatus for producing ozone. Carl Adolph Sahlström, 18, Southampton-buildings, Chancery-lane, London.

DECEMBER 2.

25417. A switch for electric circuits. Justus Eck, 5, Priory-road, Bedford Park, London.

25473. Submarine sound transmitter. Charles Henry Prichard, 6, Messina-avenue, West Hampstead, London.

25479. Electric igniter or sparker for gas, oil, or vapour engines. Frank Wheeler Canfield, 40, Chancery-lane, London. (Complete specification.)

DECEMBER 3.

25567. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. ((Siemens und Halske Aktiengesellschaft, Germany. Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

25890. Electrolytic cells. Bell and Bell.

26530. Apparatus for heating buildings and the like by means of hot fluids or electricity. Dargue, Griffiths, and Wright.

28460. Electrical accumulator. Payen. (Date applied for under International Convention, May 4, 1897.)

28492. Variable electrical resistances. Rowbotham.

28800. Electric meter. Peloux.

29530. Lighting of miners' safety lamps and the like by electricity. Davis.

29575. Adjustable electric light fitting with detachable and rotary contacts. Mortimer and Head.

29821. Electric heaters. Schindler-Jenny.

30020. Prepaid electric meters. Soames and Crawley.

30441. Primary and secondary galvanic batteries. Menges.

1898.

571. Means for making electrical connections upon railway trains. Brierley and Foster.

932. Manufacture or production of electrodes for secondary batteries. Pollak.

2382. Electric telegraphy. Picard.

7450. Conductors, conduits, and collectors for electric railways and tramways. Daniel.

10900. Electric arc lamps. Wise. (Hubbell.)

10901. System for producing luminous effects, Rontgen rays, or similar electrical effects, and apparatus for use therein. Wise. (The Moore Electrical Company.)

14907. Arc lamp with magnetic carbon movement. Klostermann. (Date applied for under International Convention, Jan. 31, 1898.)

15303. Method of and apparatus for generating and utilising electricity. Lake. (Feely.)

15885. Electromagnetic ore separators. Langguth.

18531. Means for electrically operating electrical railway switches. Baldwin and Rowland.

18940. Alternating-current arc lamps. Abel. (Swoboda.)

19248. Alternating - current electric motors. Thompson. (Bradley.)

19937. Electric braking apparatus, adapted especially for use in electric tramways. The British Thomson-Houston Company, Limited. (Linn.)

19939. Electric meters. The British Thomson-Houston Company, Limited. (Haskins.)

19941. Electrostatic measuring instruments. The British Thomson-Houston Company, Limited. (Thomson.)

20154. Form of electrical resistance. Royce and Claremont.

21265. Certain drums for holding electric cables. Oxley.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Dec. 3	3 916	3,496	+ 420	—	—
Blackpool and Fleetwood Tramroad	Nov. 18	211	—	—	13,566	—
Bristol Tramways and Carriage Co.	Dec. 2	2,478	2,206	+ 272	—	—
City and South London Railway	Nov. 27	1,114	1,060	+ 54	21,519	20,785
Dover Tramways	Dec. 3	140	77	+ 63	7,927	—
Dublin U.T., elec. cars	,, 2	504	†483	+ 21	15,070	12,538†
Dublin S.D. Electric Tramways	,, 2	514	333	+ 181	20,993	14,241
Halifax Corporation Tramways	Nov. 30	209	—	—	5,831‡	—
Liverpool Overhead Railway	Dec. 4	1,317	1,286	+ 31	—	—
South Staffordshire Tramways	,, 2	610	562	+ 48	30,349*	30,425*

* Receipts since Jan. 1. † Horse cars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	19-20
Bournemouth and Poole Electric Supply, Limited, Ord.	10	11-11½
—— 4½ per cent. Cum. Pref.	10	10¾-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	12½-13½
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	111-114
—— Ordinary	5	9½-10¼
Central London Railway, Ordinary	10	9¾-10¼
——	6	5⅝ 6¼
—— Pref. Half-Shares	1	1¼-1⅜
—— ,, ,,	5	4¼-4⅝
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	24½-25½
—— 90,001-100,000	10	23-24
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	65-68
—— Ordinary	3	3¼-4
—— 4 per cent. Debenture Stock	100	134 136
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co. Ltd.	10	12½-13½
—— ,, ,, No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅞ 2
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2⅛
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	99-101
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2¼-2⅝
—— 7 per cent. Cumulative Pref.	2	2⅝-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	¼-⅜
Elmore's Wire Company	2	¼-⅜
W. T. Henley's Telegraph Works, Ordinary	10	20¼-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7⅞-8½
London Electric Supply, Ordinary	3	3⅛-4
—— 6 per cent. Pref.	5	6-6½
Metropolitan Electric Supply, Limited, Ordinary	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5¼-5⅝
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	16-17
Oriental, Limited, 1879	1	1¼-1⅜ xd
—— £5 Shares	5	7-7½ xd
—— £4½ Shares, New	4½	6¼-6⅝ xd
Oriental Telephone and Electric Company	1	⅜-½
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1⅛	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2⅜ 3⅛
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12½	37-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-114
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

Book Received.—We have received from Messrs. Whittaker and Co. a copy of "The Electro-Plater's Handbook," by G. E. Bonney.

Knowsley Hall.—We regret that the candelabra photos we used to illustrate the description of this interesting electric installation were shown on our pages upside down.

Cables to Puerto Rica.—According to a telegram from Washington, Admiral Sampson and General Henry have instructed the officers in command at various points on the Puerto Rica coast to prevent the landing of a French cable.

Liquid Hydrogen.—We understand that the manufacture of liquid hydrogen is proceeding so well at the Royal Institution that it is on draught as a staple article. Orders for quantities less than a pint cannot now be received.

The Borough Polytechnic.—The new gymnasium and workshops of the above institute were formally opened on Thursday, the 8th inst. The occasion was celebrated by a conversazione, which we regret Dr. Oliver Lodge's paper at the Institution of Electrical Engineers prevented us from attending.

More Municipal Tramways. — The arbitration between the North Metropolitan Tramways Company and the London County Council to determine the price to be paid for the tramways has been this week before Lord James of Hereford. The proceedings are being conducted quite privately, and in this way a more reasonable settlement is likely to be arrived at.

French Atlantic Cables.—According to the Central News, with reference to certain reports respecting the cables of the Compagnie Française des Cables Telegraphiques, all that the company is doing is to change the position of one of its cables in Newfoundland waters to one of greater safety, where it is less likely to be interrupted. The work has nothing to do with the safety of the cables in time of war.

New Honour.—We are informed that the order of Commander of the Order of Isabel la Catolica has just been bestowed on Mr. Charles Alexander Gerhard by H.R.H. the Queen of Spain. Mr. Gerhard has been a telegraphist for 50 years, and was present on board the frigate "Niagara" at the first attempt to lay the Atlantic cable in 1857, and at the final laying of that cable in 1858. Two years later he became the superintendent of the Submarine Telegraph Company.

Hopkinson Memorials.—We learn that the Engineering Laboratory Syndicate of Cambridge have proposed a plan for the memorial building to the late Dr. John Hopkinson, which is expected to be ready by October next year. We may add that Alderman Hopkinson, father of the late professor, has offered £1,600 to Owens College, Manchester, where his son was a student. It is hoped that additional money will be raised to found a "Dr. John Hopkinson Electrotechnical Laboratory."

Institute of Marine Engineers.—We have received a copy of two papers said to have been read before the above institute on the 12th inst. The first is by Mr. Neville Appelbee on "Electric Lighting Works," and the second by Prof. A. C. Elliott on "Traction by Electric Power." The papers seem to be the same as were read by these gentlemen before the Bristol Channel Centre in August last, and we gave them in full in our issue for Aug. 26. They were then discussed, but we presume that a further discussion at another centre must have been held on Monday last.

Electric Traction in Canada.—The recently issued report of the Montreal Street Railway Company shows in striking fashion the success which has attended the development of electric traction in Montreal. The report gives figures for seven years, 1892 to 1898. In that period gross earnings have almost trebled, but operating expenses are a long way from being even doubled. The passengers carried in 1892 were approximately 11½ millions, but with the development and increased popularity of electric travel the number grew to over 35 millions in 1898.

An Electrophone Concert.—The directors of the Electrophone, Limited, inaugurated a new departure at their premises, Pelican House, Gerrard-street, W., last Sunday, when a number of guests listened to the first of a series of Sunday afternoon concerts and inspected the Electrophone Theatre. These concerts, which are free to subscribers, are the outcome of experiments recently made under the direction of Mr. H. S. J. Booth, the managing director. The entertainment was quite successful, the various performances being greatly appreciated.

The Birmingham Telephone Exchange.—As we have mentioned before in our notes, the whole of the telephone system in Birmingham is now being reconstructed. We gather from the local papers that the subscribers are very impatient with the service given during the transference of the lines to the new exchange. The essential alteration which is being made lies in the reduction of the number of local exchanges. As many subscribers as possible will be connected up to the head exchange, and a few local exchanges will also be enlarged to deal with larger groups of suburban subscribers.

Juvenile Lectures.—The usual short course of lectures adapted for a juvenile audience, under the auspices of the Society of Arts, will be given on Wednesday evenings, Jan. 4 and 11, 1899, at 7 o'clock, by Prof. F. Jeffrey Bell, M.A. (of the department of zoology, British Museum). The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe." The lectures will be fully illustrated with lantern slides. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received. The tickets for the lectures are now ready, and can be had by members on application to the secretary.

Winter Holidays.—We have received from Messrs. Thos. Cook and Son their illustrated programme of popular tours for the winter and spring season, and are struck by the large number of attractive excursions which it contains for the inclusive sum of 10 guineas. Not only may tours ranging from 10 to 17 days be made to Rome, or to Nice, Cannes, and Mentone, or, again, to the Swiss Riviera on the sheltered shores of the Lake of Geneva, to Davos Platz, and other similar places, but even yachting cruises in the Mediterranean of 13 days' duration, visiting Algiers, the Balearic Islands, Tunis, Palermo, Naples, and other interesting places by the steam yacht "Midnight Sun."

Automatic Telephones.—The Augusta Telephone Company, of Augusta, U.S.A., is in difficulties over financial matters. When some gentlemen representing the New York creditors visited the place for the purpose of investigating the situation, they found a number of applications for telephones which the management had not been able to put in. The company's directory of subscribers, says *Electricity*, contains this inscription on the back: "Our automatic switches have no beaux, they don't chew gum, giggle, get saucy, tired, or sleepy, and they are not at all interested in your affairs." Perhaps it was the want of

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interest shown by the automatic instruments to the affairs of the subscribers that upset the financial situation.

Royal Meteorological Society.—At the ordinary meeting of the society, to be held, by kind permission of the council, at the Institution of Civil Engineers, Great George-street, Westminster, on Wednesday, the 21st inst., at 7.30 p.m., the following papers will be read: "The West Indian Hurricane, September, 1898," by Captain A. Carpenter, R.N., D.S.O., F.R.Met.Soc.; and "The Connection between the Winter Temperature and the Height of the Barometer in North-Western Europe," by W. H. Dines, B.A., F.R.Met.Soc. We are also informed that after Jan. 2 the offices of the society will be removed to Prince's Mansions, 70, Victoria-street, Westminster.

A Portable Electric Motor.—There is described in *Cassier's Magazine* for December a very convenient arrangement in the shape of a portable electric motor which is used in the W. H. Fish Machine Works at Worcester, Mass., for testing machine tools. The motor is mounted on the base of a triangular wooden frame, in the upper part of which is a shaft carrying a large split pulley and a cone pulley. The belt from the armature shaft passes round the large pulley, and a belt from the cone pulley operates the particular tools required. There are two small wheels on the base of the frame, which just clear the floor when the machine is stationary, and by means of these the whole frame, with the motor and pulleys, can be wheeled to any part of the shop. The total cost of the frame and counter-shaft is trifling, and excellent results have been obtained from it.

Electric Lighting in the City.—The Charing Cross and Strand Electricity Supply Company, Limited, have presented us with their humble petition to the Lord Mayor, Aldermen, and Commons of the City of London in Common Council assembled. This petition for the Corporation's consent to an application for a provisional order the Corporation regret they are unable to grant. This fact we gave last week, but the 5,000 signatures on the petition of citizens wishing for a competing electric supply must, indeed, have made the members regret that a monopoly had been conferred on the present company. The signatures include those of 29 bankers, 81 insurance companies, and 82 newspaper proprietors. The petition as forwarded to us concludes as follows: "Your petitioners humbly pray that notwithstanding such inability your Council will cause to be put upon your records such memorial. And your petitioners will ever pray."

The Keely Motor.—The death of Mr. John W. Keely at Philadelphia on Nov. 18 must have been an unpleasant reminder to those who had invested money in his various companies. The sensation surrounding the name of Mr. J. W. Keely lies in the fact that no one has absolutely proved his motor to be a fraud. As far as the gentleman himself was concerned, the motors in question provided him with all the necessaries of life for many years. Although he induced many wealthy persons to invest in companies for promoting his inventions, he had, we thought, disclosed his secrets to no one. There is current a rumour to the effect that his lawyer is in possession of the secrets which were disclosed for the purpose of patenting the same. This we doubt very much, and expect that the last has been heard of Mr. Keely's inventions. A post-mortem examination of his workshops and models would throw interesting light on the mysterious experiments he has exhibited.

The Northampton Institute.—The members and students of the City Polytechnic were invited to an annual conversazione on Friday last, Dec. 9. Through the kindness of the principal, we also received invitations. The programme for the evening was excellently arranged, and included a number of entertainments and lecturettes in the large hall. The lecturettes, as a rule, lasted about half an hour. Amongst these we noticed, as specially interesting, one by Prof. Walmsley on wirele telegraphy, one on modern war vessels by Mr. Ashford, and one on colour photography by Mr. C. V. Drysdale. The whole of the floors and laboratories were open for inspection, and in this way visitors were able to see the excellent way in which the institute is carried on. The great excitement of the evening was caused by a motorcar which ran round the corridors at about 10 miles an hour and tended to keep the people circulating. Those who could not get out of the way were run over, but we understand that nobody was injured.

Accident at a California Power Plant.—A correspondent to the *Electrical Review* of New York describes a singular accident which occurred on Nov. 7 at the power house of the San Gabriel Electric Company, near Azusa, Cal. Seventeen miles from Azusa a pole was burned down by an accidental fire, and, in falling, broke the transmitting wires, opening the circuit and allowing the Tuthill wheel to run away, bursting by centrifugal force the very heavy 6ft. flywheel, throwing pieces weighing 700lb. through the roof to a distance of 100 yards, making a complete wreck of the wheel, bending the 6in. shaft badly, breaking the controlling water-gate, and allowing the water under 400ft. pressure to complete the destruction of the roof. The engineer of the company said that no very high speed was attained, but that this particular flywheel was mounted slightly out of true on the shaft, which accounts for the serious results of the accident. The gate was supposed to be controlled by a Tuthill governor, but for some cause it failed to act with sufficient promptness.

The Postal and Telegraph Service.—A meeting was held in Cork on Sunday last of the various telegraphic and postal clerks' associations to consider what action could be taken relative to the grievances that existed in the services. The Mayor of Cork presided, and he was supported by a number of Irish M.P.'s. From the speeches, as reported in the *Cork Examiner*, we gather that the first few speakers exposed one or two real grievances. After that the professional agitators had their turn, and from what we see each one of these openly professed that he knew nothing of the points in question. For instance, Alderman Green said "he could not pretend to have mastered even in the most rudimentary way a hundredth part of the grievances which he believed the Post Office and telegraph men laboured under. As a public man, however, he considered it his duty to educate himself on the grievances of any section of the community which he represented." Whether this is meant to show how bad the grievances are or how small the alderman's capabilities of comprehension are, we are not quite sure.

Tit for Tat.—The Manufacturers' Association of Canada has called the attention of the Anglo-American Commission, now holding a series of meeting in Washington, to the fact that the United States Immigration Bureau has recently made a number of rulings to the effect that the commercial travellers of Canada fall within the restrictions of the alien labour law, and that they cannot carry on their work in the United States. In bringing the matter before the Commission the statement is made that a large number of commercial travellers from the United States have regular routes through Canada, and that if America intends to exclude Canadian salesmen the Canadian Government will perforce retaliate by excluding American salesmen from Canada. Should this proceeding be carried out it will, says *Electricity*, of New York, work great hardship

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to the manufacturers of electrical apparatus and appliances, many of whom have salesmen traversing Canada in every direction in quest of orders, and they will have to be recalled. Efforts are being made, however, to have the restrictions removed on both sides.

Royal Institution.—The following are the lecture arrangements at the Royal Institution before Easter: Sir Robert Ball, six lectures (adapted to young people) on "Astronomy"; Prof. E. Ray Lankester, 10 lectures on "The Morphology of the Mollusca"; Mr. A. Henry Savage Landor, three lectures on "Tibet and the Tibetans"; Dr. Allan Macfayden, four lectures on "Toxins and Antitoxins"; Mr. William Poel, three lectures on "English Playhouses in the Fifteenth, Sixteenth, and Seventeenth Centuries"; Sir Alexander Mackenzie, three lectures on "Liszt, Tschaikowsky, Brahms" (with musical illustrations); the Right Hon. Lord Rayleigh, seven lectures on "The Mechanical Properties of Bodies." The Friday evening meetings will begin on Jan. 20, when a discourse will be delivered by Prof. Dewar on "Liquid Hydrogen." Succeeding discourses will probably be given by the Right Hon. Sir Mountstuart E. Grant Duff, Mr. Victor Horsley, Prof. H. S. Hele-Shaw, Mr. Richard R. Holmes, Sir Frederick Pollock, Bart., Prof. H. L. Callendar, the Right Hon. Lord Rayleigh, and other gentlemen.

Searchlights as Harbour Defences.—The new electric searchlights which have been erected at various points to guard the channels leading to Portsmouth Harbour against night attacks by torpedo boats were, says the *Daily Mail*, tested on Monday last by a series of experiments. These were witnessed by a large number of officers, and proved eminently successful. Two well-organised torpedo boat attacks were made on the defences of the port, but the lights swept the approaches to the harbour, and on no occasion was an entrance effected unobserved. When discovered, the guns of the forts, loaded with blank charge, were brought to bear upon the destroyers which were told off for the purpose, and which made numerous but futile attempts to elude the lights. The object aimed at was to obtain some data as to the number of rounds each quick-firing gun could put into a vessel in a given space of time. The information thus gained is considered to be of much value, and other particulars furnished during the experiments should prove of the highest utility in the event of the forts being manned in earnest during a night attack.

Canal Haulage.—We notice in our contemporary *Cosmos* that Mr. Galliot, of Dijon, has designed what he calls an electric horse for hauling barges in canals. It is interesting to note the details of the proposed system, because at the end of the article it is compared most favourably with that of Messrs. Thwaites and Cowley, which was described in our columns recently. The essential point in the Galliot system is the use of a three-wheel electric vehicle, which is able to absorb about 4 kw. to 6 kw. This vehicle runs along the canal bank, and is supplied with current from two overhead wires by the side of the towing path. An ordinary towing rope is used between the vehicle and the barge. The author considers that this, in its robust simplicity, is much superior to the Thwaites-Cowley system, but from what we know of the usual condition of canal tow-paths, we are afraid that the vehicle would take almost as much power to propel itself as to pull the barge. Another system is described in the same article, in which a rudder propeller is used on the barge itself. In this case the canal banks are likely to suffer from the backwash set up.

Engaged.—The *Financial News* on Monday last published a long account of its editor's visit to the Lime-street exchange of the National Telephone Company. The avowed object of the visit was to see if the "engaged" answer, which is so irritating when using the telephone, referred to the subscriber's line or to the telephone girl. The editor in question was convinced of the great care taken by the girls to make the required connection. The following extract from the article is interesting as confirming our leader of last month on telephone secrecy: "That an operator cannot neglect a call when the tell-tale number remains exposed to the view of the superintendents is clear. The supervision seems quite sufficient, the number of overseers and superintendents being apparently ample. The latter have elaborate instruments by which they can switch themselves at will on to any table, and carefully note how an operator attends to her work, the latter all the time unconscious that she is subject to aural as well as visual supervision." Unfortunately, the subscribers are also often, when conversing, unconscious that they, too, are subject to aural supervision.

Automatic Telephone Exchange.—The members of Glasgow Corporation recently had a chance of inspecting a direct automatic telephone exchange. The system was the same as that made by the Telephone Construction Company of London, and to which we referred in the summer. The exhibit in the Glasgow Municipal Buildings contained a miniature central exchange in full working order, and was so far approved by the committee that a contract is being entered into between the Corporation and the Telephone Construction Company, Limited, with the object of having an installation of 25 telephones placed in the Municipal Buildings. In place of there being a switchboard worked by girls in the central exchange, the connection is made by the subscriber himself through an automatic switchboard which is operated by means of a disc having numbers on its margin from 1 to 0. The cost is about the same as the switchboard now in use, but nearly all intermediate labour is done away with, and the necessity for repair is very largely minimised. The only doubt we have regarding this system is as to whether the instruments will continue to be automatic.

Telegrams to Klondyke.—We have received this week a prospectus of the Canadian, British Columbian, and Dawson City Telegraph Company, Limited, which is to provide a telegraphic communication to the new goldfields in British Columbia. The share capital of the undertaking is £300,000. The distance the line is to traverse will be about 1,400 miles, and as certain portions of the line are over comparatively easy country it seems to us that the capital is rather large. The part of the prospectus with which most fault is to be found is the estimates of receipts. The directors think that a daily income of £625 may be expected for 300 working days. From the reports which have reached this country of the Klondyke district we should very much doubt if this sum would be reached on any one day. Also, from the great variation in transport, facilities during different parts of the year, the actual need for a telegraph will hardly be felt during the winter. We also see nothing in the prospectus stating that the company will have a monopoly of the telegraphic communication to the new district. The audacious part of the proposal is the present issue of £225,000 in 5 per cent. debentures, and the fact that the ordinary shares are not to be issued yet. What security on which to issue debentures can the company have?

Pacific Cables.—The *Western Morning News* of Tuesday last claimed to have authority for the following particulars of the proposal to establish cable communication between America and the Philippines. The route to be taken will be from San Francisco to Honolulu, in the Sandwich Islands, and thence to the Uhlan Islands, where

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two branches will be formed, the one going to Sydney and the other to the Ladrone Islands. A second junction will be made at the Ladrones, one section continuing to the Philippines and Hong Kong and the other to Japan. The total length of the cable would be about 12,345 miles, and the condition of contract that it should be constructed as far as Hawaii within 12 months from its commencement. If the scheme is approved, the United States will have all their colonies linked together effectively. This is easy of accomplishment, for they lie almost in a straight line from San Francisco. Australia ought to benefit, too, if the cable is taken to Sydney, though British traders may not exactly rejoice. There is another proposal to construct a cable between the Hawaii Islands and Yokohama; but the first has the obvious advantage of going right through from the States to Asia, while the latter ends at the Sandwich Islands, from which it might be expected there would be hardly enough business to pay for working. As regards the rival all-British cable, Sir Sandford Fleming has recently stirred matters up again by an able letter to Mr. Chamberlain. Amongst other things, he advocates the abrogation of the agreement with the Eastern Extension Telegraph Company so that cable communication between Canada and Australia might be connected at Hong Kong.

The Savory Verdict.—In this week's issue will be found an account of the last two days' proceedings of the libel action brought by Sir Joseph Savory against the proprietors of the newspaper called *London*. The verdict was somewhat unexpected, and the jury evidently were influenced by the fact that no malice could be proved by the plaintiff. While we quite concur with the judge in his remark that it was indiscreet for Sir Joseph Savory to act as chairman of the Pioneer Electric Lighting Company of the City of London during his year as mayor, we also think that the comments on the subject by our contemporary were uncalled for. It is easy to be wise after the event, but in 1891 money was not easily obtainable for electric lighting purposes. The London Electric Company was then being held up as an example of the failure of a modern electrical undertaking, and the remembrance of the millions lost in the boom in the early eighties scared the ordinary investor. Certainly, there were a few electric light companies in London with their shares at par, but they had not then paid dividends to warrant large expendi ture on new works. We do not say that the company could not have been financed without the aid of Sir Joseph Savory, but can quite conceive that, with the then state of electric lighting, he acted as an essential factor in securing the financial aid required to start the electric lighting undertaking. The need of electric lighting was known to him, and the contract for the public lighting obtained from the contractors was a most favourable one. It is easy to write down monopolies as iniquitous, but our contemporary should remember that, as a rule, those interested in the monopolies at first take risks which the granters of the concessions refuse to do.

Loans for Electric Lighting.—The Newington Vestry is obtaining the necessary money for its electric lighting works from the London County Council on somewhat novel terms. The whole loan applied for amounts to some £50,000, but the whole amount will be taken up by instalments as required. The interest on this loan at 3 per cent. per annum will be paid in the usual quarterly instalments. The new procedure lies in the fact that the repayment of principal will be spread over the last 39 years only of the full term of 42 years. The reason given for this proposal is that the Vestry desire to make the undertaking self-supporting from the commencement. As the County Council have acceded to the request, they will not have to provide any sums for the repayment of capital for the first three years. The yearly instalments for the last 39 years will, of course, be somewhat larger in consequence, but we are sure that the undertaking will have no difficulty in meeting them. The relief given during the first three years will give the undertaking a much more healthy appearance in the annual reports of the Vestry, and in consequence, extensions, which are always wanted where a really good system of electric lighting is laid down, will be more readily granted. We should think that the only people who will object to the innovation will be the gas journals, who make a point of writing down all electric lighting undertakings which are not able to meet their full capital charges for interest and sinking fund. As far as we know, no electric light company—and certainly no gas company—has paid interest out of revenue during the first year of its construction. The new procedure puts a municipal undertaking on a more equal footing, as far as paper figures are concerned, with the companies.

Compounding of Alternators for Constant Voltage.—In an alternator possessing a considerable armature reaction a given weight of material is used to better advantage than under any other conditions. However, if the excitation is produced with a constant current, the terminal voltage will vary with the output, the limits of this variation being the wider as the armature reaction is greater. Moreover, such an alternator cannot be easily run in parallel with another machine of the same class. These difficulties would disappear if we could cause the exciting current to vary with the output, after the manner employed in compound direct-wound dynamos. An ingenious contrivance for reaching this end has been described by M. Maurice Leblanc before the Académie des Sciences. Two cores mounted on the same axis are wound with wires connected respectively, the one in parallel, the other in series, with the brushes of the alternator, supposing the latter to be a three-phase machine. The two rings are also provided with a winding, like that of an ordinary continuous-current armature, connected in the usual manner with a commutator. The rings revolve between two poles, due to the rotating field produced by a relative displacement between the windings of the rings. A continuous current is produced in the windings connected with the commutator, and this serves for the exciting current. Since this current will be proportional to the output of the alternator, the desired end is reached. It has been found to work satisfactorily in the case of a 60-kw. alternator. In fact, the device acts as a rotary converter with differential windings, but when considered in detail the arrangement is not so simple as commutating a part of the main current, which is already done by several firms.

Conduit v. Snow.—The unusually heavy fall of snow which visited New York on the 26th and 27th ultimo succeeded, says *Electricity*, in throwing out of service almost without exception every conduit electric railway system operating in New York City. Trouble was experienced on all the electric lines of the Metropolitan Street Railway Company which prevented the running of cars for periods ranging from a few hours to twenty-four. For some reason the line apparently the least affected was the Madison-avenue line, whereas the Lennox-avenue line had to stop operating on the evening of the 26th and traffic was not resumed until the following evening. The storm, leaving a fall of 12in. of snow on the level in the city, was probably without exception the most trying since the adoption of conduit electric traction by the Metropolitan Street Railway Company, and what undoubtedly

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added to the difficulty in keeping the lines in operation was the fact that so severe a snowstorm was scarcely looked for so early in the season and consequently caught the street railway companies unawares. The stoppage of the several underground trolley systems is explained by President Vreeland of the Metropolitan Company as follows: "The snow of Saturday last was of a particularly wet kind, and melted quickly when it touched the rails of the street car lines. Ice then formed. In the case of the electric lines the presence of ice on the tracks prevented the wheels of the cars coming in contact with the iron rails, thus preventing the establishment of a circuit. Having no electrical power, the cars, as a matter of course, could not move." The trolley systems in New Jersey were equally affected by the storm, but we can hardly understand the conduit lines having their supply of power cut off by ice on the rails. We have always understood that insulated return conductors were used on these lines, and two conductors are shown in all the drawings of this system.

Commutatrices.—*L'Electricien* contains an article in its last issue in which are described, under the above heading, some rotary converters which have been recently laid down in Paris in connection with the new railway to Orleans. The electric light station of the "Secteur de la rive gauche" distributes current by the single-phase alternate-current system at 3,000 volts, but in this instance continuous currents were especially required on account of the number of lifts, cranes, etc. In the sub-station some six 20-kw. transformers were placed to reduce the voltage to 160. The "commutatrice" has an output of 88 kw., and was constructed by the Alioth Company. As the principles on which these machines work have been described so recently in our columns, we only give details of the machine in question. The armature, which is of the Paccinotti type, is 35in. diameter and 15¾in. long. It is wound with 181 turns. The machine is a 10-pole one, and the 10 sets of brushes are used to collect the continuous current. The E.M.F. on the alternating-current side is 160 volts, which is transformed to 225 volts on the continuous-current side. The current available is 390 amperes, and the machine runs at 500 revolutions. The total weight of the machine is about six tons. The efficiency claimed for it is 90 per cent. In the article the method of starting the rotary is described. For this purpose a small induction motor is used to drive the armature by means of friction gearing. When a synchronous speed has been obtained, the alternating-current circuit is completed. Nothing is said as to whether the field is excited, and a statement is made that a reversing switch has to be placed on the continuous-current side in consequence of the polarity being dependent on the instant at which the circuit is completed. We presume, therefore, that the field is not excited before the machine is started. It would usually be better to use a small battery of accumulators for exciting the machine and driving it up into synchronism, as in that case there would be no doubt as to the direction of the current on the continuous-current side afterwards.

Society of Engineers.—The forty-fifth annual general meeting of the Society of Engineers was held on Dec. 12 at the rooms of the society, 17, Victoria-street, Westminster, S.W. The chair was occupied by Mr. William Worby Beaumont, president. The following gentlemen were duly elected by ballot as the council and officers for 1899—viz., as president, Mr. John Corry Fell; as vice-presidents, Messrs. Henry O'Connor, Charles Mason, and Percy Griffith; as ordinary members of council, Messrs. J. Patten Barber, Joseph Bernays, D. B. Butler, G. A. Pryce Cuxson, R. St. George Moore, Nicholas J. West, Joseph William Wilson, and Maurice Wilson; as hon. secretary and treasurer, Mr. George Burt; as hon. auditors, Messrs. Alfred Lass, F.C.A., and Samuel Wood, F.C.A. It was announced that owing to the increase in his private practice, Mr. Pryce Cuxson, F.S.I., had been compelled to resign his position as secretary of the society, and a very flattering tribute was paid to him for the services which he had rendered to the society. It was also announced that Mr. Perry F. Nursey had been appointed to fill the vacancy, and will take office on Jan. 1 next. The following have been elected honorary members of the society—viz., Sir J. Wolfe Barry, K.C.B., LL.D., F.R.S., M.I.C.E.; Prof. A. B. W. Kennedy, LL.D., F.R.S., M.I.C.E.; Mr. W. H. Preece, C.B., F.R.S., M.I.C.E.; and Mr. Alexander Siemens, M.I.C.E. The proceedings were terminated by a vote of thanks to the president, council, and officers for 1898, which was duly acknowledged by the president. The annual dinner of the society was held at the Hotel Cecil on Wednesday last, when Mr. W W. Beaumont again presided. The company included Sir Benjamin Baker, Sir John Durston, General Sir Oriel Tanner, Mr. W. H. Preece, Mr. W. H. M. Christie (Astronomer Royal), Mr. Alexander Siemens, Mr. J. W. Swan, the Hon. C. S. Rolls, Mr. John Aird, M.P., and various past-presidents and vice-presidents of the institution. The occasion was taken advantage of to present an address on vellum and a tea and coffee service to Mr. G. A. Pryce Cuxson, who for the past 10 years has filled with zeal and ability the office of secretary.

Yorkshire Students' Dinner.—The Association of Yorkshire Students in connection with the Institution of Civil Engineers held their fifth annual dinner in the Queen's Hotel, Leeds, on Saturday evening. The chair was occupied by Mr. H. Copperthwaite, M.I.C.E., president of the association, who was supported by Mr. W. H. Preece, president of the Institution of Civil Engineers; Sir John Wolfe Barry, K.C.B.; Dr. Tudsbery, secretary of the Institution of Civil Engineers; Mr. J. R. Baterden, president of the Newcastle Association; Sir James Kitson, M.P.; Mr. A. Greenwood, Mr. W. B. Worthington, president of the Manchester Association; Mr. A. T. Walker, and many others. Mr. Preece, in responding to the toast of the Institution of Civil Engineers, urged them to extend the membership of the institution in every way they could, for in it there was a kind of freemasonry that was of the greatest benefit to those who travelled about the world. Science was absolutely the basis of their profession, and they were bound to keep pace with all changes, besides initiating changes themselves. He maintained that the position of science at the present day was due more to the work of engineers than to the work of professors and scientific men so-called. Their profession was to apply the great forces of nature to the use and convenience of man. He was glad to re-echo the words of Lord Rosebery and the Sirdar, that the real civiliser was the civil engineer. He should like to remind them that the real object of the Sirdar's college at Khartoum was not, as many supposed, mainly to teach the English language, but to teach the principles of engineering, such as the laying of railway lines and the construction of telegraphs. Civilisation would be carried through the Soudan by the aid of the wisdom of the engineer, supplemented by the labour of the native. From the Cape there was progressing the wire which Mr. Rhodes was providing for out of his own pocket to join with Cairo, while the work of constructing a permanent line from Cairo south was rapidly progressing—indeed, a field wire was in existence now. The work of the engineer also conduced to the prolonging of life, for it added to the comfort and the peace of man.

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NOTES ON THE DISTRIBUTION OF ALTERNATING CURRENTS.

BY SIDNEY E. T. EWING.

Great diversity of opinion exists amongst engineers as to the best and most economical methods for the distribution of alternating currents. In a few years' time no doubt as great uniformity will obtain as is now the case in continuous-current work, but at the present the variations of opinion and practice are very striking, hardly two stations in the country being alike, save, perhaps, when they are the work of the same firm throughout, and have not been subjected to the ideas of an independent consultant. The following notes are intended to indicate the apparatus and methods in most general use, with such comment as seems likely to be of service to readers.

General Conditions of Economy.—From the point of view of economy, the general aspect resolves itself into the just proportioning of the interest charges on the capital cost, and the cost of generating the units lost in distribution. Naturally many factors enter the question which render the best solution in individual cases very difficult to decide. Two examples exhibiting very different conditions may be cited. The one is a company whose compulsory area is very large and scattered, and whose available capital at the outset was unduly small. In this case the only way open was to put down high-tension distributors in conjunction with house transformers. This was done, and enabled a start to be made on a fairly paying load, drawn chiefly from a residential district, and for some years a good dividend has been paid. At the present time, however, the ratio of the number of transformers in circuit to that of consumers is as one to three, and, as most of the transformers are of an old make and poor design, the magnetising load (true watts) is nearly 9 per cent. of the maximum load on the station. The other example, offering a very complete contrast, is the undertaking of the corporation of a rather densely-populated town about the same size as the above. In this case the consulting engineer, having plenty of capital at his command, arranged for some 13 well-equipped sub-stations in the central area, and a network of low-tension mains in all the principal and secondary streets of sufficient section, to meet any probable demand for several years to come. A number of large transformers were also installed, whose capacity far exceeded the demand after the first 18 months of working. The load taken up during this period being supplied chiefly to early-closing shops and offices—comparatively unremunerative customers—the undertaking has been heavily handicapped by the large interest charges. Thus in the former of these two instances an arrangement of plant which cannot be recommended in the abstract, has enabled a profit to be made under circumstances which would have debarred a more efficient, and therefore more expensive, system from doing so; while in the second the adoption of a very efficient and permanent plant has resulted in an immediate loss, where a more modest beginning, with a more elastic system, would undoubtedly have enabled a profit to be made from the outset. Under any circumstances, however, it is desirable to have a good deal of flexibility in the distribution arrangements—that is to say, ready means of enlargement to meet the increasing demand that experience has shown may be always expected, without unduly burdening the undertaking in its early days.

High-Tension Feeders.—High-tension cables are perhaps the part of the distribution system which the engineer most fears, though nowadays to nothing like the extent of a few years back. The failure of a feeder means in many cases the total extinction of a large number of lights until a repair can be effected, and unlike the low-tension mains, which can easily be arranged to help each other, the failure of a high-tension main is difficult to economically safeguard. A good deal has been written of how high-tension feeders should be duplicated and interconnected, arranged on the ring system, and so forth, but in these suggestions a cardinal point is often lost sight of. A high-tension system is adopted in most cases—though not in all—less on account of the intrinsic beauty of high tension, than because it enables the supply station to be moved to a considerable distance from the area of supply, to the site most favoured as regards the supply of coal and water and freedom from liability to injunction. Hence, high-tension mains are often so long that their capital cost approximates power for power to that of the shorter low-tension feeder, and complete duplication is too costly to bear consideration. In this, as in so many other questions in which absolute security has to be balanced against cost, a compromise is the best solution. Two sub-stations lying fairly close together, each fed by a separate feeder, may be interconnected by a main of the same section as the larger of the two feeders. A breakdown will then mean more or less irregularity of voltage over the area supplied by the two sub-stations, but the period of total extinction need only last until the requisite connections between the sub-stations has been made. The use of a "discriminating cut-out" would even prevent the extinction, but at present there is but little experience available as regards this accessory, which promises, however, to be a most valuable invention. If the low-tension mains fed from each sub-station are permanently interconnected or if arrangements allow of so connecting on emergency the voltage variation may be still further lessened. Nowadays makers are willing to guarantee their cables over a period of years, and undertake to repair all faults at their own expense during this period—a proviso of singularly small use to the user, for a cable breakdown has in nearly all cases to be repaired by the station staff within a few hours of its occurrence. Cables are always tested at the makers' works after many hours' immersion in water at something like five times the working pressure. If they are then carefully laid and jointed by men experienced in the particular class of cable, and subjected to a further pressure test to try the joints and end connections, they may be relied on not to fail for electrical reasons with considerable certainty. The all-important thing in the case of heavy cables is that they should not be unduly strained or otherwise injured during the drawing-in, and if the insulation is hygroscopic, that great care be taken that the joints and end connections are kept free from moisture during the making and sealing up. Large cables are very heavy, but are easily damaged by straining, so that the use of a winch for drawing them in is to be deprecated. Half a dozen men pulling on a rope can only exert a limited force, and experience will enable the cable-layer to judge whether a given length and weight of cable is offering more than normal resistance, which may be due to inequalities in the conduit, and whether it is safe to employ more weight on the draw-rope. Breakdowns on good present-day cables are generally due to mechanical injury, such as the bursting of water-mains, the crushing of conduits by road engines, workmen's picks, and so on—accidents against which it is not possible to thoroughly guard. The broadest distinction in cables is that between the ordinary double and the concentric class. Between these two lies the twin cable, consisting of two separate side-by-side conductors, made up in one sheathing, and having a slow twist round each other. The latter may be said to be electrically nearly equivalent to the ordinary double cable and mechanically equivalent to the concentric. There are some striking differences in electrical behaviour between these two main classes of cable. The double conductor has more self-induction for a given length and less capacity than the concentric. With small currents the inductive drop is not important, but with large currents, and when drawn into iron pipes, it becomes a factor to be reckoned with. With currents amounting to several hundred amperes its use becomes impossible for distribution work. On the other hand, on long lines the capacity current of a concentric cable comes into prominence, especially as it varies directly as the impressed voltage.

Most readers will be aware from published statements that the capacity current of the Deptford trunk mains, having a length when looped of nearly 12 miles, is between 12 and 14 amperes at the working pressure of 10,000 volts. This current, though wattless, has to be allowed for by increased section of copper in mains and generating machinery. The behaviour of twin cables comes between these two classes. Their inductance is lower than that of a double conductor, and their capacity higher. They are

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largely used in systems where a quantity of double cable has been already installed, for the reason that it is inadvisable to use a combination of double and concentric mains. The capacity between the outer conductor of a concentric main and the earth has the effect of lowering the potential of the outer to the neighbourhood of the earth potential. Connected to a system of double-conductor mains, the potential of one main is thereby brought nearly to earth potential, whereby the difference of potential between the other main and earth is nearly doubled. This has generally been found to produce disaster. In cases where nothing but concentric cable is in use, it is becoming usual to connect all the outers to earth at the station switchboard, arrangements being made that they can be disconnected singly for testing in compliance with the Board of Trade regulations. For ease of handling, and ease and cheapness of jointing, the ordinary double rubber-insulated cable decidedly takes first place. Concentric joints are rarely satisfactory unless they are made in a special joint-box. Hence, a multiplicity of joint-boxes of different sizes and shapes have generally to be kept which, being usually the makers' patents, are costly. The earliest cables were insulated with vulcanised india-rubber, and the trouble experienced some years ago has, it is to be feared, greatly prejudiced engineers against india-rubber as a dielectric for this class of work. Yet at the present time rubber-covered cables can be obtained of great reliability, and their use offers many advantages for small feeders. Being very light and flexible, they can be drawn in for considerably greater distances than lead-covered cables. Jointing is simple and rapid, and no special boxes or end connections are required. However, the price of rubber is rising so rapidly that at the present time a lead-covered paper or jute-insulated concentric cable is considerably cheaper than two rubber-insulated cables of the equivalent section, and it cannot be denied that they are fast falling out of use. The other dielectrics most in use are paper, from which all traces of moisture has been removed, impregnated with a heavy hydro-carbon oil and fibrous material, such as jute, impregnated with special insulating compounds of a bituminous nature. Both these latter classes are protected from moisture by a solid-drawn sheath of lead, which is further protected by a serving of tape and preservative compound. Paper insulation is extremely weak mechanically and very hygroscopic, but so excellent is the manufacture of these cables that immense quantities have been laid and are working successfully. Of late a decided preference has been shown for armoured cables, which can be laid direct in the ground without further covering than a tarred board to notify the whereabouts of the cable when the ground is opened for jointing or repairs, and, it is fondly hoped, to warn off the ubiquitous navvy's pick. An armoured cable costs rather less than one of similar make and cross-section, lead covered, and an iron or earthenware conduit; but it is difficult to see that this fact justifies their use in all cases. The possibility of drawing out faulty lengths, or lengths of insufficient section, rapidly and without disturbing the streets is very valuable, particularly when the undertaking is in the hands of a private company and the town authorities are apt to look askance at frequent requests for permission to open roads. But in spite of this great drawback its use is undoubtedly extending rapidly.

In the great majority of cases at present, no provision is made for counteracting the drop in pressure in the high-tension feeders at full load, beyond raising the station 'bus-bar pressures slightly during the full-load period. At best, this method can hardly be considered fully to meet requirements, and in future design there can be little doubt that a transformer with variable change ratio, or some equivalent device, will have to be placed in each feeder circuit, in which case the station pressure would be kept constant at the value necessary for the shortest or lightest loaded feeder. An important point to which little attention is usually paid is the safeguarding of men working on mains which are usually kept alive. The procedure in many stations is something as follows: The electrician in charge of mains, telephones or sends a message to the engineer at the station asking him to take off a particular main or circuit, and when he is satisfied that this has been done he tells the jointer to proceed to work on that main. If by mischance the main was not taken off the 'bus bars, or was afterwards put on prematurely, or the jointer cuts the wrong main, the responsibility may be difficult to fix upon the right person. Nothing can be better, however, than the method adopted in some stations whereby the jointer, having received his orders, goes himself to the station, and, with the permission of the engineer, opens the switch and places a wooden panel over the recess, which he padlocks, taking the key away with him. When the job is finished he goes back to the station and gives up the key. A main may sometimes be fed from both ends, and in this case some engineers provide a short-circuiting plug between the inner and the outer at the sub-station or transformer pit, and make it a rule that this plug shall always be inserted before any work is done. The outer main is of course permanently earthed at the station.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Thursday, 8th inst., the following paper was read:

Improvements in Magnetic Space Telegraphy.

BY DR. OLIVER LODGE, F.R.S., MEMBER.

PART I. (*First Portion*).

The general principles of electric space telegraphy—or wireless telegraphy, as it seems to wish to be called—are fairly old; and without going into the history of the subject, with which I need not trouble you, since it has been admirably summarised by Prof. Silvanus Thompson in his lecture to the Society of Arts, I may recapitulate the three chief methods that have been tried.

First, and oldest, the earth current or leakage method, wherein a powerful current conveyed to the earth or sea by two well-separated electrodes causes a slight difference in potential between two other well-separated tapping electrodes at a distance, and thereby produced a feeble current through a joining wire, which can be detected telephonically or galvanometrically, or in any other convenient and known way. I am under the impression that this utilisation of earth conduction for the purpose of conveying messages has played a greater part in the past, and is perhaps destined to play a greater part in the future, than most people suspect. When, for instance, as in Mr. Langdon Davies's experience, phonoporic currents have been heard in very distant telephone trunk lines, it is difficult to be sure how much of the effect is due to a true induction from wire to wire, and how much of it is due to conduction—not only conduction through the soil from earth-plate to earth-plate, but conduction also through metals, whether gas-pipes or overhead wires or other conductors arranged for other purposes. Whenever an open circuit is employed with earthed terminals, conduction is liable to assist induction, and this may very likely be regarded as an advantage. It may also be to some extent a disadvantage, owing to its resulting in the mixing of messages; it may, in fact, contribute to ordinary telephonic cross-talk.

The second method that has been tried for purposive space telegraphy is the method by magnetic induction between two insulated line wires stretched parallel to one another along opposite coasts. This method, as is well known, has been tried under the auspices of the British Post Office, and is known as Mr. Preece's method. It is, I think I am right in saying, the only system in actual regular work; for near Cardiff, between Lavernock Fort and the neighbouring fort on the island of Flat Holme, I have myself seen it at work, and have admired the ingenious system of "call" devised by Mr. Evershed and there employed. I desire to say that when I gave a short preliminary note to the British Association at Bristol this year, on a "call" that I had invented, I was unaware of Mr. Evershed's work in the same direction. He has undoubtedly achieved the result there aimed at, though with the expenditure of a good deal of power; and had

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I known, I should certainly have referred to it in my communication at Bristol. But after the Bristol meeting Mr. Preece gave me permission to visit Lavernock, and I went in company with Mr. Partridge, the telegraphic superintendent at Cardiff, to whom also I am obliged.

In the third system of space telegraphy—that by Hertz waves—the public owes its knowledge and interest also to Mr. Preece; for, had Mr. Preece not taken up the subject, very few persons would, in all probability, have heard of Hertz waves and Branly detectors and coherers to this day. As it is, owing to Mr. Preece's great influence and power of lecturing, this third and most recent method has become the best known of all; and, indeed, Italy is generally credited with the whole discovery. I do not intend to refer to this interesting method again to-night, but before leaving it, it may conduce to clearness if I explain wherein the Hertz wave method—at which I have also worked in conjunction with Dr. A. Muirhead—differs from the older magnetic inductive method of Mr. Preece, Willoughby Smith, and others.

Every alternation in a suitable medium produces waves in one sense, but the intensity of those waves is immensely dependent on the rapidity of the alternations. A rapid pulsation of air, in and out of a hollow vessel like a resonator, may cause an extremely loud sound; a slow pulsation, of the same or even of much greater amplitude, would cause no perceptible effect, beyond an alternate rise and fall of a sensitive barometer. Again, a reed vibrating slightly but quickly is audible at a distance, while a fan vibrating strongly but slowly is not audible at all. The waves emitted by the one are strong, by the other are exceedingly weak. A magnetic alternation of sufficient rapidity induces an alternating electrostatic field, and is therefore accompanied with emission of energy. A slow magnetic alternation is practically unaccompanied by any electrostatic effects, and so practically all the energy emitted at each pulsation returns again to the source. For a progressive wave must necessarily have half its energy static, and half of it kinetic energy; whereas in ordinary current induction all the energy is kinetic.

Interrupting the explanation for a moment to touch on a practical point, it might seem, from what we have so far said, as if all the advantages lay with the rapid vibration or wave method. But when really large distances are contemplated, or when obstacles intervene, its advantages diminish and ultimately disappear; for slow magnetic pulsations are independent of all obstacles, except actual iron, if they are slow enough, and are only slightly weakened by conductors; whereas rapid pulsations or true waves are stopped by conductors and are greatly affected by obstacles. It is probable, as I have hinted above, that earth-conduction plays a considerable part in some of the coherer signalling which is supposed to occur by means of waves in space, and in all cases it is a possibility to be constantly borne in mind. The coherer is a detector of electric jerks transmitted by the earth or by uninsulated conductors such as gas-pipes, and the response of a coherer is no conclusive demonstration of the receipt of actual Hertz waves.

To detect the radiation of energy, something capable of responding to waves, such as an eye, an ear, or a coherer, is appropriate; to detect the fluctuations of pressure or of magnetic field, something akin to a barometer or magnetometer would seem to be appropriate; but, inasmuch as these instruments only indicate the state of things at their immediate locality, another device can be employed which shall integrate the effect over a considerable area and therefore be much more sensitive. Such a device is afforded in the case of magnetism by Faraday's current induction. A circuit connected with any electric detector, such as a telephone, may surround a large area and give an induced current depending on the variation in the total lines of force passing through the entire area. In the Lavernock signals, considering them as due to wire induction, the inducing and induced areas are both long narrow strips in a vertical plane, with their long sides horizontal and their faces parallel, each being constituted by the space between a long overhead line on posts and the return earth—or, rather, sea—circuit. But in some interesting experiments made by Mr. Stevenson near Edinburgh, he employed a horizontal coil of wire approximately circular—in one case utilising some farm fencing, I believe—and by means of a battery and key at one station was able to hear Morse signals in a telephone half a mile away. This certainly resulted from pure induction, and it may be considered to represent the closest approach hitherto made to the method I have to bring forward to-night. Unfortunately, Mr. Stevenson made a slight error in the theory, and perhaps for that reason did not continue the attempt over larger distances. He says that with a given number of ampere-turns the hearing distance increases with the square root of the diameter of one of the coils, or with the simple diameter of both coils, thus making it necessary to double the size, quadruple the area, of each coil if the distance is to be doubled; and, since he used 1,600 yards of wire in each coil to signal half a mile, he may have considered the cost prohibitive for any really great distances, as, indeed, it is with mere unaided coil induction.

But, in truth, the law of distance is not the square root of the diameter, but the two-thirds power, with a given primary current; and so doubling the circumference of each coil will enable signalling over more than double the distance, if other things can be kept the same. It is true, however, that for such magnification the thickness of the wire must be magnified likewise, or else more power will be consumed in the enlarged coil; and this consideration, together with others shortly to be stated, does speedily make the cost prohibitive, unless some fresh revolutionary devices are employed. The devices I have to lay before you to-night contain nothing new in principle—*i.e.*, they involve no discovery—but, inasmuch as they make practical over big distances what has been actually successful over small distances, I venture to attach some importance to them, and think them worthy of your attention.

First, I have to explain my system of magnetic induction telegraphy, and next the extra sensitive receiving instrument which may be employed with it. The chief feature of my magnetic system is the outcome of an electric resonance experiment which I described eight years ago (see *Nature*, vol. xli., p. 368)—viz., the experiment of the sytonic Leyden jars. The term "resonance" is generally and properly understood as having an acoustic significance, and where no reference to sound is intended I advocate the use of the more general term "syntony" to denote the sympathetic response between two vibrators attuned to the same "note," or more generally to the same frequency of vibration, whether that vibrator be mechanical or electric or magnetic. Two similar Leyden jars connected to similar circuits are, or may be, thus syntonised, and any electric oscillation in one causes a feebler electric oscillation in the other; the medium of communication in this case being the alternating magnetic field between the two circuits, the lines of force of the one circuit penetrate the other, and by their fluctuation cause an alternating E.M.F. of feeble intensity. In a distant circuit *not* containing a Leyden jar, and therefore not susceptible of any tuning, because it has no natural frequency of vibration, nothing can be perceived; but when a Leyden jar exists in a circuit, that circuit has at once a natural frequency of vibration which may be syntonised with that of the emitting circuit, and in that case the intensity of the reverberating induced E.M.F. may rise as high as several thousand volts, and cause a spark over a very perceptible air-gap. Now for telegraphic purposes I replace the Leyden jar by a condenser of considerable capacity, and the circuit of the jar becomes a large horizontal coil of wire—it may be of one turn or it may be of more; and the frequency of vibration, instead of being the million or so per second appropriate to Leyden jars, becomes the thousand or even hundred per second appropriate to sound. Hence, instead of using a spark-gap to detect the disturbance, I use either a coherer or else a telephone as a shunt to the receiving condenser. Further, although the momentary oscillation of a spark constitutes a possible sender, I generally employ some form of alternating or intermitting machine of considerable power as the sending appliance, and carve its fluctuating current into long and short spells, as everyone else working at the subject has done. In the original paper a detailed quotation concerning Mr. Stevenson's experiment was here made, under the belief that signalling

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to a lighthouse at the Shetlands had been tried; but this was a mistake. The experiment was only a preliminary one near Edinburgh, and does not appear to have satisfied the Post Office officials who helped to conduct it.

I have at my house a cable a quarter of mile long altogether, enclosing an elongated rectangle, say, 150 × 30 square yards, and with that I can hear all that goes on in the neighbouring telephone wires, and can even answer back with a suitable microphonic transmitter; but, there being, I suppose, no phonopore in the neighbourhood, I hear no stray musical note; the only musical note I hear is the one belonging to the desired signals when they are being sent to me from an equal length of cable round an equal but squarer contour at the college about two miles away, or 2·5 km. in a direct line. I may say that, although the Leyden jar or condenser constitutes a leading feature of my system, I have occasionally, as an experiment, dispensed with it, and tried what could be done with the area-enclosing circuits alone. But under those conditions, with the power I had at my disposal, I was not usually able to hear anything. I was using a small low-frequency dynamo of the Pyke and Harris pattern, and at the sending end had a current of 10 or 12 amperes going round the circuit, sometimes as much as 25 amperes. Under these circumstances, on the ordinary National Telephone Company's telephones, the sound could be heard many miles away: away over in Cheshire, towards the Dee, the signals could be clearly heard, while close to the college the subscribers, unfortunately, became rampant; but through empty space the signals only became audible at a distance of two miles when a condenser was used and the circuit properly attuned. I am speaking now of the early trials when no suitable receiving telephone was employed, but only the first to hand. The cable, bought for the purpose of the trial, was described as anti-inductive telephone cable (not exactly the variety required), and it was very badly insulated, having been bought as little more than old materials; but still it might, perhaps, have been expected to do better. Directly the circuits were syntonised, however, there was no difficulty in hearing the note and the signals. I should say that I did not work with the fundamental frequency of the dynamo—128 per second, or thereabouts—but with the third harmonic, which is fairly strong in these Pyke and Harris alternators, of frequency 384. Such a note is pleasanter to listen to than a deep bass, the ear is far more sensitive to it; and, moreover, to attune the circuit to the lower frequency would have entailed a prodigious capacity. As it was I used 28 microfarads, and had to insert the thick wire of a Hedgehog transformer in the circuit, too, in order to get the induced circuit frequency as low as 384 with the quarter-mile length of cable once round. I generally used a couple of Ader telephones in series, each of about 70 ohms resistance, and connected them thus as a shunt to the receiving condenser. The resistance of the receiving cable itself was only 0·07 ohm (it consisted of 100 No. 18 wires all in parallel), so that if the telephone had been in series with it a very low-resistance winding would have to be employed, and in the early trials I did not happen to have such a telephone handy. I did, however, use a Western Electric loud-speaking telephone of two ohms resistance occasionally. A transformer, of course, was sometimes used, but it wastes power. Besides, the low resistance of a transformer winding is apt to be rather illusory when its higher resistance secondary is closed. At the sending end, also, condensers were employed, in series with dynamo and coil, in order to strengthen by resonance the third harmonic at the expense of the fundamental. The cable there was about 400 yards of well-insulated telephone cable, consisting virtually of 20 strands of separately insulated No. 16 wire, slung on poles round a squarish contour; but, unfortunately, it was again sheathed in lead so as to be nominally "anti-inductive." I found it best usually to join these 20 wires in five series of four strands each; and the current in each strand being then, say, six amperes, I call the whole current in the cable 24 amperes. The receiving cable I could also at first employ in separate strands, for its 100 wires were supposed to be insulated with thin indiarubber. The first time I heard the note I had 19 of these strands in series without a condenser, constituting a coil of 19 turns, connected to an Ader telephone. Since then, however, the insulation has so much broken down that I am constrained to use all the wires in parallel, which for many purposes is not so convenient.

Advantage of Syntony.

Now proceed to consider more particularly the elementary theory of magnetic induction telegraphy between two large distant horizontal coils—first without, then with condensers; taking the case, however, of an alternating current, and not the simple make-and-break battery arrangement employed by Mr. Stevenson, which obeys somewhat different laws. The first proposition I wish to maintain is that no unaided simple induction process can work satisfactorily over really big distances unless an altogether prohibitive amount of wire or an extravagant amount of power is employed. This proposition I prove by considering the strength of current induced in the distant circuit. Let a and b be the radi of the two coils, considered circular, n and m their turns of wire, and r their distance apart from centre to centre, this last being considerable; then the mutual induction coefficient—*i.e.*, the total lines of force passing through one coil due to unit current in the other—is

$$M = \frac{n\pi a^2 m\pi b^2}{r^3}.$$

The resistance is

$$\frac{2\,n\,\pi\,a}{\pi\,c^2}\,\rho \text{ for one, and } \frac{2\,m\,b}{d^2}\,\rho \text{ for the other.}$$

The self-induction is

$$4\,\pi\,\mu\,n^2\,a\left(\log\frac{8\,a}{c} - 2\right);$$

or, for present approximation—accurate if one coil is like the other magnified—*i.e.*, if they are really "similar coils"—the self-inductions are

$$k\,n^2\,a \text{ and } k\,m^2\,b.$$

Now, if E is the electromotive amplitude maintained in the primary, current amplitude induced in the secondary is

$$x = \frac{p\,M\,E}{J_1\,J_2},$$

when J_1 and J_2 are the impedances. For rapid alternations and good stout wire the value of J is not much bigger than $p\,L$; hence the most favourable case for the mere pair of circuits without condensers gives

$$\frac{x}{E} = \frac{M}{p\,L_1\,L_2} = \frac{n\,m\,\pi^2\,a^2\,b^2}{p\,n^2\,m^2\,k^2\,a\,b\,r^3},$$

which is, therefore, the "virtual conductance" of the whole system.

The first and most important thing we observe here is that p occurs in the denominator, so that high frequency is actually disadvantageous—other things being equal, which they usually are not, because high tones are best to listen to. The next thing to notice is that number of turns of wire occurs in the denominator, so that a single contour is much better than a coil of many turns; except in so far as many turns help to emphasise self-induction at the expense of resistance, and so to bring about the above "most favourable" conditions where resistance can be neglected. Lastly, we observe that the linear dimensions of each coil occurs only once in the numerator, and that their product is, therefore, incompetent to cancel the cube of the distance in the denominator, when both wire and distance are magnified in the same proportion, and when both are big. Observe, we are not here taking the case of a *given current* in the primary, but the more practical case of a given E.M.F. Moreover, we see that extra thickness of wire gives no advantage. If the wire is thin, the induced current will be less than the above; but no increase of thickness can make it greater than the value of x now calculated—viz.,

$$x = \frac{\pi^2\,a\,b\,E}{k^2\,p\,m\,n\,r^3}.$$

Hence I say that no simple induction system can work over really big distances unless an altogether prohibitive

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amount of wire or an extravagant amount of power is employed. If for a certain distance a total length of wire is just sufficient, it is best disposed in equal contours of one turn each; and the ratio between the induced secondary current and the applied primary E.M.F., without allowing anything for the impedance of the receiving telephone, is then

$$\frac{l^2}{16\,k^2\,p\,r^3} \quad \ldots\ldots \quad (1)$$

To signal double the distance $2\sqrt{2}$ times the length of wire is necessary; and to signal 10 times the distance the necessary length of wire is 32-fold, its thickness being increased at the same time so as too keep resistance down.

Introduction of Condensers.—But now, directly condensers are introduced both into sending and receiving circuits, and are adjusted until each circuit is attuned to the applied frequency, the conditions are greatly altered. When the correct note is reached all self-induction is abolished, and the impedance becomes simple resistance. Hence in this case the induced current is

$$y = \frac{p\,M\,E}{R_1\,R_2}, \text{ or } \frac{y}{E} = \frac{p\,a\,b\,\pi^2\,c^2\,d^2}{4\,\rho^2\,r^3}.$$

The most important thing to notice here is that p occurs in the numerator, so that high frequency is specially advantageous. The number of turns is immaterial, instead of being objectionable, as in the former case, and this fact is often convenient for tuning. And a great gain results from increasing the thickness of the wire, whenever a big distance is to be attempted.

If the whole bulk of wire employed is V, and if it be distributed equally between the two stations in a single turn at each, the ratio between the secondary induced current and the applied primary E.M.F., again without allowing for the resistance of the receiving telephone (its "reactance" has been already neutralised if it is connected in series), is in this case

$$\frac{p\,V^2}{64\,\rho^2\,r^3} \quad \ldots\ldots \quad (2)$$

Comparing this with (1), the chief difference consists in the position of p; but this is a tremendous difference—representing something like a million-fold factor.

To take a numerical example in illustration of the two cases: Let the applied E.M.F. be 100 volts, the frequency 400 per second, the total length of wire, say, 2 km., and its thickness 2 cm. (about five tons of copper altogether)—then

$k = 125$ about, $p = 2{,}500$, and $\rho = 1{,}600$ sq. cm. per second. So at a distance of 100 km. the maximum received current possible is, by simple conduction without condensers,

$$\frac{4 \times 10^{10} \times 10^{10}}{16 \times (125)^2 \times 2{,}500 \times 10^{21}} \text{ C.G.S. units,}$$

or 0·0064 microampere; which is quite insufficient to affect a telephone. Whereas, with proper condensers, the current might be

$$\frac{2{,}500 \times (6 \times 10^5)^2 \times 10^{10}}{64 \times (1{,}600)^2 \times 10^{21}} \text{ C.G.S.,}$$

or 0·5 milliampere, which is quite a strong telephonic current.

DISCUSSION.

After some very interesting experiments by Prof. Lodge, Mr. W. H. PREECE said he was bound to confess that he should have liked to have deferred his remarks until they had received the paper by Mr. Evershed, but he could not resist the opportunity given him to thank Prof. Lodge for bringing this subject before them. He had lectured extensively on this subject, but he was that evening in the novel position of being on the other side of the table. It was just 16 years since he first introduced the subject before the British Association. Prof. Lodge had shown them this mode of magnetic signalling in a very attractive manner. He felt that the time had arrived when something should be done on a practical scale. He was, in fact, to have an interview with the professor the next morning on the subject. There was now only one practical system at present in daily work, and that was at Lavernock. During many months they had not had one stoppage, and the only difficulty they had had to surmount was the coil. He would confine his remarks to this until the reading of Mr. Evershed's paper.

The discussion was then adjourned on account of the lateness of the hour, and will be continued at a special meeting on Dec. 22.

At the ordinary meeting last night the paper read was as follows:

Electric Intercommunication in Railway Trains.

BY W. E. LANGDON, VICE-PRESIDENT.

The first practical means of communication between the passengers, guards, and the driver of a railway train was that established by Mr. W. H. Preece, C.B., F.R.S., past-president, on the London and South-Western Railway in 1864. The agency employed was electricity. The need for some means of communication between the passengers and the officials in charge of railway trains had been long felt. The Railway Commissioners, as well as the Board of Trade, urged its desirability. On two occasions it formed the subject of enquiry by committees of the House of Commons; and prior to 1866 no less than three committees composed of the general managers of the various railways had specially considered the subject. In 1865 the Board of Trade instructed Captain (now Sir Henry) Tyler, then one of the inspecting officers for the Railway Department of the Board of Trade, to examine and report upon the question. His report, which was issued the same year, was in favour of the establishment of "some" means of communication. In 1867 the Board again drew attention to the subject; and in 1868 an Act of Parliament made it incumbent on all railways to provide a means of communication between the passengers and the guards of every train travelling over 20 miles without stopping. The railway companies themselves had not been indifferent to the need, for, as Mr. Preece, in a paper* read by him before the Institution of Civil Engineers in 1866, relates, the London and North-Western Railway had spent a considerable sum of money in an endeavour to establish an electrical means of communication, while experiments had also been conducted with a like object on the London and South-Western Railway. It was not, however, until Mr. Preece produced his system in 1864 that a satisfactory basis for effecting the long-felt need was laid down. This was rapidly followed, on the South-Eastern Railway, by Mr. C. V. Walker, one of our first presidents, who produced that known under his name in 1866. Varley, about the same time, established an electrical form of communication on one or more London and North-Western trains. The London and South-Western fitted up several trains with Preece's system, and trial trains were also fitted with the same system on the Midland and London and North-Western. An improved mechanical "cord" system was produced about the year 1868. The "cord" system is that with which every railway traveller is acquainted, and which, passing along the eaves of the vehicles, is available from the outside and from one side only of the train. Eventually, in 1868, the railway companies elected to employ the mechanical rather than the electrical mode of communication; and to this the Board of Trade extended conditional approval. The South-Eastern Company declined to fall in with this decision. Recognising the advantages which an electrical means possessed over that of the mechanical cord, they desired to retain it; and in this they were subsequently† followed by the London, Brighton, and South Coast Railway. Each of these companies have now their entire passenger stock fitted with an electrical communication. The London and South-Western—a company having more trains electrically fitted than any other company at the time when the "cord" system was

* Preece, "On the Best Means of Communicating between the Passengers, Guards, and Drivers of Trains in Motion," Institution Civil Engineers, 1866-67.

† The electrical passenger and guard communication on the Brighton line was introduced in 1874, and from that date gradually superseded the mechanical cord.

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adopted—presumably found the difficulty of keeping together a partially fitted stock too great, and in course of time abandoned the effort. In 1872, Captain Tyler reported the working of the "cord" system as unsatisfactory, and in the course of his remarks observed, "an electrical apparatus appears, on the whole, to offer the best chance of success." The "cord" communication has, however, been retained in use on the majority of railways, the only exceptions being the two lines previously referred to. The Hull and Barnsley (the stock of which was electrically fitted at the opening of the line in 1885), together with a portion of the stock of the Chatham and Dover Company, the Furness, Great Central, and Cambrian lines employ to a certain extent a partial application of the vacuum brake.

In considering the action of the companies so far, we have to bear in mind the conditions associated with railway travelling at the date of the inauguration of the "cord" system. That an electrical system afforded the railway passenger a more ready means of access there could be no doubt. That the "cord" system could prove of little service in case of outrage is equally clear. But was the prevention of outrage the object of the communication? It was possibly one reason, but no doubt primarily that which was in the minds of people was the possibility of some derangement of the train. Another point for consideration is the fact that the magnitude of most of our main-line trains has greatly increased. Such a means of communication might possibly serve the purpose for which it was established with a moderate number of vehicles, while its utility for a much larger number would have to be largely discounted. However this may be, the somewhat recent outrage on the London and South-Western Railway has not only made it clear that if this means of communication is to provide, as far as the railway companies can, against outrage, the means for operating it must be within easy reach of the passenger, but it has still further demonstrated that outrage of the direst character does not need the time occupied by a train to travel 20 miles in which to accomplish it. The whole question has now been brought to a climax by the report of the Departmental Committee appointed by the Board of Trade in 1897 to consider and report upon the subject. As is now well known, the result of the deliberations of this committee was the condemnation of the mechanical cord and the recommendation of an electrical system, accompanied by certain suggestions in relation thereto.

The adoption of an electrical system involves some very important considerations. The question has now to be viewed from a vastly different standpoint to that from which it has been considered hitherto. It is to be applicable to the entire passenger stock. It is desirable it should appeal against outrage as well as meet other demands. The interchange of railway stock between the various railway systems is now a matter of everyday occurrence, consequently the system to be adopted should have a common basis, and the mode of connecting the various vehicles should be absolutely uniform. How is this to be accomplished? The railway companies have, practically, at this moment an open field before them. The total number of passenger traffic vehicles belonging to the entire railway service of Great Britian and Ireland amounts, exclusive of 18,099 locomotives, to 55,868—in all 73,967. The total stock of the three companies which have their coaches already electrically fitted comprises 5,430 vehicles and 977 locomotives; so that, if an entirely new system had to be adopted, the number of vehicles which would require modification would, in comparison to the whole, not prove very considerable; and this especially so should the modification of the stock already fitted prove of a very simple character. I propose to consider the question under the following heads: (1) the electrical system; (2) mode of connecting vehicles; (3) the means for claiming the attention of the officials in charge of the train.

1. The Electrical System.

Fig. 1 illustrates diagrammatically the system introduced by Preece in 1864. I reproduce this because it forms the basis on which this form of communication has, in almost all cases, been framed; and it, moreover, constitutes the only basis upon which a practical form of passenger and guard communication can be established. A is an insulated wire proceeding through the train; B represents the rails upon which the train is travelling; *c* is the engine; *d*, *d'*, guards' vans; and *e*, *e'*, *e''*, coaches. Each of the guards' vans is provided with a bell, battery, and a bell key. The passenger vehicles are provided, in each compartment, with a switch, or means of joining the two conductors, A and B. The batteries are, as will be observed, arranged in parallel. The

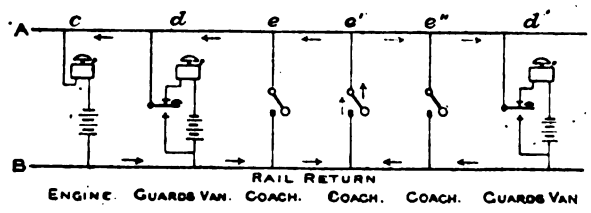

Fig. 1.

condition is practically one of balanced currents. All is in tension, but until the balance is disturbed no action sufficient to operate the bells can take place. If the switch at *e'* is closed, we at once form this outlet, and each battery finds its circuit, as shown by the arrows. Every bell in the train is thereon set ringing, and continues to do so as long as the connection at *e'*, or, of course, any other like connection, remains good. The same occurs when either of the guards desires to signal to the other, or to the driver. By pressing the bell key the two conductors, A B, are joined in precisely the same manner as when connected at *e'*, but the guard who makes the signal, in doing so, removes his own bell from the circuit.

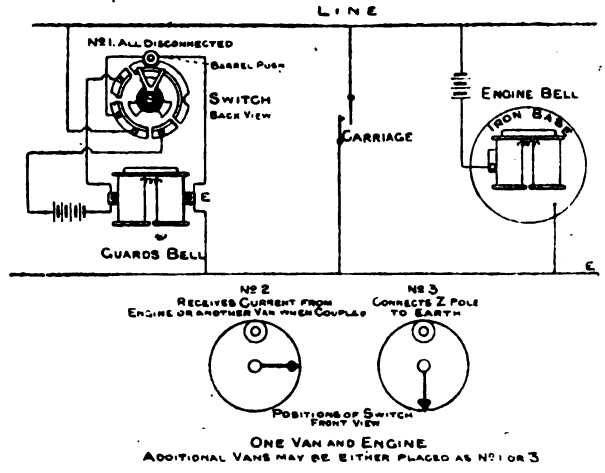

Fig. 2.

Fig. 2 illustrates the arrangement inaugurated by Walker. Considerable modifications have been introduced by Mr. Leonard, Mr. C. V. Walker's successor, but some complication still attaches to it. One insulated wire is employed; the rails, as a rule, forming the "return," although, latterly, Mr. Leonard is supplementing the rail return by an open wire jointed to the rail connections. The batteries of the two end vehicles only are in use. They are in parallel; but a three-way switch has to be provided in each van, and the guard has to arrange the switch of his van according to the position the van occupies

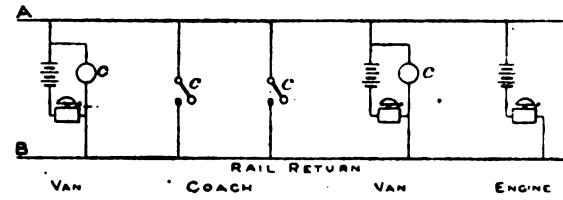

Fig. 3.

in the train. When intermediate between the engine and another guard's van, it is so placed that his bell may ring but that his battery may be out of circuit.

Fig. 3 represents the Brighton Company's system. It is essentially Preece's. A is the insulated wire, B the rail return conductor, and *c*, *c*, *c*, *c*, are short-circuiting or con-

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necting switches. Mr. Houghton, the company's electrical engineer, informs me that he also is now forming, by means of an open wire carried under the frame of the vehicle, a metallic return—not independent, but supplementary to the earth or rail connections. It is found that the rail "return" is not reliable, especially in very dry weather—a result which might be anticipated.

The London, Chatham, and Dover have somewhat recently applied an electrical form of communication to certain of their trains. The system is termed Varley's, but it has, at the suggestion of the company's electrical engineer, Mr. Burnham, undergone some modification. The principle now being pursued is shown in Fig. 4. It is, in practice, very similar to that in use on the South-Eastern. The batteries of the two end vans are in circuit. The batteries of intermediate vans are cut out. The system is a two-wire system, both wires being insulated. It will be observed by the diagram that the guards' vans are provided with three connections, two of which are applicable to

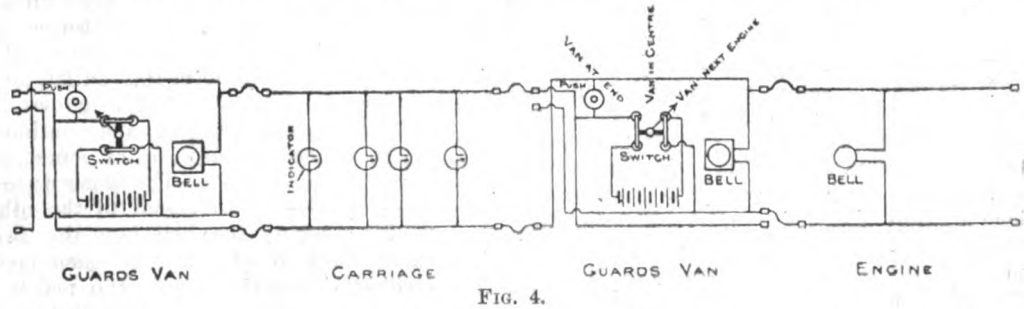

FIG. 4.

the connection between the van and the locomotive, and that the bell in the van adjoining the engine is in parallel with that on the locomotive. This dispenses with a battery on the engine, but, in order to ensure equal action on the part of the two bells, it is necessary that the *resistance* of the conductors and instruments should be fairly equal. The system employed on the Hull and Barnsley is also a two-wire system, and the circuit arrangements call for the provision of adjusting switches in the guards' vans, in like manner to those employed on the South-Eastern and Chatham and Dover.

Considerable attention has been called to a train fitted up by the Great Eastern. The rails are not in this system made use of. One insulated wire passes through the train. The iron tube serving the brake is taken advantage of to form a portion of the return circuit, which is, consequently, uninsulated. The electrical arrangement is shown in Fig. 5.

wire is so small that it is questionable if it would amount to that incurred in making the connections to the wheels or other portions of the vehicle in order to ensure a satisfactory earth return where this course is pursued. Indeed, it is difficult to imagine why a one-wire system should ever have been preferred, unless it is to be accounted for—as is probably the case—by the fact that a two-wire connection may have presented some difficulty in the matter of coupling up the vehicles. With this branch of the subject, however, we will deal later on. In October of last year the author, with a view to obtain data on the action of battery cells joined in groups, in parallel, caused three sets of bichromate cells, composed of two-quart jars, and three sets of ordinary Leclanché, of No. 1 size, to be connected with bells as shown in Fig. 1, the connecting wires being insulated. The working capacity of the cells was taken each day from Oct. 18 to Nov. 20. There was apparently no depreciation. The positive element was free from crystals, and the electrolyte did not show depreciation. Consumption, of course, there was, but it was exceedingly small. This tallies with the experience of Mr. Houghton, who tells me that the consumption of battery power on the Brighton Company's trains—which, it will be observed, are worked under this system—is very little. The adoption of the parallel battery arrangement, uncostly in battery consumption, possesses also the great merit that it enables the vehicles to be turned about and connected up indiscriminately, independent of the position they may occupy in the train. Switches are not needed, and, manifestly, if this is so, it is a convenience as well as an economy to dispense with them. Their object, except, perhaps, with a view to economising battery power, is not apparent.

2. Mode of Connecting Vehicles.

It has been suggested that possibly the question o coupling up the vehicles has proved influential in th

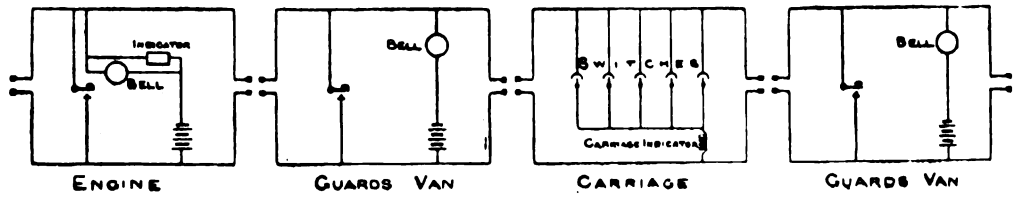

FIG. 5.

The batteries are in parallel. The system is that of Preece, with the exception that an open "return," independent of the earth or rails, is provided. A train has also been fitted by the Midland. The electrical system is that represented in Fig. 1, with the exception that two insulated wires are employed—neither rails nor brake pipe are touched. All portions of the electrical system are protected from moisture, so that there may be no leakage.

We have now before us the various electrical "systems" calling for criticism, and the first question which will present itself for consideration is whether a one or a two insulated wire system is to be preferred. We have seen, from the experience of the London, Brighton, and South Coast Railway, that an earth or rail return is not satisfactory. It will be also be clear that with an open—*i.e.*, an uninsulated—return any leakage which may arise in the insulated wire, or its connections, will result in short-circuiting the batteries to a less or greater extent according to the amount of leakage, and it will be equally obvious that with two insulated wires any defect in one would not produce such a result. The cost of the second adoption of the single insulated wire and earth return. With an earth return it is necessary to make provision for joining one wire only through from carriage to carriage, the opposite pole being connected to the wheels and frame of the carriage so as to afford metallic connection with the rails. This branch of the question appears to have proved a somewhat serious stumbling-block. In the Board of Trade report we find it laid down as one of the conditions to be achieved that the electrical coupling should be combined with one of the couplings already in use—the brake, heating service, the screw coupling, or the side chains. All, except the first named, we may at once dismiss as unsuitable, or too difficult in application to merit consideration. Fig. 6 is an illustration of the coupling employed by the South-Eastern. It consists merely of a piece of wire arrranged as a spiral, with a loop at either end, which passes over a hook on the end of the vehicle, and which forms the termination of the line wire. Fig. 7 represents the coupling employed by the Brighton Company. It is formed of a spiral of wire enclosed in an indiarubber tube. The wire terminates at each end in a galvanised iron loop, which at

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the end which is attached to the vehicle passes over a hook forming the termination of the line wire; but the loop

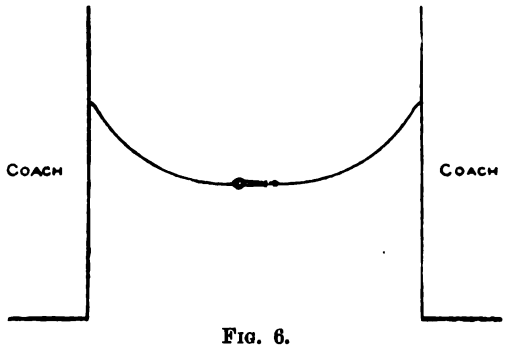

FIG. 6.

at the end which has to be coupled up is divided at *a*, so as to admit the loop of the corresponding part,

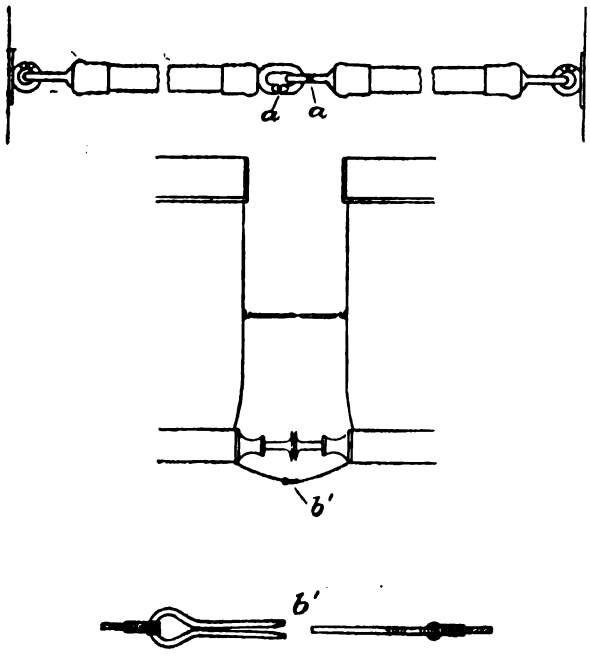

FIG. 7.

applicable to the adjoining carriage, passing through it. Each of these companies is, as previously indicated, gradually

FIG. 8.

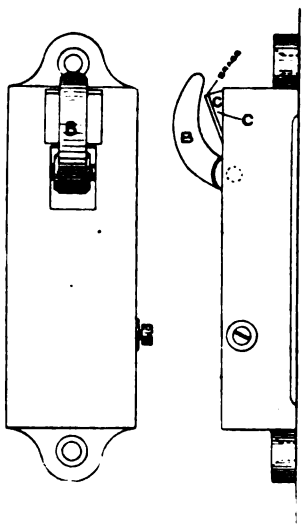

FIG. 8A.

introducing an uninsulated return wire, the rails in dry weather not proving satisfactory. This return wire is coupled through by a bare stranded copper wire terminated with a split spring connection, *b'*, as shown in the illustration. Fig. 8 is the coupling used by the Chatham and Dover Company, and 8A is the coupling box. The loop, A, in coupling up, is passed over the hook, B, which, under the influence of a strong spring, holds it in good contact with the projection C.

Following the views of the Board of Trade, Mr. Hollins, the electrical engineer to the Great Eastern Railway, has succeeded in combining the electrical communication required for this purpose with the brake coupling. The electrical

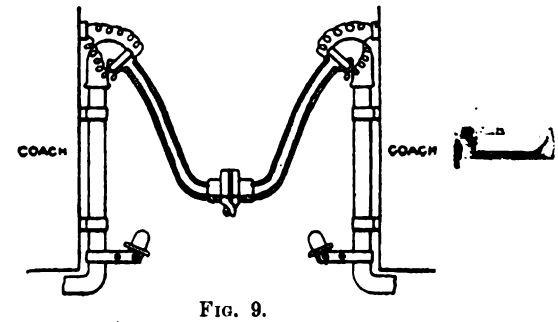

FIG. 9.

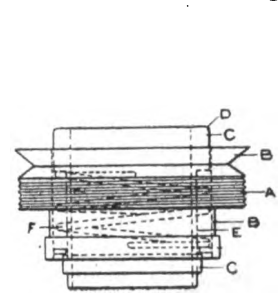

FIG. 9A.

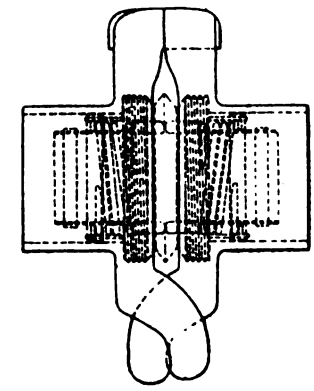

FIG. 9B.

parts of the coupling are countersunk in the metal portion of the brake coupling, which is cut away for their reception. The wires are arranged inside the brake tube, being connected, at the coupling end, to the electrical connections, and carried through the tubing at the end which connects with the vehicle, as shown in the illustration. Mr. Hollins has applied his electrical contact to both the Westinghouse and vacuum brake. The illustrations Figs. 9, 9A, and 9B refer to the latter, which is perhaps the more simple of the two, although I believe it is Mr. Hollins's opinion that the Westinghouse forms the better contact. Fig. 9A shows the contact-making arrangement, which is screwed into the metal portion of the coupling, as seen in Fig. 9B. A is a ring of insulating material, to which metal flange and tube, B B, is secured. This tube serves to hold within it the contact-

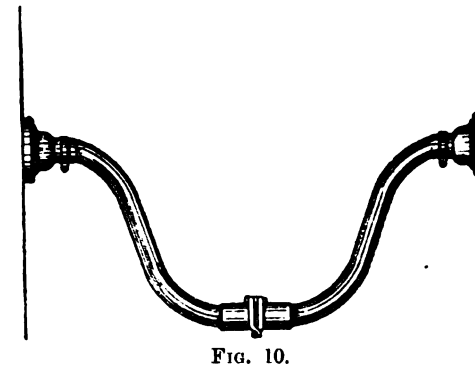

FIG. 10.

making piece, C, which is formed of a metal tube, reduced, as shown by the dotted lines at E, in order to receive a spiral spring, F, the duty of which is to press forward C so as to ensure good contact with the corresponding part of the coupling around the edge of the tube, D, which is milled to assist in making good contact. G is a metal collar which limits the action of the spiral spring in that direction.

In 1885 the author was granted letters patent for combining an electrical with the vacuum brake coupling, but in this instance the electrical portion was superimposed

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upon the brake tube and coupling. It was not, however, allowed to remain long in use, serious objection being raised by that department of the service responsible for the satisfactory operation of the brake. It is believed these are the only practical attempts made with a view to effecting this combination. The coupling adopted by the author

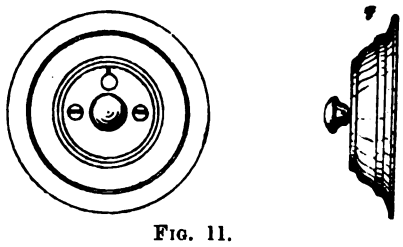

FIG. 11.

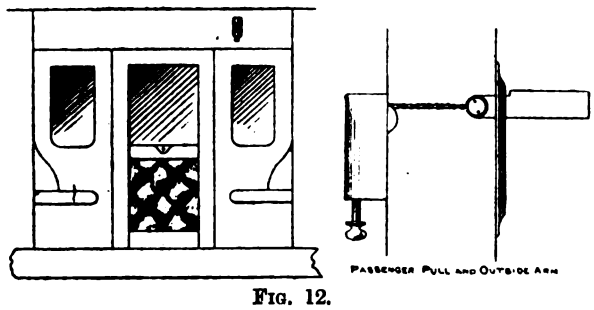

FIG. 12.

for the Midland train is shown in Fig. 10. The electrical portion consists of two plates of metal, insulated the one from the other, to which the two wires forming the communication are attached. These plates are so cut that that belonging to one part of the coupling shall dovetail into that belonging to the other portion. The two plates are so fixed within an iron case, formed after the fashion of, but smaller than the vacuum brake coupling, that that applicable to the positive wire of the one coach shall engage with that applicable to the similar pole of the connecting coach. It is thus impossible to cross the wires, while the one coupling serves for the two wires. The vacuum brake form of coupling has been selected as the protecting and guiding cover for the reason that the mode of coupling it up being so well known no difficulty can possibly attend its application to the purpose of an electrical coupling. The wires are carried from the contact plates to the end of the vehicle in tubing similar in character but smaller than the brake tubing. The wires of each vehicle terminate on an insulated plate fixed to each end of the carriage, so that any changes needed may be readily effected. The wires throughout are fully protected from moisture.

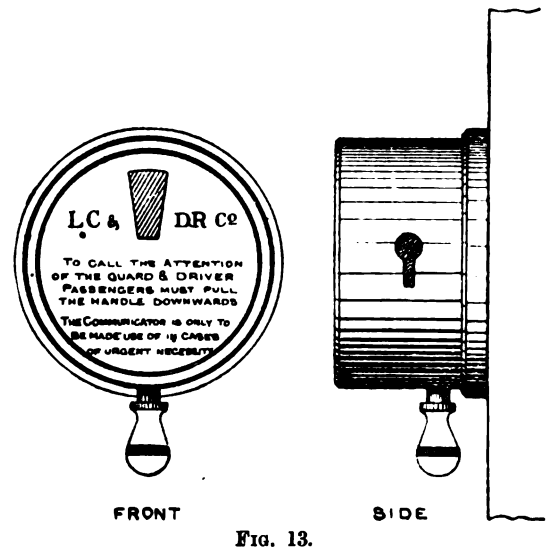

FIG. 13.

Samples of all these couplings will, it is hoped, be placed upon the table.

3. THE MEANS FOR CLAIMING THE ATTENTION OF THE OFFICIALS IN CHARGE OF THE TRAIN.

In the Brighton Company's carriages this is secured by the operation of a knob (Fig. 11). This knob forms the handle of a commutator, and on being pulled out it, by means of the commutator, connects the line and earth wires. It is fixed in the centre of the partition which divides one compartment from another. Each compartment

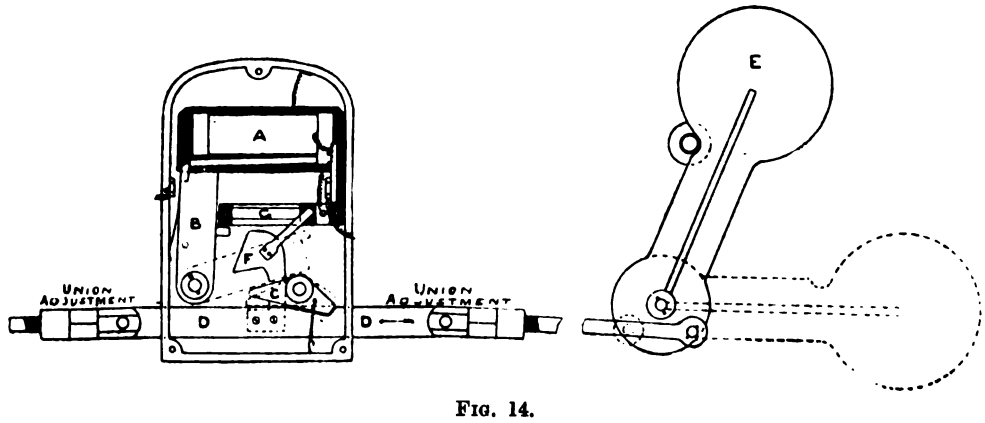

FIG. 14.

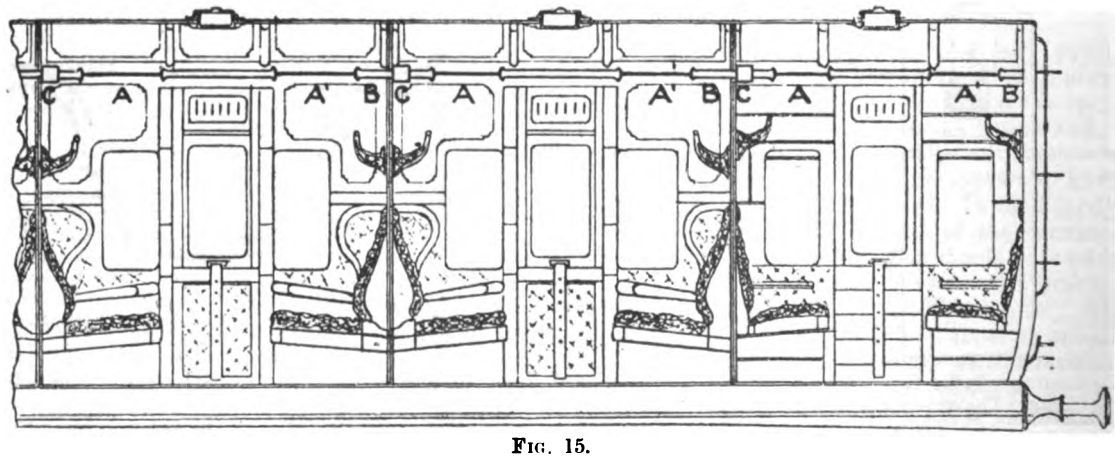

FIG. 15.

is thus provided with a means of raising an alarm from one position. On the knob being pulled out, to a certain extent it becomes locked, and requires the presence of the guard to release it. The bells continue to ring so

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long as the commutator remains extended. The Brighton Company employ no outward indicator to identify the vehicle from which the alarm has been raised. It is the duty of the guard to examine the commutators throughout the train until he finds that which has been pulled. It is not understood that any difficulty has attended the absence of such an indicator. In the South-Eastern Company's stock considerable improvements in the mode of operating the alarm commutator have been effected by Mr. Leonard. The commutator is placed over one of the quarter windows, and is provided with a knob as in the Brighton Company's trains; but this knob is arranged to pull *downwards* (see Fig. 12), and is thus more readily operated than if it had to be pulled outwards. Each compartment has but one point from which the alarm may be raised. Each first-class compartment, and nearly all second-class compartments, are provided with an outside indicator, but to the third-class one indicator only is allotted to each carriage. Fig. 13 illustrates the design of the commutator employed by the Chatham and Dover. Each compartment is provided with one commutator fixed in the centre of the division. There is no indicator to show the source of alarm. The commutator in each instance is of the most simple character—merely connecting the line and earth wires or the two line wires—and, where used, discharging mechanically the indicator affixed to the outside of the vehicle or compartment as may be arranged. The commutator, once operated, remains locked until reset by the guard. The coaches which have been fitted by the Great Eastern are, in like manner, provided with a commutator fixed in the centre of the division between the compartments. The user turns a switch handle, capable of being moved in either direction—to the right or to the left—which closes the circuit. Each coach is provided with an outside indicator on either side of the vehicle for the purpose of indicating whence the alarm is raised. On the circuit being closed by any one compartment, the current passes through the indicators and discharges them. The principle upon which this indicator is constructed is that of the Sykes signal reverser. The current energises an electromagnet, A (Fig. 14). On the armature being lifted, a heavy bar, B, is discharged, and, falling upon C, forces it out of the notch, is which it normally rests, in the bar, D. E is the indicator, and it is heavily weighted, so that, on C being lifted out of D, it pushes the rod before it in the direction of the arrow. As D is moved forward it carries with it the *replacer*, F, which is attached to it, placing the spring which projects from it in contact with G, thereby short-circuiting the electromagnet. F at the same time forces back B into its normal position, where it is again held by the armature of A. On the guard lifting E into its upright position, the rod, D, is drawn forward until the detent or locking piece, C, falls into its slot, when the entire arrangement is reset and ready to be again discharged. The readjusting portion, F, has, along with D, been moved forward, and the short-circuiting spring attached thereto again rests upon an insulated part.

(To be continued.)

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Members.—H. M. Hobart, 83, Cannon-street, E.C.; E. T. R. Murray, Public Offices, Dyne-road, Kilburn; M. Parker, Meadow Bank, Burstall-road, Rochester; G. B. Parlett, care of Messrs. A. Dickinson and Company, 120, Colmore-row, Birmingham; J. G. Statter, 68, Victoria-street, Westminster, S.W.; P. Still, 19, Cadogan-gardens, S.W.

Associates.—T. G. Aldrich, Clive Lodge, Ealing; J. A. Anson, 159, Denmark-hill, S.E.; J. J. C. Bacon, 20, Lansdowne-road, Dalston; D. E. Batty, Argyle, Tisbury-road, Hove; A. D. Bennett, The Croft, Cox-street, Coventry; W. J. Benton, Commercial-buildings, Park-row, Leeds; J. A. Blackwood, 110, Fenchurch-street, E.C.; F. J. Borland, Sheepscar Grove Works, Leeds; F. L. Bowen, 3, Tokenhouse-buildings, King's Arms-yard, E.C.; G. T. Bradley, Town Hall, Birkenhead; G. V. Braulik, 217 and 218, Upper Thames-street, E.C.; D. R. Broadbent, 4, Montague-street, Russell-square, W.C.; W. Bullard, Eastern Extension Telegraph Company, Shanghai; W. B. Burnie, South-Western Polytechnic, Manresa-road, Chelsea, S.W.; A. J. E. Catto, 66, Schubert-road, Putney, S.W.; A. B. Child, 4, Old Oak-road, Uxbridge-road, W.; J. Clarke, 10, Sardinia-street, Lincoln's-inn-fields, W.C.; A. F. Cooke, 52, Beversbrook-road, Tufnell Park, London, N.; A. C. Cormack, Strathleven-place, Dumbarton, N.B.; C. Coton, 144, Lakedale-road, Plumstead, S.E.; A. Curtis, Holmwood, 50, West-hill, Highgate; A. V. M. D'Arcy, Medina Lodge, Ravenscourt-square, Ravenscourt Park, W.; A. H Darker, Highleigh, 49, Tressillian-road, St. John's, S.E.; F. E. De Guerrier, 177, Camden-road, N.W.; M. C. Dent, 36, Great George-street, Westminster; A. W. Dixon, Imperial-buildings, Newcastle-on-Tyne; W. E. D. Duncan, care of Messrs. Laing, Wharton, and Down, 82, New Bond-street, E.C.; O. Francis Francis, Kilmorey-park, Chester; W. R. N. Grimley, 3, Marlboro'-road, Ealing, W.; W. H. Hall, Rockville, St. Edmonds-road, Bootle; R. W. Hammond, 5, Linden-gardens, Highgate, N.; L. C. Harvey, Addiscombe, Prestwich, Manchester; T. J. S. Hewson, Engineer's Office, Great Northern Railway, King's Cross, N.; R. W. Hughman, 18, Richmond-gardens, W.; T. Hunter, 40, Eccleston-gardens, Belgravia, S.W; A. Jaray, 7, Torrington-square, W.C.; T. B. Johnson, Engineering Department, Postal Telegraphs, Sunderland; H. Jones, 151, Wardour-street, W.; J. McBean, East Rand Proprietary Mines, Limited, Johannesburg, S.A.R.; C. F. McInnes, Victoria Villa, Crumpsall, Manchester; N. McLean, Electricity Station, Harrogate, Yorks; H. L. Mills, 20, Junction-road, Croydon; G. F. A. Norman, Corporation Electricity Department, Harrogate, Yorks; C. Oliver, 61, Wilson-street, Finsbury, E.C.; A. F. Page, 35, St. George's-square, S.W.; R. C. N. Palairet, Newton Electrical Works, Taunton; J. W. Parnell, Victoria Barracks, Melbourne, Victoria, Australia; S. R. Pedroza, East Indian Railway Telegraphs; W. M. D. Pell, 24, Graham-street, Eaton-terrace, S.W.; M. P. Plunkett, 54, Sydney-street, Chelsea, S.W.; W. J. Polyblank, jun., 4, Harley-street, Bow, E.; C. H. Powell, A.R.S.M., her Majesty's Patent Office, 25, Southampton-buildings, W.C.; D. P. Reid, Railway Department, Ipoh, Perak, Straits Settlements; W. Riley, Villa Rivara, Via Camilla, Sturla Ligure, Italy; C. J. F. Sevier, 1, Hollywood-road, South Kensington, S.W.; C. E. Skelton, 2A, Highfield-road, West Hampstead, N.W.; D. H. Slack, 35, Charleville-road, West Kensington, W.; Charles Arthur Slater, Cedar Villa, Newbold-road, Rugby; Archer Wellen Smith, National Telephone Company, Limited, Northampton; A. C. Soutter, 16, Prebend-gardens, Chiswick, W.; L. Sunderland, 39, Victoria-street, S.W.; F. Suter, 66, Berners-street, London, W.; G. E. Taylor, Beckbury Villa, Buxton-road, Thornton Heath; F. R. Thackrah, care of Messrs. Laurence, Scott, and Co., Gothic Works, Norwich; J. Todd, 30-42B, Hampstead-road, N.W.; D. B. Walker, 47, Ashburnham-grove, Greenwich, S.E.; G. Weston, 58, Fenchurch-street, E.C.; F. C. H. White, 10, Rathcoole-parade, Hornsey, N.; A. E. Wiggins, 21, Wharton-street, Lloyd-square, W.C.; N. G. Wigram, 12A, Savile-row, London, W.; A. J. Wilkins, 104, Carysfort-road, Clissold Park, N.; J. B. Willis, Heaton Works, Newcastle-on-Tyne; W. N. Withers, 35, Weymouth-street, Portland-place, W.; T. H. R. Wray, 41, Salisbury-road, Bexley, Kent.

Students.—R. D. T. Alexander, King's College, London; V. M. Allen, Central Technical College, Exhibition-road, S.W.; A. L. Andrews-Speed, 134, Queen's-gate, South Kensington, S.W.; W. H. Arundell, Hildesheim, College-avenue, Maidenhead; F. C. N. Bergh, 18, Pennard-road, West Kensington, W.; H. F. Blake, Central Technical College, Exhibition-road, S.W.; H. E. Britten, Holmwood, Knatchbull-road, S.E.; J. H. Brown, 19, Trevor-square, Knightsbridge, W.; J. F. Caine, 36, St. John's Wood-road, N.W.; J. C. Callander, 12, Hampton-road, Forest Gate, Essex; C. Calliphronas, Nedging Rectory, Bildeston, Suffolk; H. R. Carson, Accarfane, Hook-road, Surbiton; W. G. Carter, 42, High-street, Kensington, W.; E. H. B. Clark, Syon Park House, Brentford; P. D. Collins, 131, Churchill-road, Willesden Green, N.W.; A. R. Crane, Thringstone Rectory, Leicester; C. Crompton, Thriplands, Kensington Court, W.; H. J. Densham, Faraday House, Charing Cross-road, W.C.; F. M. Denton, Central Technical College, Exhibition-road, S.W.; E. Fawssett, Louth, Lincolnshire; R. Forrest, Hopcott, Minehead, Somerset; W. B. Giles, jun., The Grange, Leyton, Essex; R. C. Goldston, York Villa, Nottingham-road, Loughborough; P. Good, 108, Fentiman-road, Clapham, S.W.; C. W. Hill, Christ Church Rectory, Salford, Manchester; F. C. Hounsfield, 153, Finborough-road, S.W.; Henry John Humphreys, 13, Cremorne-road, Chelsea, S.W.; T. C. Hunt, Ware, Herts; P. Hunter-Brown, 91, Toothill-road, Loughborough; A. J. Hurst, Faraday House, Charing Cross-road, W.C.; F. E. L. Hurst, King's College, Strand, W.C.; A. P. Hutchinson, 5, Norfolk-place, Halifax; T. L. James, 48, Tregunter-road, South Kensington; H. L. E. Kennard, 57, St. Clement's-mansions, Lillie-road, Fulham, S.W.; W. Mackintosh, Faraday House, Charing Cross-road, W.C.; F. J. Masters, Royal Arsenal, Woolwich, S.E.; S. W. Melsom, 23, Bark-place, Bayswater, S.W.; R. M. Moberly, 59, Albert Bridge-road, S.W.; A. N. Moore, 93, Toothill-road, Loughborough; D. S. Munro, 58, Kelvingrove-street, Glasgow; A. C. Nash and E. R. Nash, Glenfall Lawn, Cheltenham; C. N. Nettley, 81, Macfarlane-road, Shepherd's Bush, W.; C. E, Newton, Westover, Mount Ephraim-road, Streatham, S.W.; F. H. Nicholson, 25, Cliveden-place, Eaton-square, S.W.; C. A. Phillips, Faraday House, Charing Cross-road, W.C.; A. N. Pitcairn, 93, Toothill-road, Loughborough; J. St. Vincent Pletts, 32, West-hill, Sydenham, S.E.; Arthur Milnes Pooley, 33, Queen Anne's-grove, Bedford Park, W.; William Roberts, North End House, FitzGeorge-avenue, West Kensington, W.; N. C. Sawers, 7, St. John's-park, Blackheath, S.E.; W. G. Shee, 55, West-hill, Wandsworth, S.W.; W. Spencer, Percy House, Twickenham Park, S.W.; A. L. Stephens, 28, Toothill-road, Loughborough; J. H. Stone, 3, Oak-grove, Cricklewood, N.W.; P. Sumner, 16, Gloucester-place, Portman-square, W.; H. E. Tatham, 93, Toothill-road, Loughborough; G. S. Taylor, Faraday House, Charing Cross-road, W.C.; H. J. Thomson, Central Technical College, Exhibition-road, S.W.; H. T. Tovey, King's College, Strand, W.C.; L. Vignoles, Streatley, Reading; C. E. Vines, Kempsford-gardens, S.W.; E V. Watson, 30, South-parade, Chelsea, S.W.; H. S. Watson, Park-road, Loughborough; F. V. Wimhurst, 36, Rendlesham-road, Clapton, N.; M. A. Wood, 23, Palliser-road, West Kensington, W.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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Vol. XXI. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

TRAMWAY FIASCO.

It is never satisfactory to count chickens before they are hatched, and even then due allowance must be made for casualties during infancy. Many people were doubtful as to the policy pursued by the London County Council in regard to tramways, but when the purchase became a fact most thinking men agreed to accept the inevitable and assist the working by all means at their command. It was evident, too, that the salary offered by the Council was intended to influence a particular man to offer his services as manager. So far all went well. The particular man—Mr. Young, of Glasgow—became a candidate, and was duly selected. Subsequently, however, difficulties seem to have arisen, and at the beginning of this week all the world interested was surprised to learn that Mr. Young declined to accept the office. The matter came before the Council at its meeting on Tuesday, when the fact was made clear that Mr. Young had declined the position, but the reasons for his action were not so clear. Various reasons have been given. The *Chronicle*—which should in anything concerning the Council be in the know—states that the decision arose because Mr. Young was not permitted to engage his second in command at a salary of eight hundred pounds a year. The discussion at the Council meeting put this particular matter in another way—namely, such engagement must be in accordance with the usual procedure of the Council. However we read the matter it seems to lead to one conclusion—the Council desired the services of a particular man and at the same time determined to hamper his work by not allowing him a free hand to engage or dismiss his assistants. Now, we are prepared to contend that the London County Council has not been successful in obtaining the services of men of the highest ability, and never will be successful. Any capable, honest man in a responsible position must be assumed to have a sufficient knowledge of human character and business capabilities to engage his subordinates. He knows what he requires in order to carry out his designs, and no body of men, however talented, can take his place. It is an acknowledged fact that the whole of the London County Council's work is a sink of mismanagement, because the mistaken ingenuity of its members is to "boss" the show themselves. Men have been elected on the Council from a political and not from a business standpoint, and these men, steeped to the lips in the sweet sound of their own utterances, are utterly incapable of organising anything, because they have not had the necessary training thereto. They are not managers of men, but talkers and dreamers. Some of them do not take the world as consisting of busy, bustling, money-making men, but maintain the doctrine of equality of mankind. They do not understand human nature and human passions. They dream of a millennium wherein everybody is to be good and nobody bad. Well, that time is not yet; hence to successfully conduct a business concern we must take things and men as they are, and not as we wish them to be. Thus, we contend that the man who

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is to have the responsibility of the success of a huge business undertaking thrust upon his shoulders should be allowed to engage and dismiss his subordinates, to give orders, and see them carried out in his own way without the slightest shadow of interference from council, committee, or individual. After appointing the responsible head, the sole work of the Council is to hold him responsible for success. If he is not successful, and the want of success is due to his unfettered action, their remedy is to dismiss him and appoint another man. More than that they ought not to do. Every successful concern in this world is due to the personality of one-man—that is, every successful concern is a one man concern, and it is impossible to point out an instance of success where the meddling and muddling interference of committees and councils have had free play. The proper course of the London County Council in regard to tramway management was to get the best man in the country and to give him a free hand. Probably tramway men will be agreed that they got hold of the best man, and that their failure to retain him was in not giving him a free hand.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DREHSTROM.

SIR,—I should feel greatly obliged if you would kindly answer me the following questions in the columns of your paper:

1. What is a good, easy book (not a big one) to explain in a simple, practical way what three-phase, etc., or polyphase currents are, how they are produced, and what their use? 2. Is the German "Drehstrom" the same as "Wechselstrom," or "alternating current," or is it something else? (I saw the word in some English paper some time ago; I forget which.)—Yours, etc., C. ROGGENKAMP.

Appingedam, Holland.

[If our correspondent only wants the rudiments of three-phase work, he would do well to get Mr. Alfred Hay's book on "The Principles of Alternate-Current Working." Practical details and general theories on the same subject he will find in Prof. S. P. Thompson's book, entitled "Polyphase Electric Currents." The word "Wechselstrom" is used for single-phase alternate currents, and "Drehstrom" for polyphase alternate currents.—ED. *E. E.*]

FORTHCOMING EVENTS.

FRIDAY, DEC. 16.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Kentish Town Widening, Midland Railway," by Walter Daniel, Stud.Inst.C.E.

North-East Coast Institution.—At Literary Society's Rooms, Sunderland, at 7.40 p.m., "An Improved Method of Strengthening Copper Pipes."

SATURDAY, DEC. 17.

Institution of Junior Engineers.—At 11 a.m., visit to Messrs. Yarrow's works at Poplar.

TUESDAY, DEC. 20.

Institution of Civil Engineers.—At 8 p.m., discussion on "The Ventilation of Tunnels and Buildings," by Francis Fox, M.I.C.E., and, time permitting, a paper will be read on "High-Speed Engines," by John Handsley Dales, A.M.I.C.E.

THURSDAY, DEC. 22.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., "Telegraphy by Magnetic Induction," by S. Evershed. The discussion on Dr. Lodge's and on Mr. Evershed's papers will be opened by Dr. Fleming and Mr. W. H. Preece, with experimental demonstrations.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

(Continued from page 755.)

The under-hung form of porcelain insulator, however, did not prove successful nor satisfactory. The insulator was heavy and cumbersome, and no satisfactory method was devised for holding the wire. A wooden pin lacks strength, and a metal pin reduces insulation. Moreover, smaller insulators of the ordinary form were found suitable for higher pressures than was anticipated.

Some measurements were made of the losses on the Pomona insulators. Twenty-four insulators were mounted on wooden pins. A wire was run along the tops of the insulators, and a second wire connected the pins. The increase produced in the reading of a wattmeter in the primary of the raising transformer when the wires were connected to the high-voltage terminals, was taken as the loss on the insulators. The loss at 25,000 volts was about two watts per insulator. This voltage between pin and wires corresponds to 50,000 volts between transmission wires.

LOSSES BETWEEN WIRES.

The loss over the surface of insulators was quite small—in fact, almost insignificant compared with the amount of power which would ordinarily be transmitted. The various displays of energy about high-tension wires led us to investigate and determine whether this loss was one of importance. In order to measure the loss between wires, eliminating what occurs on the insulators, it was desirable to have a considerable length of wire, to support it without insulators, and preferably to arrange the wires in such a form as to give a considerable loss. Nine wires, each 60ft. long, were stretched 4in. apart in a horizontal plane and were held in place by strings several feet in length at each end. The wires were No. 19 B. & S. gauge, 0·036in. in diameter. They could be connected in various ways, and any pair or pairs of wires could be omitted as desired.

The power supplied to the raising transformer was measured by a wattmeter placed in the primary low-tension circuit. When the load was placed on the transformer, the wattmeter reading increased, and the amount of increase was taken as the power delivered to the load. This method involves certain errors which will be pointed out further on, but, on the whole, it gives an approximate and fairly correct indication of the power, and is sufficient to show clearly the general form of the loss curves and a number of interesting characteristics.

The first measurements of this loss are recorded Feb. 26, 1895. The first, third, fifth, seventh, and ninth wires were connected in multiple to one terminal, and the other wires were connected to the second terminal of the raising transformer; successively increasing voltages were applied.

The wires began to give a hissing or crackling sound, and in the dark began to appear luminous at a little below 20,000 volts. As the voltage was increased the sound became more and more intense, the wires vibrated and became more and more luminous, until at the higher voltages they were surrounded by a coating of soft blue light many times the diameter of the wire. Often there were bright points along the wire, probably corresponding to bits of dust or rough places resembling points on the wire. The large room soon became strongly charged with ozone.

Results of measurements on all wires, alternate wires being connected together to one terminal, and the intermediate wires to the other terminal of the raising transformer, are given in the accompanying Fig. 1. Three curves are given for a frequency of 60 periods per second, or 7,200 alternations per minute. Two of these curves give the wattmeter readings for the different voltages, one for the transformer alone, and the other for the transformer and high-tension wires; the third curve gives the difference between the two, and therefore represents approximately the loss on the high-tension wires. Corresponding curves are given of tests made at a frequency of

* Paper read before the American Institute of Electrical Engineers.

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133. The loss in the transformer is less at the higher frequency, but the loss on the high-tension wires is almost the same for both frequencies. These losses are very small below 18,000 volts, but increase rapidly up to 30,000 volts, which is the highest pressure used.

As the two sets of tests were made with dynamos having different characteristics, they may not accurately represent the relative effects of the frequencies. The difference due to causes other than the frequency are, however, probably small, so that these tests are correct in showing the general relation between the loss and the pressure, and in indicating that the loss depends little if at all upon the frequency.

Tests were made with different numbers of wires. In one case the measurements were made with the arrangement described above, in which five wires were connected together and the four intermediate wires were connected to the second terminal of the raising transformer. Two wires at one end were then left off. Two of these were next omitted, leaving three connected to one terminal and

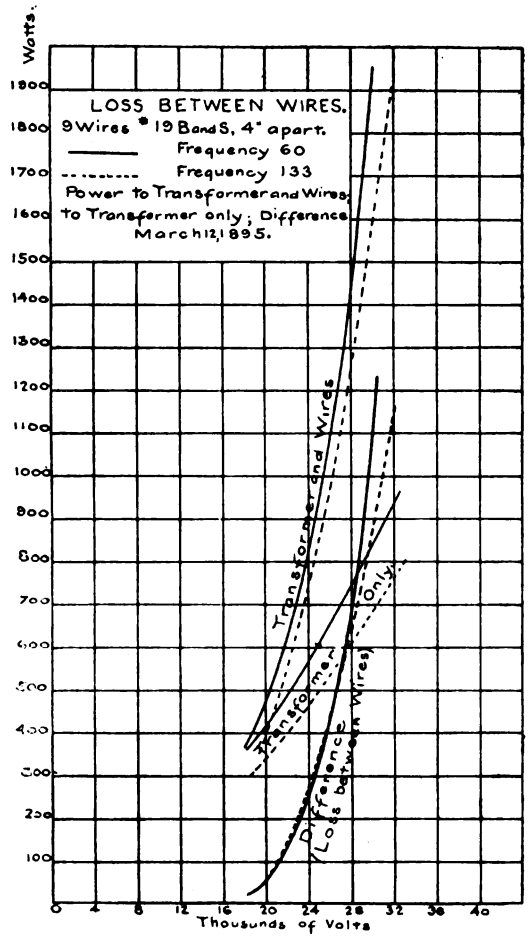

FIG. 1.

two to the other. One of these was left off, leaving the first and third wires connected together, and the second and fourth also. The first and ninth wires were then connected together, also the second and eighth. As the first and second wires were well separated from the eighth and ninth, the mutual effect between them is negligible, so that the loss in this case may be considered as double that which would be obtained from the first and second wires alone. The results of this measurement are plotted in Fig. 2. The points for both loss and current fall on a straight line and indicate that each additional wire causes a definite increase.

Measurements made upon wires at greater distances show that the action is considerably less as the wires are separated. The loss is approximately the same at 28,000 volts when the wires are 4in. apart, that it is at 36,000 volts when they are 16in. apart. The loss for a distance of 8in. is intermediate.

Other measurements were made, but nothing of further importance was developed. It is interesting to note that within a few days of the first measurements the general characteristics of this loss were determined—namely, that the loss between wires increases rapidly after a critical voltage is reached, that the loss is practically independent of the frequency, that it is much less as the distance between wires is increased. When a loss of 1,200 watts was obtained on a total length of 540ft. of wire at only 30,000 volts, the important bearing of this phenomenon upon transmission became very evident. The tests were stopped, as preparations were begun for the continuation of the work at Telluride.

TRANSFORMERS AT TELLURIDE.

The original Telluride plants operated at 3,000 volts. Both the generator and the synchronous motor were wound for this pressure. Two transformers were furnished for the high-voltage test, one for raising the generator voltage for transmission, and the other for lowering the voltage for the motor. The windings were connected with a number of terminals, by which the high-tension voltage could be varied over a wide range up to 60,000 volts.

Coils of similar shape were placed side by side in what is known as the "parallel" form of construction. Each coil had many layers of wire and but few turns per layer, thus securing a small difference of pressure between consecutive layers. The high-tension winding was divided into four similar coils, each designed to give a maximum of 15,000 volts. The individual coils could be differently connected, either in series or in multiple. The low-tension coils were five in number, and were provided with loops, by which the number of effective turns could

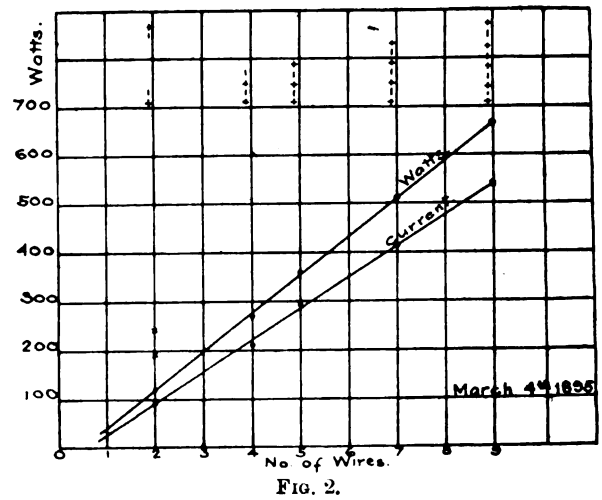

FIG. 2.

be varied. Three low-tension coils were placed between two pairs of high-tension coils, and the two remaining low-tension coils were placed on the two ends. Between the low-tension and high-tension coils metallic shields were placed, which were connected to the ground for protecting the low-tension circuit from danger in case of accidental contact with the high-tension circuit, and also for screening the low-tension circuit from electrostatic induction from the high-tension windings. The transformer was immersed in a case containing oil. The iron, and the case of the transformer, as well as the shields between the coils, were connected to the ground.

There was also an auxiliary transformer whose primary was connected across the generator terminals, while its secondary was placed in series with the circuit to the raising transformer, thus either raising or lowering the generator E M.F. as desired. The secondary had a number of steps, so that the voltage could be varied at will.

THE TRANSMISSION LINE.

The line extends from the power station near Ames, which is a few miles from Telluride, Colorado, to the Gold King mill. The line passes over an exceedingly rugged country, and has a total length of nearly 2¼ miles (11,720ft.). There are 62 poles, each carrying three cross-arms, the upper being about 26ft. from the ground. Each cross-arm carries two wires supported by insulators, which are designated as follows: large glass, small glass, porcelain (see Figs. 3 and 4). The large glass insulator is the same as that used on the circuit in the San Bernardino and Pomona plant. The total height is 5in. and the maximum diameter

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5½in. The bottom of the insulator stands 1½in. above the cross-arm. The porcelain insulator is 4 1/16in. high and 5⅞in. in diameter. The bottom is 3 1/16in. above the cross-arm. The small glass insulator is 3½in. in height, 4¼in. in diameter, and stands 2¼in. above the cross-arm. This insulator is triple petticoat; the other two insulators are double petticoat. The circuits were strung with galvanised

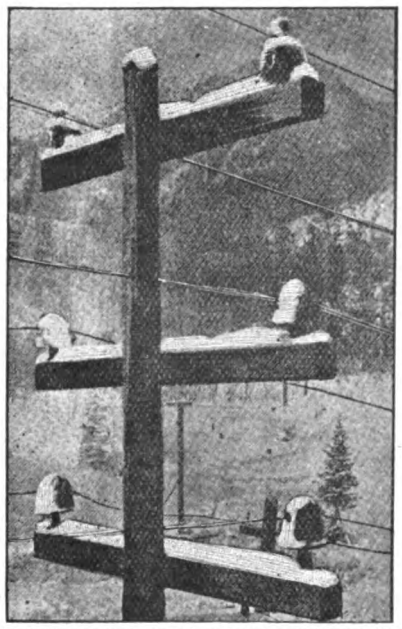


FIG. 3.—50,000 Volts on Large Glass Insulators (Upper Cross-Arm) and on Porcelain Insulators (Lower Cross-Arm).

iron wire 0·165in. in diameter, which is No. 8 B.W.G., and about No. 6 B. & S. gauge. Later the circuit on porcelain insulators was changed to No. 6 B. & S. copper wire

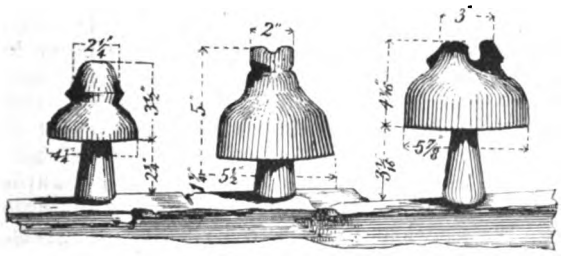


FIG. 4.—Insulators used in High-Tension Tests at Telluride.

0·162in. in diameter. The measured resistance of one of the iron wire circuits was 66 25 ohms at −7deg. C.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

124. Show clearly how to calculate from the indicator card the amount of water used per stroke per indicated horse-power in (*a*) condensing engines, (*b*) non-condensing engines. W. H. P.

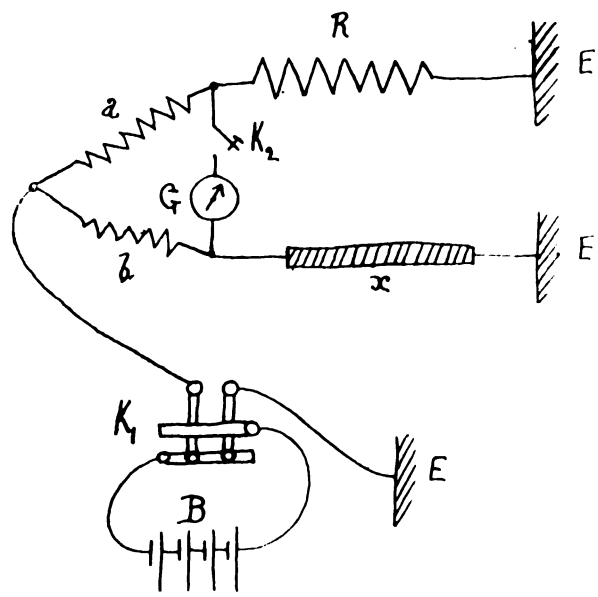
125. How do you determine the secondary drop in volts between full and no load in a transformer?—C. S.

ANSWERS.

Question No. 118.—When making cable tests to earth, and especially when endeavouring to localise a fault, the positive end of the battery is invariably put to earth direct. Why is this done; could not more accurate results be obtained by putting the positive and negative ends to earth alternately and taking a mean value of the readings thus obtained?

Best Answer to No. 118 *(awarded* 10*s.)*.—The chief reason for putting the positive pole of the battery to earth in testing for faults, and more especially in attempting to localise them, is that the broken end of the cable may be kept clean, and so give a true indication of the resistance of the cable between the testing instruments and the fault. It may generally be presumed that the "fault" admits moisture to the conductor, and that electrolytic action interrupts the continuity of the wire by corrosion. Sometimes it is advisable to send a positive current for a short time and then a negative current for a short time along the wire, and to continue this alternation until the measurable resistance becomes constant, but the resistance must always be measured when the positive pole of the battery is put to earth and the current passed for a short time, because when the positive pole of the battery is put to earth the broken end of the cable—*i.e.*, the fault—will be kept clean by electrolytic action, and so a true reading may be obtained. If the positive pole of the battery were put to the cable, then the broken distant end of the cable would be oxidised, and the oxide (say) of copper so formed would add to the resistance of the cable or wire and give a false reading on the testing instruments. Possibly, also, the oxide being in contact with the sea-water, the earth, or some other metal, might set up an E.M.F. which would also give a false reading. When water is decomposed by electrolysis, the hydrogen goes *with* the electric current and oxygen goes *against* the direction of the current. It will be remembered that water is composed of hydrogen and oxygen. Hydrogen has the power of withdrawing oxygen from metallic oxides, so reducing them to the metallic state commonly known as clean metal.—F. G. A.

Answer to No. 118 *(awarded* 5*s.)*.—In testing the insulation resistance of submarine cables, we have always to earth the cable first in order to discharge it, and leave it earthed a sufficient time to allow all the residual charge to leak out. It is natural, therefore, to connect the negative pole of the battery to the discharged cable and the positive pole to earth when ready for the test, so as to avoid charging the cable afresh when making the test. With electric light cables this is not so important, as their capacity is relatively at least very much smaller. When localising a fault, whether by the direct deflection or by the Wheatstone bridge method (Fahie's) given below, it is always best to have a reversing key in the battery circuit, so that either the positive or negative pole may be put to earth. In the direct deflection method, if x be the true resistance to the fault, and x_1 and x_2 the apparent resistances when the positive and



When Localising a fault $x = R\, b/d$.

negative poles of the battery are put to earth respectively then $\frac{2}{x} = \frac{1}{x_1} + \frac{1}{x_2}$.

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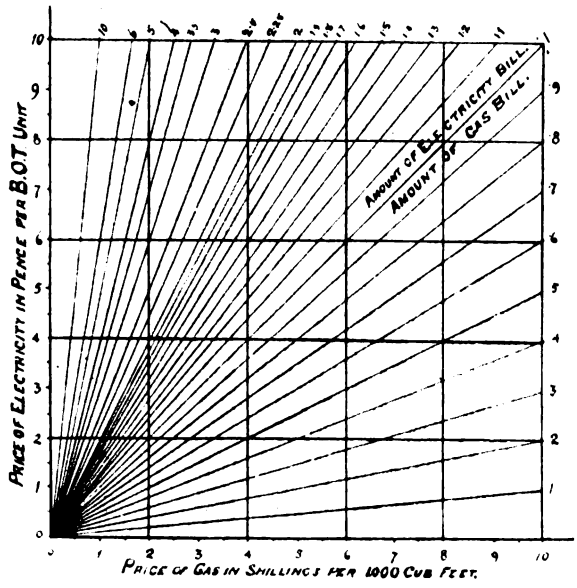
In the Wheatstone's bridge method the corresponding formula is $x = \sqrt{x_1 x_2}$. In neither of the methods does the simple mean, $\frac{x_1 + x_2}{2}$, give the correct value except in the very special case when x_1 equals x_2.

The best method of localising a break on the cable is the Wheatstone bridge method, the connections for which are shown in the figure. The best method of procedure is as follows: (1) Join up as in the figure. Put K_2 down, battery being out of circuit, and note where the spot of light goes. This gives us the *false zero* due to earth currents, and in making the test we balance to this zero. (2) Adjust R until there is a balance with one tapper of the reversing key down, and let the apparent resistance be x_1. Then adjust R until there is a balance with the other tapper of the key down, and let the corresponding apparent resistance be x_2, then $x = \sqrt{x_1 x_2}$.—J. C. R.

Question No. 119.—Assuming that a 16-c.p. gas-burner consumes five cubic feet of gas per hour, and that a 16-c.p. incandescent lamp requires 60 watts, show by a diagram the relative cost of the meter bill for gas and electric lighting; the price of gas varying from 1s. to 10s. per 1,000 cubic feet, and electricity costing from 1d. to 10d. per B.O.T. unit.

Best Answer to No. 119 (*awarded* 10*s.*).—For ready reference the diagram should show at a glance the relative amounts paid for gas and electricity for any given pair of prices per unit. Such a curve is given below. It is easily



obtained by considering that, by the terms of the question, one gas lamp requires $\frac{5}{1000}$ or $\frac{1}{200}$ of a unit per hour, and one electric lamp of the same brilliancy requires $\frac{60}{1000}$ = 1/16·7 of a unit, and since 1/16·7 is just 12 times $\frac{1}{200}$, the expense of a gas lamp will be the same as the expense of the equivalent electric lamp if the price of gas in shillings per 1,000 cubic feet is equal to the price of electricity in pence per Board of Trade unit—an easily remembered rule. This gives us the line marked 1 in the diagram. All the other lines can then at once be got by proportion.

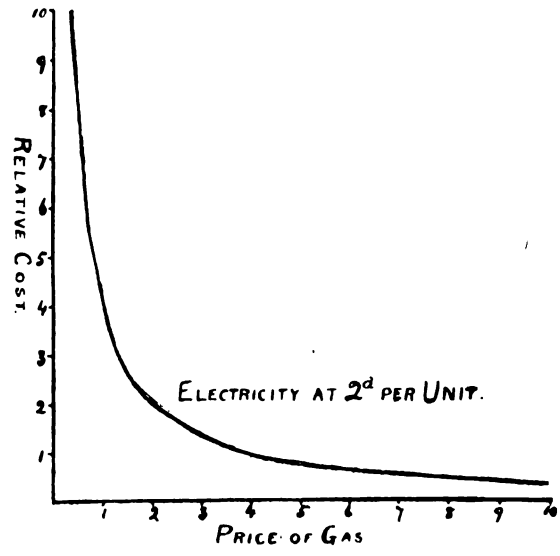
To use the curve: Find the point on the paper where the vertical line drawn from the given gas price meets the horizontal line from the given electricity price. Then the radial line on which this point falls gives the amount payable for electricity, calling the amount given for the equivalent quantity of gas, 1. Thus, gas at 4s. and electricity at 3d. meet at a point about midway between the lines marked ·7 and ·8, say at ·75: therefore the saving effected by changing from gas to electricity with these prices would be 25 per cent.—Q.

Answer to No. 119 (*awarded* 5*s.*).—If y pence be the price of a Board of Trade unit, then in 200 hours a 16-c.p. lamp will consume 12 units, and therefore the meter bill for the 200 hours will be y shillings. A gas-burner will obviously burn 1,000 cubic feet in 200 hours, and if gas costs x shillings per 1,000 cubic feet, the meter bill for this time will be x shillings.

The relative cost of electricity as compared with gas will therefore be $\frac{y}{x}$. Let r denote this relative cost, then

$$r = \frac{y}{x}. \quad \therefore y = x r.$$

For a given value of y, therefore, if we plot out the relative cost for varying values of x we get a rectangular



hyperbola. In the figure the relative cost of electricity and gas is plotted out for the case when electricity costs 2d. per unit. We see from the figure, for example, that when gas costs 4s. per 1,000 the gas bill will be twice as dear as the bill for electric light at 2d. per unit. Similarly, when gas costs 1s. per 1,000, the gas bill will be only half as dear as the electric bill.

For the other prices of electricity mentioned in the question we would get nine other hyperbolas all similar to the one we have drawn. There is, however, no necessity to draw them, as they are all similar curves, and the relative cost for any price per unit can be got almost directly from the figure. For example, suppose that electricity cost 7d. per unit, then the relative cost could be got from the curve drawn by simply multiplying the ordinates by $\frac{7}{2}$. We see, then, that electricity at this price would be equivalent to gas at 7s. per 1,000.—J. C. R.

Answer to No. 119 (*awarded* 5*s.*).—The solution of this problem will perhaps be best obtained by considering it as a particular case of a general proposition, as follows:

Let w = watt-hours of electrical energy consumed in producing a light which has a certain candle-power;

and let f = cubic feet of gas per hour consumed in producing a light which has the same candle-power.

Let p_e = price of one Board of Trade unit of electrical energy;

and let p_g = price of 1,000 cubic feet of gas.

Then the given candle-power is produced at a cost of $\frac{w\,p_e}{1{,}000}$ by electricity, compared with a cost of $\frac{f\,p_g}{1{,}000}$ by gas, per hour. Let these be denoted by P_E and P_G respectively, then the relative cost for a given time and for the same candle-power:

$$= \frac{P_E}{P_G} = \frac{w\,p_e}{1{,}000} \times \frac{1{,}000}{f\,p_g} = \frac{w}{f} \times \frac{p_e}{p_g}.$$

The problem is thus reduced to a graphical solution of an equation of the form $X = \frac{Y}{Z}$, where X is the dependent variable $= \frac{P_E}{P_G}$, and Y and Z are equal respectively to $\frac{w}{f} \times p_e$ and p_g, and constitute the independent variables.

This equation, $X = \frac{Y}{Z}$, having three variables, repre-

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sents a surface, the general shape of which is indicated in Fig. 1, where part of it, A B C D, is shown bounded by four lines lying on it. The axes of X, Y, and Z are taken as being rectangular.

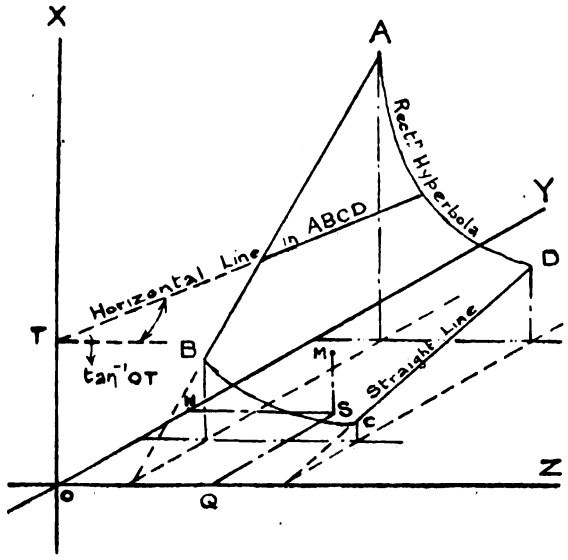

FIG. 1.

The meaning of this, in reference to the relative costs of lighting by electricity and gas, is that if O Q, say, represent any value of p_g and O N represent, on the same scale, a value of $\frac{w}{f} \times p_e$, and if Q S and N S be parallel to O Y + O Z respectively, then S M (M being the point where the perpendicular at S cuts the surface) represents on a suitable scale the relative costs of lighting—*i.e.*, $\frac{P_E}{P_G}$.

We can now reduce this diagram to a two-dimensioned surface. But first note one or two important characteristics of the surface $X = \frac{Y}{Z}$. (*a*) Every horizontal line on the surface—*i.e.*, every line representing a series of equal values of $\frac{P_E}{P_G}$ passes through O X. For if the surface be intersected by a horizontal plane, the X of the intersection is constant, and the line is therefore given by $\frac{Y}{Z}$ = a constant. This is a straight line passing through the origin—which is on O X—and making with the plane, X O Z, an angle $\tan^{-1} \frac{Y}{Z}$; *i.e.*, $\tan^{-1} \frac{P_E}{P_G}$. (*b*) Every section of a surface by a vertical plane parallel to O Y is a straight line. For

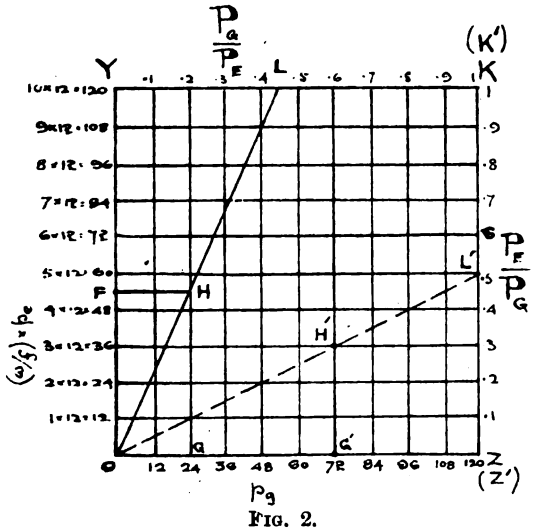

FIG. 2.

in this case Z is constant, and the intersection is given by $\frac{X}{Y}$ = a constant = $\frac{1}{Z}$, and this is a straight line passing through the origin, on O Z, and making with O Z an angle $\tan^{-1} \frac{1}{Z}$; *i.e.*, $\cot^{-1} p_g$. (*c*) Every section of the surface by a vertical plane parallel to O Z is a rectangular hyperbola. For in this case Y is constant, and the intersection is given by X Z = a constant = Y. This is a rectangular hyperbola whose axes are in the plane of intersection and parallel to O X and O Z, and the product of the co-ordinates of any point on it is $X Z = Y = \frac{w}{f} \times p$.

The method of obtaining the required relation on a flat surface (see Fig. 2) is as follows. It will tend to clearness to consider only the particular case given in the question, the symbols being put in brackets after the figures to serve as a guide where necessary. In this case $\frac{w}{f} = \frac{60}{5} = 12$. Take a rectangle (in this case a square), Y Z, whose sides, O Z and O Y, are in the ratio of 120d. (maximum value of p_g) to 12×10d. (maximum value of $\frac{w}{f} \times p_e$). Take O Z to represent varying prices of gas (p_g) and O Y to represent varying prices of electricity (p_e) multiplied by 12 $\left(\frac{w}{f}\right)$. If the rectangle be not a square, as it is here, cut off from the longer side, O Z, say, a part O Z′ equal to the other side O Y, and draw Z′ K′ parallel to O Y. Z′ K′ Y O is then a square. In this case it corresponds exactly with Z K Y O. Divide Y K (Y K′) and K Z (K′ Z′) each into 10 equal parts as shown, and figure them ·1, ·2, etc., up to 1·0. Then along Z K (Z′ K′) will be found values of $\frac{P_E}{P_G}$ directly, and of $\frac{P_G}{P_E}$ by taking reciprocals; and along Y K (Y K′) values of $\frac{P_G}{P_E}$ directly, and of $\frac{P_E}{P}$ by taking reciprocals, by the following construction:

Suppose the price of electricity is 4½d. per unit, and of gas 2s. per 1,000 cubic feet. Take F, corresponding to $12 \times 4\frac{1}{2} \left(\frac{w}{f} \times p_e\right)$, and G corresponding to 24d. (p_g), and draw F H and G H parallel to O Z and O Y respectively; join O H, and produce it to L. Then Y L is 4, the required value of $\frac{P_G}{P_E}$. It is easy to show that Y L represents this value by considering property (*a*) of the surface in Fig. 1. For the rectangle, Y Z may evidently be regarded as the projection of part of this surface, the rectangle being the horizontal plane, Y O Z, in Fig. 1. Now, in the plane of the rectangle L H passes through O, which corresponds to the origin in Fig. 1. But it was shown that horizontal lines in the surface are straight, and pass through O X (of which O is the projection), at a height = $\frac{P_E}{P_G}$, and, further, that the angle which they make with a vertical plane through O Z has a tangent equal to $\frac{P_E}{P_G}$. The projection of such a line will therefore be a straight line on the horizontal plane, Y Z, and will make with O Z an angle $\tan^{-1} \frac{P_E}{P_G}$, which is $\tan^{-1} \frac{\frac{w}{f} p_e}{p_g}$. But if $\frac{w}{f} p_e$ = O F = H G, and p_g = G O,

$\therefore \tan G O H = \frac{\frac{w}{f} p_e}{p_g}$, and $\therefore$ also O H is the projection of a horizontal line on the surface at a height of = $\frac{P_E}{P_G}$.

Hence we have $\frac{P_E}{P_G} = \tan G O H = \frac{H G}{G O} = \frac{O Y}{Y L'}$,

or, $\frac{P_G}{P_E} = \frac{Y L}{O Y} = \frac{4}{1} = 4$;

in other words, Y L, scaled along Y K, gives the required ratio of the costs of gas and electricity for the same candle-power used during the same times. A similar proof holds good for values on L′ K′ of $\frac{P_E}{P_G}$ when O H intersects it in L′, say.—T. C.

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ELECTRIC LIGHTING IN THE CITY.

At yesterday's meeting of the Court of Common Council at the Guildhall, a petition was presented from the Charing Cross and Strand Electricity Supply Corporation, showing that they were desirous of supplying electrical energy within the whole of the City of London and the liberties thereof, and that they had made application for such powers. A memorial in favour was also submitted, 150 yards in length, signed by over 5,000 persons carrying on business in the City. It was asked that, notwithstanding the inability of the Corporation to consent to the same, the Court would cause the said memorial to be put upon their records.

The petitioners' representatives were called to the bar of the court, when Mr. BROOKE-HITCHING asked whether their chief object was not to get a profit out of the citizens of London for their shareholders?

The PETITIONER: We do not profess to be philanthropists, but the ratepayers will not have reason to regret it if we are allowed to enter the City. They were aware there were 7,000 consumers in the City at present, but felt confident there would be 30,000 if the circumstances were different. It was true only 5,000 had signed the memorial, but had there been time for canvassing a much larger number would have been obtained.

An HON. MEMBER asked whether the Court would be placed in a worse position afterwards against the company when the Bill was before Parliament if this memorial were placed on record?

The TOWN CLERK replied that by the fact of its having been read the memorial would necessarily appear on the record.

In reply to further questions it was stated that in St. Martin's and the Strand district the price charged by the applying company ranged from 6d. to 4d. for lighting, and from 3d. to 2d. for motive power. If they came into the City it would be proposed to charge over the whole area of supply a maximum of 5d. and a minimum of 4d. for private lighting, and 3d. to 2d. for motive power.

Mr. WALLACE: Assuming the Corporation decided to become the lighting authority for the City, would you regard it as an act of bad faith if your memorial was disregarded?

PETITIONER: Certainly not.

Mr. WALLACE: The fact of your memorial being recorded to-day would not establish, in your judgment, any prior claim to be considered against we having dealt with the present company?—There might be some sentimental feeling of the sort, but we should not regard it as bad faith. The object of the signatories to the memorial was to show that they were dissatisfied with the present service. In the event of the petitioners getting into the City, they would be most willing to agree to all reasonable conditions that might be imposed for the protection of the citizens.

The petitioners then withdrew, and Mr. LEE moved that the memorial be put on record. It was one of the most influential ever presented to the Court, and was entitled to all respect.

Mr. MORTEN seconded, after Mr. Lee had agreed to add to his motion that the memorial should be referred to the Streets Committee for report. The signatories were sound business men, and not mere adventurers, speculators, nor company promoters. During the last few days the verdict of a jury had completely altered the circumstances. The Court was now perfectly free to consent to any other company coming into the City or to go in for electric lighting itself. Clause 42 of the Sewers Act of 1848 enacted that in the event of any member of the Court being directly or indirectly interested in any contract entered into by the Commissioners of Sewers, such contract should be null and void, and the interested Commissioners were liable to penalties. On Wednesday week a member of the Court stated on oath that he was interested in the electric light contract to the extent of £625 directly. That clause therefore came into operation, and the Corporation was free to do as it liked. He thanked the jury and the Royal Courts of Justice for liberating the Court from the captivity in which they placed themselves in 1891. The Streets Committee should thoroughly consider the matter on scientific and legal advice, and doubtless now that all the circumstances of 1890-91 were known care would be taken that the citizens were properly protected, not only with regard to electric lighting, but also in other matters.

Mr. BROOKE-HITCHING deprecated reference to the recent lawsuit without going further and saying that the judge distinctly stated that there had been no corruption on the part of Sir Joseph Savory. (Mr. MORTEN: I did not say there was.) Whether the Corporation would be able to invalidate their agreement with the City of London Electric Lighting Company was very doubtful. The Corporation ought certainly to be the lighting authority for the City, and yet here were Mr. Lee and Mr. Morten proposing that still another company should be allowed to fatten and batten out of the citizens of London, although the citizens had had the terrible incubus of the present company upon their shoulders for the last seven years. The petitioners were simply anxious to get a footing in the City before two other companies who were applying.

Mr. WALLACE thought that they ought to be perfectly clear as to whether this was to be a continuation of the policy of giving the City over to private companies. If the Streets Committee were to consider the matter *de novo*, and the whole question was to be reopened, he would support the reference; but if otherwise, he hoped the Court would reject the memorial.

Mr. PANNELL supported the motion, and thought the more publicity given to the affairs of the Corporation the better. He contended that under the circumstances the Corporation itself would have done as nearly as possible the same as the Commissioners of Sewers did in 1891. It was all very well eight years afterwards, when circumstances had entirely changed, to criticise the action then taken. It had further to be remembered that in 14 years the Corporation would be able to undertake the private lighting without paying a penny, and anyone could see what would happen before that time had expired.

The motion that the memorial be sent to the Streets Committee for consideration and report was then agreed to *nem. con.*

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Wednesday at Winchester House.

Mr. W. Andrews, who presided, said the financial result of the six months was not unsatisfactory, for they were able to show an amount to credit of revenue of £39,612, against £38,209 for the corresponding half-year of 1897, and the expenses had been £21,704, against £21,426, leaving a balance of £17,907, which, with £721 brought from last account, made a total of £18,629, with which it was proposed to deal as follows: first preference shares, dividend, six months to June 30, 6s. per share, £10,369; second preference shares, dividend, six months to June 30, 6s. per share, £1,400; ordinary shares, 1s. 6d. per share, free of income tax, £6,624; balance to current half-year's account, £236. He paid a high tribute to the staff on the spot for their services in very trying times. He acknowledged the honesty always shown to the Company by the Spanish Government up to the last moment, and said that now Cuba and Puerto Rico were in the hands of the United States Government, the directors looked forward to better results still.

The report was adopted and the dividends were declared.

PROVINCIAL TRAMWAYS COMPANY, LIMITED.

A meeting of this Company was held on Friday last, Mr. J. Barber Glenn in the chair.

The **Chairman** stated that, with regard to the notice given of a Bill to enable the Cleethorpes section of the Great Grimsby street tramways to be extended and worked by electric traction, and to enable the Company, on the one hand, and the Corporation of Great Grimsby and the Cleethorpes Local Authority, on the other hand, to enter into agreement with regard to the postponement of the dates of purchase, the Corporation of Grimsby would be entitled to purchase in the year 1900, but they were hopeful that an arrangement would be come to by which the Corporation would lease the line to this Company for 21 years.

The report, showing a profit of £29,163, against £31,123 for the previous year, and recommending a dividend of 8s. per share, was adopted.

CAPE ELECTRIC TRAMWAYS.

The ordinary general meeting of this Company was held at Winchester House on the 8th inst., Colonel Sir Charles Euan-Smith presiding.

The **Chairman** congratulated the shareholders on the result of the past year's working and on the Company's solid prospects of further assured prosperity and success. A dividend of 5½ per cent. had been paid after making provision for many expenses, more or less unforeseen, that had arisen in the formation of a company of that magnitude, and commencing to work a system on entirely new lines. The extensions now decided on would be paid for out of the issue of the remaining £25,000 of debenture stock, and they looked to them to yield a substantial increase of revenue to the Company.

The report was adopted.

HALIFAX AND BERMUDAS CABLE COMPANY, LIMITED.

The report of the directors of this Company for the year ended June 30 last was adopted at the general meeting held on Wednesday. The receipts in the past year were £10,154, as compared with £3,742 in 1896-7. This increase was due to the opening of the Jamaica cable, and to the interruption of other routes during the Spanish-American war. The net result was a profit of £6,655, as compared with £952, an increase of £5,703. A dividend of 5 per cent., amounting to £2,500 was proposed, leaving £4,155 to be carried forward. Mr. Geo. G. Ward and Mr. Fred Ward have been elected directors.

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LEGAL INTELLIGENCE.

SAVORY v. EDWARD LLOYD, LIMITED.

(Continued from page 763.)

THURSDAY'S PROCEEDINGS.

Mr. W. H. Preece, F.R.S., C.B., examined by Sir E. Clarke, said he was engineer-in-chief and electrician to the General Post Office. He was consulted as to electricity in the City as early as 1882. He attended several meetings of the Streets Committee. On Nov. 22, 1882, he made a report saying that the question as to the distribution of electricity was in a tentative state, and that those corporations which had taken upon themselves the distribution of electricity had taken upon themselves an obligation difficult to discharge. In March, 1883, he made another report pointing out the responsibility the Corporation of London would undertake if they themselves embarked upon electric lighting, and recommending that a small area only should be undertaken. At that date the knowledge of electric lighting was in a very backward state compared with the present date. He prepared certain specifications, and tenders were advertised for, but none being satisfactory they were rejected. In rejecting the tenders the Commissioners of Sewers consistently acted upon his advice and that of Colonel Hayward. In 1888 the time limit was altered from 21 years to 42. He also made a report in August, 1884 still urging that a small area only should be taken. The Commissioners from year to year took great trouble. The Corporation of the City of London took more trouble than any other corporation, and spent a great deal of money. In 1889 the City of London was divided into three districts—east, west, and central. In 1889 and 1890 it was decided that action could be taken and tenders were advertised for. The Brush and Laing tenders were accepted upon the recommendation of himself and Colonel Hayward. He was practically responsible for the contracts. They were, in his opinion, good and profitable contracts for the City of London. He inspected the works up to 1893. At no time had the plaintiff anything to do with him. He had no communication with him. No member of the Corporation or Commissioners of Sewers ever attempted to influence him. London was a very difficult place in which to estimate what amount of electric light would be wanted. The City day was an "unknown quantity." There were a great many dark passages and cellars which made the amount of light required very difficult to estimate. Coal, land, labour, and breaking up streets were more expensive in London than in other towns, and the difficulty of estimating the amount of light made an expensive plant necessary.

Cross-examined by Mr. Carson, Q.C. : No one asked him his opinion as to the Pioneer or City of London Electric Lighting Company. He had nothing to do with financial matters. In 1889 he was an advocate for potential competition. He thought it would encourage a spirit of emulation. He never suggested that it should be handed over to one company. In 1889 tenders were received from the Brush, House-to-House, Metropolitan, Laing, and London Electric Supply Companies. He selected the Brush and Laing Companies because he thought they could carry out their contracts. He did not mean to give it to a company not yet in existence. The Metropolitan and London Electric Supply Companies withdrew.

Re-examined : If the contracts were given to a large and rich company it would lead to economy. From May, 1890, the Corporation had nothing to do with the financial part of the contracts, so far as he knew.

Mr. M. Bates, examined by Mr. Bankes, said he was now principal clerk to the Public Health Department of the City of London. From 1875 to 1895 he was assistant clerk to the Commissioners of Sewers. The electric light question was first raised in 1878. In 1882 a select committee was appointed. It advised tenders. Seven tenders were sent in, and Mr. Preece reported that they should not be accepted. In June, 1883. Mr. Preece prepared a specification. Nothing came of that. In October, 1883, the Select Committee reported that it was advisable to obtain a license. On Nov. 14, 1883, Mr. Preece wrote and said he was doubtful if there was any private company in a position to carry out the work. In November, 1885, Colonel Hayward reported against the Corporation selecting an area and trying it tentatively. In 1888 conditions for tenders were drawn up, and in 1889 the tenders of the Brush and Laing Companies were accepted. During the whole time the Commissioners took the independent advice of Mr. Preece and Colonel Hayward. During the whole time the plaintiff had nothing to do with electric lighting, and attended no meeting of the Commission.

Cross-examined by Mr. Carson, Q.C.: In 1890 Messrs. J. F. Hepburn, B. S. F. MacGeagh, A. Purssell, and C. E. Smith were members of the Commission; also Mr. W. H. Pannell. Mr. MacGeagh was a member of the Streets Committee. In 1891 Messrs. J. F. Hepburn, Walter Brown, MacGeagh, A. Purssell, and C. E. Smith were members of the Commission of Sewers. Messrs. Brown and C. E. Smith were members of the Streets Committee, and Mr. A. Purssell was specially added to assist in the matter of the electric lighting. He could not say whether the Commissioners were aware that Mr. Pannell was auditor of the Pioneer Company. The Pioneer Company was registered on Feb. 5, 1891, and the prospectus was issued on Feb. 6. Mr. Pannell was appointed after Feb. 10 in that year. Up to Jan. 27, 1891, there was no intimation from the Brush or Laing Companies that they would not themselves carry out their contracts. The Commissioners had no knowledge on Feb. 10, 1891, that the Laing Company had entered into an agreement to transfer their contract. The Commissioners were not consulted before the transfer was made. On June 23 the Commissioners passed a minute that it should be signified to the Board of Trade that the Commission saw no objection to the transfer, provided the constitution and capital of the Pioneer Company were sufficiently established. The Commissioners had nothing before them as to the cost of promotion of the Pioneer Company. Nor did they know of the payment of £10,000 and £15,000 by the Laing and Brush Companies to the Electric and General Investment Company. The Commission had no knowledge of what the Pioneer Company was to get. An amendment disapproving of the transfer, moved at the meeting of the Commission on June 23, was correctly set out in the libel, although the allegation as to suspicion of something not being right was incorrect. On June 24 Mr. Brooke-Hitching brought forward the matter of the electric lighting. On Feb. 4, 1890, Mr. Pannell was added to the Streets Committee.

Re-examined by Sir E. Clarke, Q.C. : Between 1890 and 1891 the plaintiff had nothing to do with electric lighting. He took no part in the discussion or deliberations of the Commissioners. In 1890 there were 92 members of the Commission of Sewers and 30 of the Streets Committee. On June 23, 1891, Mr. Pannell only of those gentlemen who were now suggested as being interested voted for the transfer of the contracts. There was no secrecy as to Mr. Pannell's firm being auditors of the Pioneer Company.

Mr. D. J. Ross, M.I.C.E., examined by Mr. Bankes, said he had been for 27 years in the employment of the Commissioners of Sewers. They had made every effort to tackle the question of electric lighting to the advantage of the City. The Brush and Laing Companies' contracts were advantageous to the City. The street-lighting in the City was exceedingly cheap.

Mr. J. B. Braithwaite, jun., examined by Sir E. Clarke, Q.C., said that he was a member of Foster, Braithwaite, and Co., stock-brokers, and a cousin of the plaintiff. Sir Joseph had nothing to do with the subscription by members of his family to the shares in the companies. In February, 1891, Sir Joseph made £14. 19s. 9d. by the sale of his Brush shares. He (the witness) was a director of the Brush Company. Sir Joseph thought he ought to sell, as he was a director of the Pioneer Company, with whom the Brush Company had a contract. The Brush Company received nothing for parting with the concessions. They never meant to carry out the contracts themselves. The Brush Company paid the £15,000 to the Electric and General Investment Company in order to relieve the City of London Lighting Company of their preliminary expenses.

Cross-examined by Mr. Carson, Q.C. : In 1890 he was a director of the Brush Company, and became chairman in 1893 and 1894. In 1891 the Brush Company was in a position to issue further capital. The Brush Company promoted the Electric and General Investment Company, in order to promote the schemes of the Brush Company. The Electric Investment Company could not have promoted the City of London Electric Lighting Company because the risk was too great. He got £100 a year as director of the Brush and of the Electric and General. He placed shares for the Electric and General and got 1s. per £10 share. He was a director of the Pioneer Company, but thought his firm got no commission for placing the shares. The Electric and General Investment Company did not arrange the contract between the Pioneer and Brush Companies, by which the Brush was to transfer to the new company the contract with the Corporation. The Electric and General Investment got the £15,000 from the Brush Company for obtaining the subscriptions to the new company. He risked £1,000 in the Pioneer and his firm £5,000. He went on to the larger company—*i.e.*, the City of London Electric Lighting Company—and his firm became brokers of it. They got 1s. per £10 share for placing the capital. They got the usual fee for putting their name on the prospectus of the City of London Electric Lighting Company—viz., 1,000 guineas.

Mr. Carson, Q.C.: How many shares did you place?—I cannot say, unless you will allow me to answer in my own way.

How much did you get for placing the shares?—I do not know. We got 1s. a share We also got 1s. a share for the preference shares we placed. I cannot say how much we got altogether. We also got a fee on placing the debentures.

Cross-examination continued : He could not say how much the Exploration Company got. He thought about £4,000, and they practically did nothing. The Baring crisis was the key of the position. [**Mr. Carson, Q.C.**: I am sure it is.] He never told the Board of Trade nor the Commissioners that the Brush Company did not intend to carry out the contract themselves, but they were perfectly cognisant of the facts. The £15,000 that the Brush Company was to pay to the Electric Investment Company was provided out of the margin of profit on the contract. It was not allowed for in the tender by the Brush Company.

Re-examined by Sir E. Clarke, Q.C. : In handing over the contract with the Commissioners, the Brush Company obtained a contract to do such works of the new company as were within its scope. The Pioneer paid the Brush £21,750 for work done. It was impossible to bring out a company with the capital of the City of London Electric Lighting Company without considerable preliminary expenses. The difficulty of placing capital was so great that of £400,000 issued in the City of London Electric Company only £200 000 was subscribed by the public. His firm and another each found £50,000, as it was thought allotment ought not to be gone to on less than £300 000.

Alderman F. Green, examined by Sir E. Clarke, Q.C., said that in February, 1890, he was elected to the chair of the Commission of Sewers. The contract of May, 1890, was considered the best possible arrangement for the ratepayers. Sir J. Savory had nothing to do with the matter. There was no influence brought

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to bear upon the Commissioners with regard to the transfer of the Brush contract.

Cross-examined: He thought the Brush Company intended to carry out the contract, and that it was competent to do so. He first heard that the plaintiff had made a profit in connection with the Pioneer to the amount which had been stated when he was in court yesterday.

Mr. W. H. Pannell, examined by Sir E. Clarke, Q.C., said he had been a member of the Corporation of the City of London since 1874. His firm had been employed to audit the accounts of a great many companies, including the Pioneer and the large company. He had, apart from that, no interest in any of the companies of any kind. His only interest was to see the City of London well lighted.

Mr. Walter Brown, a member of the Commission of Sewers, was also called, and said that he sold the 20 shares he held in the Pioneer Company as soon as he could after he became a commissioner at a profit of £32. Until he sold them he took no part in the proceedings of the Commission.

Mr. J. L. Sayer, a member of the Corporation, and chairman of the Streets Committee in 1891, was also called, and said that he considered the contracts most advantageous to the ratepayers. As a member of the Streets Committee in 1890 he was a party to the making of the contracts. He wrote a letter of explanation to *London*, which was not published by the paper, the editor saying it would be necessary to comment upon it if it were published, which he did not wish to do, as an action brought by Sir J. Savory was being defended.

Cross-examined by Mr. Carson, Q.C.: He had a subsequent conversation with a representative of *London*, at which he said that he was compelled to support his colleagues and to do his best for the citizens in the matter of electric lighting. He had taken an immense amount of trouble in the matter, and had only had criticism in return. The contract for the public electric lighting was an extremely favourable one, although the private lighting might not be quite so cheap.

Mr. MacGeagh, examined by Sir E. Clarke, Q.C., said he became a member of the Commission of Sewers about 10 years ago. Sir J. Savory had nothing to do with electric lighting. He (witness) applied for 10 shares in the Pioneer Company and was allotted one. He also took some shares in the City of London Electric Lighting Company, and about that time retired from the Commission. He did not vote on the committee with regard to electric lighting while he held the Pioneer share.

Mr. C. E. Smith, also a member of the Corporation and a member of the Commission of Sewers and of the Streets Committee in 1891, examined by Sir E. Clarke, Q.C., said that the plaintiff never communicated with him in any way with regard to electric lighting. He applied for 25 shares in the large company and got five. He only held them a week. His only aim had been the public interest.

Cross-examined: The directors of the City of London Electric Company gave him no reason why they only allotted him five shares. He could not say that he entirely approved of the Lord Mayor having made a profit.

At this stage the Court adjourned.

Friday's Proceedings.

Mr. Smith, recalled, said that he had been mistaken the previous day when he stated that he held no shares in the Pioneer Company. He did hold one share.

This closed the plaintiff's case.

Mr. Carson, Q.C., said that he would call his witness before addressing the jury.

Mr. Robert Donald, examined by Mr. Foote, Q.C., said that he was the editor of *London* and the writer of the article complained of. He saw the circular of Mr. Brooke-Hitching and the report of the Investment Company. He then made independent enquiries and wrote the article. He had no personal knowledge of or ill-will towards the plaintiff.

Cross-examined by Sir E. Clarke: By "monopolistic rights" he meant the Pioneer Company, which extinguished competition in 1891. That monopoly was created by several members of the Corporation. The Streets Committee managed the matter. In 1890 only one person named in the article was on that committee. In 1891 Messrs. Walter Brown, Smith, and Pannell were on the committee. Witness did not impute dishonesty to these three gentlemen. He did impute wrong, not personal dishonesty. He maintained that their action was against a high standard of municipal honesty. He knew they did not vote or take part in the discussion, but they were present when the Commissioners of Sewers discussed the question. He did not know if they were present when the Streets Committee discussed it. Witness charged Mr. Pannell with becoming auditor of the two companies while he was a member of the committee which had to deal with the companies on behalf of the City. The headline "Impanelled" was merely jocular, and was not intended to impute any dishonesty to Mr. Pannell.

Re-examined: None of the gentlemen named had brought actions. Everything done by the Streets Committee had to be ratified by the Commissioners of Sewers. Witness was of opinion that a man elected as commissioner of sewers did not fulfil his duty by abstaining from voting.

Mr. Carson, Q.C., for the defence, said the previous day had been spent in trying to cover up the evidence of the day before. The plaintiff had tried to obliterate the effect of his own evidence by calling various respectable gentlemen who were not parties to the action. It was now necessary to get back to the real point at issue, which was the character of Sir Joseph Savory. After commenting on the evidence called on Thursday, the learned counsel proceeded to say that the point of the charge was that a Lord Mayor of London had become a promoter of these companies and had used his official position to make private gains for himself and his friends. The defendant had, in writing the article complained of, first set out the facts of the case absolutely truly. He then proceeded to draw his own conclusions. Whether those conclusions were wrong, the public, having all the facts before them, could judge for themselves. It could not be denied that the company's price had been too dear, for the company's £10 shares were now worth £22 to £24 each. That showed that the ratepayers' interests had been sacrificed to the shareholders'. Mr. Brooke-Hitching proposed a scheme by which the Corporation should buy out the monopoly. The difficulty of the matter arose from the way in which the company's £1,200,000 of capital had been increased, by the prices charged for lighting, to £2,500,000 *London* devoted itself to municipal affairs, and it was very proper for such a paper to take an interest in this affair. The editor had acted in the public interest and not out of spite towards the plaintiff, and he had acted after due investigation. The charges were that the Corporation created a monopoly, and that the Lord Mayor became a promoter of that monopoly, and obtained private gain for himself and his family therefrom. That was a state of things upon which comment could hardly be too severe. Mr. Braithwaite had told the jury that when the Brush Company tendered for the contract that company never had any intention of carrying it out. It was only obtained in order to part with it to the Pioneer Company, and thereby make additional profits for the directors. In November, 1890, the plaintiff became Lord Mayor. As such he was not only a member, but chairman, of the Commission of Sewers and of every sub-committee appointed by the commission. He was, therefore, actually chairman of the Streets Committee. He might at least have kept himself informed of what went on at the committee. Indeed, since he had time to attend Board meetings of a private company he might even have found time to attend some meetings of the committee. The Brush Company had among its directors Mr. J. B. Braithwaite and the Duke of Marlborough. The City of London Electric Supply Company was brought into existence merely to carry out a contract which they had no power to investigate. The Electric and General Investment Company was formed to finance the earlier company. Mr. J. B. Braithwaite and the Duke of Marlborough were directors of that company also. In both capacities they refused to take the risk of advancing the sum needed in February, 1891, to carry on the lighting scheme. So they made themselves into a third company—the Pioneer Company—and the defendants alleged and would stand to it that the Pioneer Company was only formed to make money for the Savorys and the Braithwaites. In the multitude of companies there was profit, and that was the object of these companies. The three companies meant three sets of fees for directors and brokers; and shareholders in the Pioneer Company who advanced their money for six months got it back with 50 per cent. interest. In short, the Pioneer Company was a sham, and it was for the jury to say whether the Lord Mayor of London ought to have appeared on the prospectus of such a company; whether he and all his relations ought to have made 50 per cent. out of such a company. Contracts were made between all these companies; Mr. J. B. Braithwaite and the Duke of Marlborough as one company made agreements with the Duke of Marlborough and Mr. J. B. Braithwaite as another company, and in each case commission was paid for negotiating these agreements between the same persons. Twenty-five thousand pounds was paid to the Electric and General Investment Company for negotiating a contract for the Brush Company and the Laing Company. The plaintiff never looked into these matters, and never made any enquiries before appearing on the prospectus of the Pioneer Company. Negotiations followed between the Sewers Commission, of which the Lord Mayor was chairman, and the Pioneer Company, of which the Lord Mayor was chairman. How was it possible for the plaintiff to do his duty to both sides? It might be said that the sums were not large; out of the Pioneer Company, for example, the plaintiff had only made some £600. But it was the principle of the thing that they objected to, and if the Press was to be gagged when it commented on an affair like this they would soon see the profits growing larger. Then came the City of London Electric Supply Company, with the Duke of Marlborough and Mr. J. B. Braithwaite on the Board. It was said that all this was rendered necessary by the Baring crisis. Why? The Barings were not electrical engineers. It was also said that at that time the future of electric lighting was very uncertain. That was not the story that appeared in the prospectus, at any rate. In that prospectus there were stories of magnificent profits, and the profits had since been actually made. Those were the facts, and the plaintiff complained of the comments made upon those facts. Mr. Carson then read a part of the article, and proceeded to argue that the comment was fair and honest. In conclusion, the learned counsel disclaimed any desire to attack Sir Joseph Savory, and suggested that he might have been the dupe of Mr. J. B. Braithwaite. But if that was so he must take the consequences, and should not try to stifle criticism.

Sir E. Clarke, Q.C., in reply, contended that definite accusations of shameful transactions had been made against the plaintiff in connection with the other gentlemen who had been called. The evidence that had been given ought to satisfy everyone inside or outside the court that nothing had gone on of which Sir Joseph Savory need be ashamed. It had been shown that Sir Joseph had taken no part in the giving of the contracts for electric lighting in the City. The plaintiff was not a member of the Streets Committee or of the Sewers Commission in any but a technical sense.

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No Lord Mayor ever attended the Sewers Commission more than once or the Streets Committee at all. In 1890, after 20 years of consideration, a scheme was arranged by which, for electric lighting purposes, the City was divided into three parts. In each of these areas one company had a monopoly upon terms approved and adopted in May, 1890, and which had continued ever since. It was not until months after this approval had been given that the plaintiff became even a nominal member of the Sewers Commission. The accusation now made was that the plaintiff had caused the City to pay too highly for its light. But, as a fact, the City was very well and very cheaply lighted. The facts were that in February, 1891, the contracts with the Brush Company and the Laing Company were on the point of breaking down, and that would have meant the indefinite postponement of the scheme. It was to prevent this that the Pioneer Company was founded, and to prevent this that the plaintiff, as Lord Mayor, came forward. A report of the Sewers Commission in 1889 had recommended the lighting of the City by one large company rather than several small ones, and it was with this object that the Pioneer Company was founded. At the time it was impossible to bring out a large company, owing to the Baring crisis, which upset the whole life of the City, and tha Pioneer Company was necessary to pave the way for the flotation of a larger company. The plaintiff's action throughout was for the benefit of the City. His action was public, and might have been attacked at the time, but no one had said a word against it for seven years. As to what had been said about the series of companies, of course it might be wrong for one company to promote another where such an arrangement was a cover for fraud. But in this case there was no allegation that anyone had made an illegitimate profit. The sums paid by the Brush Company and the Laing Company to the Electric and General Company were only their shares of the expenses of promoting the single large company. Mr. Braithwaite had done nothing which could in any way be objected to. He was a connection of Sir Joseph Savory's, and acted for various members of the Savory family. That being so, it was natural that many members of the family should take shares in undertakings recommended by Mr. Braithwaite's firm. There was nothing in the whole evidence to support the charges of corruption which had been made against the plaintiff. The statements were utterly reckless, and reckless journalism of that kind should be severely dealt with.

Mr. Justice Day, in summing up, said that the question was whether the statements made were true and whether the comments on those statements were fair and without malice. On the evidence it was clear that there could be no foundation for any charge of corruption against the plaintiff, although he might have been indiscreet. On the other hand, there seemed no ground for suggesting that the defendants had any personal illwill against the plaintiff. It did seem that the plaintiff had been indiscreet in joining the Pioneer Company. The matter was one with which the plaintiff had nothing whatever to do. It was said that he only joined under pressure; but it appeared that the pressure was exerted by two persons who could hardly be of much consequence in the City—Mr. Braithwaite and the Duke of Marlborough. After dealing with the evidence, his Lordship said that if the charges made by the defendants against the plaintiff were unfounded, the defendants had acted in a very reckless way. It was for the jury to say whether these charges were true.

The jury, after consulting together for a quarter of an hour, asked if they were bound to express an opinion as to whether there had been corruption.

Mr. Justice Day: No. You have only to say whether the libel is true or not.

The jury then found a verdict for the defendants.

Judgment was entered accordingly.—*The Times*.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Commissioners of the Burgh of Stirling invite tenders for boilers, engines, dynamos, etc. Tenders by Jan. 2, 1899.

Leeds.—The City Council require tenders for the supply of (*a*) underground conductors; (*b*) switchboards, etc. Tenders by Dec. 29.

Dublin.—The Corporation invite tenders for the supply of a high-tension single-pole switchboard. Further particulars appear in our advertising columns. Tenders by Dec. 28.

Sunderland.—The Corporation are prepared to receive tenders for the supply of three 125-kw. direct-current high-speed steam dynamos, 460 volts. Tenders by noon on Dec. 30.

Selby.—Tenders are invited for the supply of accumulators for electric lighting. Particulars on application to Mr. J. E. Prossor, manager, Yorkshire Bacon Curing Company, Limited, Selby.

Londonderry.—The Corporation invite tenders for the supply of arc lamp globes and carbons till year ending Dec. 31, 1899. Further particulars appear in our advertising columns. Tenders by Dec. 30.

Edinburgh.—The Magistrates and Council invite tenders for various work in their electric lighting station in Macdonald-road. Further particulars appear in our advertising columns. Tenders by Jan. 2, 1899.

Burnley.—The Corporation invite tenders for the supply and delivery at their electricity supply station of underground cables. Further particulars appear in our advertising columns. Tenders by Jan. 10, 1899.

Glasgow.—The Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Further particulars appear in our advertising columns. Tenders by Jan. 3, 1899.

Hull.—The Corporation invite tenders for the following work in connection with the tramways—viz. (Contract No. 16) pipes and fittings for power station and condensing mains from dock; (20) builders' work for two car-sheds and other buildings, area about 4,000 square yards; (21) steel roof trusses, steel columns, etc., for above car-sheds. Particulars, etc., may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, after 19th inst. A deposit of £1 for each contract will be required, which will be returned on receipt of a bona fide tender. Tenders before noon on Dec. 30.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Canterbury.—The Town Council have accepted the tender of Mr. Geo. Wiltshire, at £107, for wiring the electric light works.

Shoreditch.—The Vestry have accepted the tender of the British Insulated Wire Company for laying and supplying conduits at a cost of 10s. 8d. per yard.

Waterloo (Lancs.).—The Urban District Council have accepted the tender of Killick and Cochran, 51-53, Seel-street, Liverpool, for the supply of 16 electric arc lamp columns and carriers.

Liverpool.—The Corporation have accepted the tender of Willans and Robinson, Limited, Rugby, at £6,939 per set, less 2½ per cent., for the supply and delivery of four sets of plant similar to those on order for the Pumpfields station.

Bradford.—The Gas and Electricity Supply Committee of the City Council have recommended for acceptance the tender of Siemens Bros. and Co., Limited, at £4,150, for supplying and fixing at the Valley-road electricity works two steam-engines and dynamos.

Tanfield (Durham).—The Tanfield Urban District Council have received the following tenders for the supply and erection of various electric plant throughout their district, including engines, dynamos, cables, insulators, poles etc., to cover a distance of between one and two miles:

No. 1.—Installation.

Corlett Electrical Company, Mosley-street, Newcastle-on-Tyne	£480	0	0
H. Armstrong, Chester-le-Street	618	11	9
W. Dalzell and Co., Quay-side, Newcastle	700	0	0
S. H. Gowdy, Cloth-market, Newcastle	1,080	0	0
Brush Electrical Company, Queen Victoria-street, London	1,471	0	0

No. 2.—Engine, dynamo, &c.

Corlett Electrical Company	440	0	0
H. Armstrong	380	5	9
W. Dalzell and Co.	320	0	0
S. H. Gowdy	1,550	0	0
Brush Electrical Company	870	0	0

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Barrow.—The Electric Lighting Committee have accepted the tender of Crompton and Co., Limited, at about £1,107, for the supply, delivery, and erection of 21 arc lamps, mains, and fittings, etc., subject to the lamp columns being of the type suggested by the Highway and Lighting Committee, and approved by the committee, instead of the type tendered for, and to the omission of the lowering gear.

BUSINESS NOTES.

Paisley.—The electric light is being installed at the Liberal Club.

Ealing.—The Town Council will oppose the new tramway scheme referred to elsewhere.

Walsall.—The Council intend to oppose the South Staffordshire Tramways Company Bill.

Rhyl.—The electric lighting scheme proposed by the District Council is estimated to cost about £17,000.

Havant.—It is stated that an installation of the electric light in Havant may be looked for in the near future.

Whitby.—The Urban District Council intend to ask the Board of Trade to extend their provisional lighting order.

Hereford.—The electric light installation at the outfall works has been completed and is working very satisfactorily.

Pemberton.—The District Council have appointed a deputation to visit the electricity works at Whitehaven and report.

Halesowen.—The Council are applying to the Board of Trade for sanction to supply the district with the electric light.

Wigan.—The County Borough Council have resolved that an installation of electric light should be put down to supply the town.

Grimsby.—It is suggested in connection with the electric lighting scheme that a destructor should be erected at the back of the town hall.

Sleaford.—The Urban District Council have resolved to obtain the advice of a competent consulting engineer before applying for a provisional order.

Wakefield.—Designs and plans for lighting the front of the town hall with electricity will be laid before a committee of the City Council this week.

Drury Lane.—The first section of the electrical stage appliances at the Theatre Royal, Drury-lane, designed by Mr. Edwin O. Sachs, was completed on Tuesday.

Morecambe.—At the last monthly meeting of the District Council tenders amounting to £4 480 for additional electric light plant were recommended for acceptance.

Greetland.—The Halifax Corporation have signified their approval of a scheme to extend their electric tramway to Greetland, about a mile beyond the borough boundary.

Liversedge.—The District Council have decided to support the application of the British Electric Traction Company for the laying of a tramway from Dewsbury to Cleckheaton.

Worksop.—The Urban District Council have sealed the memorial to the Board of Trade for a provisional order as to electric lighting. The amount to be expended is stated at £20,000.

Bath.—The Town Council have practically given authority to the Electric Lighting Committee to introduce the electric light in any case where found suitable and convenient.

Crosby.—The basis of agreement in connection with the construction of electric tramways in the District Council's district by the Liverpool Overhead Railway has been confirmed.

Waterford.—The Board of Works have intimated to the Town Commissioners that the powers obtained by the Council under the provisional order for the electric lighting of the city have ceased.

Heywood.—The Town Council have sealed the application to the Board of Trade for a provisional order to authorise them to supply electricity for public and private purposes within the borough.

Woking.—An expert is to be consulted, at the expense of the Station ward, by the Urban District Council with regard to the advisability of acquiring the works of the existing electric light company.

Salisbury.—The formal opening of the Salisbury electric light works by the Right Hon. the Earl of Pembroke will take place on Dec. 19. A dinner at the White Hart Hotel will follow the ceremony.

Stockport.—The electric lighting station opened on Friday last with a roll of 46 consumers of incandescent lights, and it is anticipated that 36 arc lights will shortly be in working order in the streets.

Dublin United Tramways Company.—The mileage open under this system is now 16 miles electrically and 28 miles by horses, as against 11 miles electrically and 31 miles by horses for corresponding period last year.

Sowerby Bridge.—The Council are considering schemes for electric lighting and extension of their district by the inclusion of Sowerby, Skircoat, and Norland, and parts of Warley, Greetland, and Upper Greetland.

Camberwell.—At Wednesday's meeting of the Vestry, the Libraries Committee was instructed to report on the probable cost of lighting the central library, the art gallery, and the Livesey Library, Old Kent-road, with electricity.

Leeds.—The formal transfer of the House-to-House Electricity Company's undertaking to the Corporation took place yesterday. According to the agreement, the whole of the official and working staff will be taken over by the Corporation.

St. Olave's.—The Board of Works have decided not to offer any objection to the County of London and Brush Provincial Electric Lighting Company's application as to the system of supply for the purposes of the St. Olave's Electric Lighting Order, 1895.

Heckmondwike.—The District Council will at a special meeting consider the plans referring to the British Electric Traction Company's application to the Light Railway Commissioners for powers in respect of the proposed tramway through the Council's district.

Retford.—The Town Council have sealed the memorial to the Board of Trade, praying for a provisional order under the Electric Lighting Acts, 1882 and 1888, to enable the Council to supply electric energy for public and private purposes within the borough.

Darlaston.—The Electric Construction Company have asked for the sanction of the Council to the provision of light railways between Willenhall and Darlaston. The Council have decided to consult other local authorities as to the action they proposed to take.

Telephonic Communication between Lifeboat Stations.—We learn that as soon as the necessary funds are available arrangements will be made to establish direct telephonic communication between the coastguard stations at Trevose Head and Mawgan Porth.

Camborne.—A committee having reported against the obtaining of a provisional lighting order by the Urban District Council, a special meeting will be held next week to consider the application of the Camborne Electricity Supply Company for a provisional order.

Eccles.—The Town Council have decided to supply the Guardians with electric current at the same charges as other consumers—*i.e.*, either at a uniform rate of 3d. per unit or at an all-round rate of 7d. per unit. The electric light works were opened on Dec. 14.

Hiram S. Maxim Electrical Corporation, Limited.—This Company has been registered, with a capital of £250,000, with the object of acquiring from the Hiram S. Maxim Electric Lighting and Engineering (Pioneer) Syndicate, Limited, the H. S. Maxim electric lighting plant.

Hastings.—We learn that the Local Government Board have intimated to the Town Council that they approve of the proposal to purchase the electric light undertaking of the Hastings Electric Light Company, Limited, at a cost of £54,000. The term of repayment allowed is 21 years.

Scarborough.—Plans and a model of the proposed tramway from the North Cliff to the Sands, which provide for a lift to run to the elevation of 117ft., and which it is proposed to place opposite the head of New Queen-street, have been referred to a committee of the Town Council for report.

House-to-House Electric Light Supply Company, Limited.—We are informed that the debenture stock register of this Company will be closed from the 22nd inst. to 31st inst. (both days inclusive) for preparation of interest warrants for the half-year ending the 31st inst., and payable on Jan. 1, 1899.

Tees-Side Tramways.—The Stockton and Middlesbrough Water Board have decided to dissent from the tramways company's application to the Light Railways Commissioners for an extension of their electric tramway system on Tees-side until protection to gas and water pipes has been guaranteed.

Poole.—The Town Council have consented to an application from the Bournemouth and Poole Electric Supply Company, Limited, for a provisional order, having for its object the transfer to the company of the undertaking authorised by the Poole and Branksome Electric Lighting Order, 1897.

Stockton.—The Local Government Board is to be requested to approve of the proposed alteration in the site of the electric light works on the ground that the erection of the same nearer the town would entail less cost to the ratepayers. It is stated that the proposed change will save an expense of £500.

Merthyr.—The Urban District Council have fixed upon the conditions upon which they will support the British Electric Traction Company's provisional order for the electric lighting of Merthyr, and asked the company to send down a responsible official to confer with them upon further details.

Canterbury.—The Town Council are applying to the Local Government Board for £72,000 to cover both the increased expenditure already made, and the proposed extension of electric lighting plant. Mr. N. Stanland has been invited to submit application and testimonials for the post of electrical engineer.

Hove.—At a recent meeting of the Town Council the proceedings of the Town Hall Committee, recommending that electric footlights should be provided for the large hall, and to light the orchestra by electricity at a joint cost of £56, and to provide an electric fan for the ventilation of the kitchen, were carried.

York.—The Streets and Buildings Committee, in recommending the erection of a dust destructor, say that they had to keep in view the electric lighting, and they recommended a particular

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destructor because they believed that they would be able to have more steam, and be able to produce the electric light at less cost.

Greenwich.—At the last meeting of the District Board a letter from the County of London and Brush Electric Lighting Company asking the Board's consent to the grant of an order conferring power to supply electricity in the parishes of St. Paul and St. Nicholas, Deptford, was referred to the committees of those parishes.

Litherland.—At a recent meeting of the Urban District Council a letter was read from the town clerk of Bootle stating that in due time he would send a copy of the clauses of the proposed electric lighting Bill. He enclosed a copy of a section of the St. Helens Corporation Act, 1898, which was the only section in that Act relating to the matter.

Sutton-in-Ashfield.—At a recent meeting of the Urban District Council a discussion ensued with respect to the advisability of obtaining a provisional order with regard to the lighting of the district by electricity, and a deputation already appointed was requested to seek an interview with the deputy town clerk of Mansfield on the matter.

Rotherham.—An application having been made by the Drake and Gorman Electric Power Syndicate, Limited, asking the Corporation to sanction a scheme of tramways from Rotherham to Rawmarsh, the Council have decided to reply to the effect that they could not entertain the application as they intended to construct tramways themselves.

Llanrwst.—Electric lighting is making considerable progress in North Wales. Most of the principal coast towns have either got it or are arranging to get it, and now this Urban District Council are to consider the whole question, they having received a letter from a Manchester electric supply company with reference to the lighting of the town by electricity.

Oldham.—A town's meeting has sanctioned the promotion of the Corporation's proposed Bill for power to take over and extend the local tramways. It was announced that the construction of the lines, which cover about 12 miles, would cost £78,000, and the Corporation had practically decided to adopt electric traction to replace the present horse and steam systems.

Hull.—During a discussion at the Sanitary Committee last week in reference to the driving power for the proposed laundry at the sanatorium, it was said that there was a possibility of the sanatorium eventually getting the power from the city installation scheme of electricity, as there was a possibility of the Alexandra Dock in the near future applying to the Corporation for the electric light.

Bromley Electric Light Company.—The first annual meeting of this company took place last week, Mr. D. Grinsted presiding. Mr. F. E. Gripper was re-elected a director. The report stated that applications for current equal to 3 000 8-c.p. lamps were at hand, and it was expected that a supply for about an equal number would be required by the Chislehurst Electric Light Company.

Northfleet.—With regard to the application about to be made to the Board of Trade for certain extensions in the existing tramway from Gravesend to Northfleet and for permission to introduce electric traction, the Council have agreed to consider the matter in committee after their next meeting, and Messrs. Ashwell and Co. have been asked to send a representative to confer with the committee.

Derby.—The Parliamentary Committee of the Derby Corporation have presented a report to the Council stating that, subject to the approval of the Council, they have agreed to purchase the tramways for £32,000. The committee have also recommended formal opposition to the Bills of the General Power Distributing Company and of the Leicestershire and Warwickshire Electric Supply Company.

Blackwell.—A committee has been appointed to consider an application of the Shirebrook Colliery Company, Limited, for permission to take electric mains into Shirebrook for the supply of private customers. The company, who are already supplying the hotel and shops on their property, also ask whether the local authority would be prepared to deal with them for publicly lighting Shirebrook by electricity.

Blairgowrie.—Mr. Frederick Yorke, M.I.E.E., Glasgow, visited Blairgowrie last week, and along with Mr. Lake Falconer, architect, examined various sources of power with a view to the introduction of electrical lighting into the town. It is reported that Mr. Yorke was very favourably impressed as to the feasibility of the scheme. It is further reported that a syndicate is being formed with a capital of about £10,000.

Hackney.—At Wednesday's meeting of the Vestry, a report of the Electric Lighting Committee was submitted with reference to a letter from the County of London and Brush Provincial Electric Lighting Company on the subject of their application for a provisional order under the Electric Lighting Acts, and stating that the committee had instructed the Vestry's solicitor to take all necessary steps to oppose such application.

Arbroath.—The Committee of Management of the Gas Corporation have approved of the proposed provisional order for electric lighting purposes within the burgh. Powers are sought to expend a sum of £9,950 on the works, made up as follows: buildings and appliances, £1,000; generating plant, £2,900; private lighting, mains, feeders, etc., £4,450; public lighting and mains, £850; legal and expert services and contingencies, £750.

Richmond (Yorks).—At the last meeting of the Town Council the report of the Gas Committee, to which was appended correspondence from several electrical engineers on the subject of electric lighting, was adopted. The replies showed that the Council could not get advice without paying for it, and the cost would be from £3. 3s. to 50 guineas. The Council appears to be still in doubt as to who they will employ in this matter.

Bury.—The Electric Lighting Committee have decided to apply to the Local Government Board for sanction to a loan of £14,000 for the lighting of the compulsory area only. In addition to that it is suggested that certain streets be included, at an additional cost of £1,500, promises having already been received to the extent of 500 lights in those streets, and such additional area also comprising an important residential portion of the town, including the principal churches.

Newcastle.—At a meeting of the new Tramways Committee of the Corporation on Wednesday, the sub-committee reported that they had had under consideration the reports of Messrs. Colam and Hopkinson as to the annual expenditure of working the Newcastle system by cable and electricity, with a 2½ minutes' service. Arrangements were also made to carry out the recent resolution of the Council to visit several places where the cable and electricity are in use.

Salford.—At the last meeting of the Council a report was received from the Tramways Committee on the subject of tramways in Hamburg. Some remarks were made in favour of the conduit as against the overhead system of electric traction, but it was pointed out that whatever system Manchester adopted, they in Salford must also adopt. It was agreed to engage a consulting electrical engineer to advise the Corporation in regard to contemplated expenditure.

Birkenhead.—Major-General Crozier, R.E., an inspector under the Local Government Board, held an enquiry on the 8th inst. into an application of the Town Council for sanction to borrow £15,000 for purposes of electric lighting. The Town Clerk explained that the money was required to provide machinery for increasing the generating power at the central electrical station, and also for providing new mains within the borough to meet the demand for the supply of electricity.

Uxbridge.—Having obtained the sanction of the Light Railways Commissioners for the construction of a light railway from Hanwell to Uxbridge, the London United Tramways Company, Limited, have now issued a notice to the effect that it is their intention to apply for an order to authorise its extension from Hanwell eastwards through Ealing and Acton, and thus form an unbroken connection between Uxbridge and the terminus of the Central London Electric Railway at Shepherd's Bush.

Hyde.—At a recent meeting of the Electric Lighting Committee it was resolved that the Electrical Power Distribution Company, Limited, and the Board of Trade be informed that the Council would not consent to the provisional order being applied for by the company, on the ground that the Corporation had under consideration a scheme of its own. It was said the committee were practically prepared to bring forward an electric lighting scheme for the borough, and to ask for borrowing powers.

Canadian, British Columbian, and Dawson City Telegraph Company.—This Company has been formed to construct and work telegraph lines authorised to be built by the Dawson City and Victoria Telegraph Company, Limited, covering a distance of about 1,400 miles. The line is expected to be in operation not later than April next. The capital of the Company is £300,000, divided into 60,000 shares of £5 each, and the present issue consists of £225,000 5 per cent. first mortgage debenture stock, which is offered at 95.

Doncaster.—The Corporation has formally decided to make application under the Light Railways Act of 1896 for powers to construct and work an electric tram service in the borough and adjoining townships, where the Corporation have a large amount of property. At the last meeting of the Guardians the question of lighting the new workhouse by electricity was considered, and it was stated that Mr. Morton, the architect, had invited tenders, and when received the committee would be called together to consider them.

Swansea.—The work of relaying the tramway system is being pushed forward, and on Saturday the cars on the Morriston section were able to run through without a break. When the real work of electrically equipping the system will be commenced is not known, but it is expected that the present improvements will be completed before the extensions to the suburbs are taken seriously in hand. In the meantime the motorcars by the new company that has been formed for their supply are promised in the course of a few weeks.

Waterloo.—At the monthly meeting of the Urban District Council the Street Electric Lighting Committee recommended that an application should be made for a loan of £550 for street electric lighting, and also to apply to the Local Government Board for their recommendation. The minutes were adopted. At the same meeting the clerk read a communication he had received from the engineer of the Liverpool District Lighting Company, stating that the directors had decided to reduce the price per unit for electric lighting from 8d. to 6d. from Jan. 1 next.

Bristol.—The Sanitary Committee are raising £14,763, this being the balance of a sum which the committee arranged to borrow temporarily, the money being required for the Electric Lighting Committee, who had been authorised to raise a loan for electric lighting purposes. A conference has been arranged between the committee's engineer and electrical engineer and the tramway company's representatives with regard to the proposal that in the streets traversed or proposed to be traversed under the Electrical Powers Act, 1898 (with certain exceptions) centre poles should be used.

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Carlisle.—The Town Council have agreed to supply electric current for motive power at a charge of 2d. per unit for the first 100,000 units per annum. A sub-committee has reported upon the tramway scheme and the various systems of electric traction in vogue in other towns. They recommend the adoption of the overhead trolley system, following the lines of that in operation at Dover, provided the tramway company undertake to obtain the electric current from the Corporation. The report was adopted on Tuesday last. It is stated that the company intend to proceed at once with the scheme.

Rochdale.—Colonel A. J. Hepper, R.E., inspector of the Local Government Board, has held an enquiry into the application of the Corporation for sanction to borrow £30,000 for purposes of electric lighting in the borough. The site has been purchased. The estimates are: £9,500 for buildings; £4,700 for engines and dynamos; £4,000 (instead of £4,800 as originally estimated) for boilers, economisers, condensers, and pumps; £1,000 for switchboards; £1,000 for accumulators; £5,600 for cables and laying them; £1,000 for meters and service; and £1,000 for superintendence and legal expenses. This leaves £2,000 for contingencies.

West Bromwich.—The West Bromwich Town Council have decided to oppose, so far as West Bromwich is concerned, the Bill which is being promoted to empower the South Staffordshire Tramways Company to grant to the British Electric Traction Company, Limited, lease or leases in perpetuity or for such other term as might be authorised by the intended Act of all or any part of their powers. A similar resolution has been carried with regard to the notice submitted by the Midland Electric Corporation for Power Distribution, Limited, of their intention to apply for a provisional order to supply electricity in districts, including West Bromwich.

Wolverhampton.—A meeting of ratepayers will be held next Monday to confirm the action of the Corporation in promoting the Corporation Bill. This Bill comprises 90 clauses, which deal mostly with the tramway question, the Corporation asking for powers to buy the existing lines, to construct new ones, and, further, to work the tramways. It is proposed to lay down a number of new lines in parts of the borough where a tram service has not hitherto been introduced. The Corporation ask to be empowered to use electrical energy for traction, and, if necessary, to lease the lines and to take on lease other lines outside the borough. It is proposed to use part of the cattle market in Cleveland-road as a tram depôt.

Tunbridge Wells.—The Lighting Committee of the Town Council have referred to the engineer a suggestion by Lieutenant-Colonel Bell that more light could be obtained from the arc lamps if reflectors were used. The committee have recommended the Council to sanction five additional arc lamps in Calverley-road. The town clerk has been instructed to appeal against the increase in the assessment of the electric light undertaking. It has been decided to extend the mains in Upper Grosvenor-road and Ferndale. The Local Government Board have sanctioned a loan of £15,000, at the same time requesting that in future the Council will obtain their sanction before commencing the works in respect to which the loan is raised.

Eastbourne.—The Town Council have sealed the application to the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, to authorise them to supply electrical energy for public and private purposes within the borough of Eastbourne, and the carrying into effect of any agreement which may be arrived at for the purchase by the Corporation of the undertaking and works of the Eastbourne Electric Light Company, Limited. A special meeting of the Ratepayers and Property Owners' Association was held on Monday, when it was resolved that a requisition should be sent to the Mayor for a public meeting of ratepayers to be held for the purpose of discussing the advisability of purchasing the electric light company's works.

Ilkeston.—Mr. Talbot's report, which has been adopted by the Council, sets out that by combining the mains for the two undertakings (lighting and tramways) great economy would result, and less spare plant would be needed. Land and buildings had been included in each set of estimates, and if both undertakings were carried out this part of the two estimates would be modified. He estimated the cost of the electric lighting plant capable of supplying 3,000 8-c.p. lamps at one time and 50 arc lamps for street-lighting, with ample reserve plant, at £15,765; and for tramways, including buildings, permanent way, power station and plant, overhead construction feeders and 10 cars, with the necessary car shed and repairing shop, at £64,740. 4s. 9d.

Edmundsons' Electricity Corporation, Limited.—This Company is making an issue of 75,000 4½ per cent. first mortgage debenture stock at par, and the list will be open from to-morrow until Tuesday, 20th inst., at 4 p.m. In the prospectus which appears in another column a detailed statement of assets is made, showing a total of £189,405 (exclusive of goodwill) as security for the debenture stock. The additional capital sought for is required for completing contracts in hand for the laying of central stations and for similar new business. Central stations either have been or will shortly be completed by this Company in Winchester, Salisbury, Folkestone, Bromley, Alderley Edge, Chislehurst, Newmarket, High Wycombe, Ventnor, and Woolwich.

Darwen.—The Town Council on Monday passed a resolution authorising the purchase of the undertaking of the tramways company running between Blackburn and Darwen, in conjunction with the Blackburn Corporation. The apportioned price for Darwen's share of the tramways is £26,400, in which is included £2,000 for the depôt, which will be the property of Darwen. As the Darwen Corporation were only applying for powers to work the system, a lease will be granted to the Blackburn Corporation, who will work the line and pay Darwen £85 per quarter for the repairs of the rails, etc., and £916. 10s. by way of rent. Mr. Alderman Lightbown, in seconding the resolution, said the company were receiving a very fair price, and the Corporations a very valuable property.

Brisbane Tramways Company.—The Tramways Construction Company, Limited, placed on the market this week £167,000 5 per cent. first mortgage debentures at 105 per cent., equivalent, with accrued interest, to £103¾, the amount being part of a total of £250,000 (the balance being held in Brisbane), and redeemable at par on Oct. 1, 1917, or prior to that date at £105. The Company has a capital of £250,000 in £5 shares, fully paid, and was formed in 1895 to acquire the Brisbane tramways, and to convert them from horse to electric traction on the trolley system, and to construct several extensions. These works are now nearly completed, and the routes already finished comprise 10 miles of double and six miles of single track. For the half-year to Sept. 30 last the net profit was £8,878, which rate is expected to be largely increased. The Municipality has the right to purchase the undertaking in 1917.

Blackpool.—Last week we referred to the temporary stopping of the erection of the overhead poles by the newly-elected Council. The General Purposes Committee subsequently convened a meeting, at which it was pointed out by the Borough Electrical Engineer that on a fine day the minimum leakage of current under the present system was 45 per cent. That was a very serious matter, as the Board of Trade only allowed a maximum of 2½ per cent. Then the new copper conductors cost £800 per year, repairs to collectors absorbed £400, whilst the cost price of the electricity which ran to waste in the earth, and from which they derived no benefit, was £700 per year. That caused a loss of £2,200 per year, and the overhead system would prevent it. It was decided to adopt the overhead system by 25 votes to 11. The cost of the change will be £6,000, and this sum, it is anticipated, would be saved within two years.

Islington.—At the last Vestry meeting, in reply to questions, it was stated that there were 216 arc lamps in the parish, costing annually £6,822. 13s. 4d., or about £31 per annum each lamp. The number of lamps displaced by arc lamps were 440 gas lamps, which cost the parish £1,747. 17s. 4d., or £3. 19s. 5d. each per annum. The Surveyor said he did not think the electric lighting mains in the parish were laid too near the surface of the pavement. At the meeting of the Guardians last week it was resolved: "That the portion of the report of the Highgate-hill Infirmary Committee of Oct. 27 having reference to the electric lighting of the new infirmary be rescinded." A speaker said that the Guardians had acted hastily when they passed the resolution, and argued in favour of the Guardians obtaining the light from the Vestry. The price per unit had been reduced, and would be further reduced in the future.

British Schuckert Electric Company, Limited.—This Company has been registered, with a capital of £200,000 in £10 shares, with the object of carrying on in Great Britain, her colonies and dependencies, the business of electrical and general engineers, manufacturers of cables, lamps, switchboards, wires, lamps, electrical signals, etc., as producers and suppliers of electricity for the purposes of light, heat, or power; the application of electricity to metal work, mono-rail, and hanging rail and tramroads; manufacturers of angles, plates, nuts, bolts, chains; insulator manufacturers; woodworkers; to construct and maintain experimental or show lines; as wire-drawers; to acquire and turn to account any real or personal property, patents, patent rights, and inventions; as company promoters, bankers, financiers, and concessionnaires. The first directors are Messrs. H. S. Alderson, P. R. MacMahon, L. Mannelle, E. Kraftmeier, F. T. Eggers, and A. Hassler.

Plymouth.—The *Western Morning News*, in a report on last Monday's meeting of the Borough Council, states that, answering questions, Mr. Radford said there was little doubt that the town would be able to supply electric light cheaper than it could be obtained by private installation. There had been some unfortunate delays in connection with the work. They were waiting now for the completion of the buildings, and the new light ought to be in full working order by next March or April. Mr. Eyre said a rumour had got abroad that the engineer had underestimated the work to the extent of £10,000. Mr. Rider (borough electrical engineer) said that was the estimate on capital; it had nothing to do with revenue. His estimate of £46,000 included a certain sum for buildings, and that had been considerably exceeded, and that only. The whole of the engineering contracts had been kept practically within the estimates. Mr. Eyre: Who is responsible for the excess? Mr. Rider: I am. The minutes of the committee were approved.

Appointments Vacant.—The Blackheath and Greenwich District Electric Light Company, Limited, require the services of an experienced clerk of works. Applications to be forwarded to the Secretary, 11, Charing Cross-road, W.C., by 20th inst. The salary is £4 per week.—The Electric Lighting Committee of the Hull Corporation invite applications for the appointment of a mains superintendent. The salary is £120 per annum, rising by three equal annual increments to £150. Applications are to be sent to Mr. A. S. Barnard, city electrical engineer, Dagger-lane, Hull, by 21st inst.—The St. Annes District Council are advertising for an electrical engineer.—The Corporation of Carlisle require an assistant engineer (£130), two drivers, and a switchboard attendant. Applications must be made before Dec. 31.—A dynamo attendant is also required by the Lancaster Corporation.—There are several vacancies for works managers,

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draughtsmen, armature winders, etc., particulars of which will be found in our advertisement columns.

Dublin.—At a special meeting of the Corporation, held to consider the report of the Finance and Leases Committee on the estimates for the nine months ending Sept. 30, 1899, the Electric Lighting Committee's estimate was adopted. The Chairman said the committee had no occasion to ask the Council to provide in the estimates for any expenditure in the electric light during the coming year because they provided a credit balance to draw from. That was most creditable, in spite of the defects that occurred from time to time and he hoped it would be a good augury of the larger scheme which the Corporation was going to take up. It was stated that the price of electric light was very high, but when it was adopted all over the city they hoped to be in a position to reduce it to the same price as that of other cities. The larger scheme would mean, when adopted, that the citizens would be able to get the electric light for a less price than that now paid for the gas. They expected to be able, when the larger scheme was adopted, to supply electric light at 4d. per unit.

Southport.—At the last meeting of the Town Council it was stated that a provisional order was being applied for by the British Electric Traction Company for power to lay down lines along the route which the Corporation themselves intended to use for that purpose. The Southport Tramways Company had also given notice of a Bill to enable them to generate electricity and work its trams by electric traction. The lines used by the company were the property of the Corporation. However, the General Purposes Committee and the Parliamentary Committee would shortly meet with a view to a petition being lodged against the Bill of the Southport Tramways Company, and to consider a statement of objections of the Electric Traction Company. It was agreed not to oppose the Bill promoted by Mr. Wood, civil engineer, of Liverpool, for power to carry out a scheme for connecting Southport with Lytham by means of a tramway. The Electricity Committee have decided to apply to the Local Govern Board for authority to borrow £3,500 for the purpose of providing a condensing reservoir for the electricity works.

Gateshead.—At a recent meeting of the Town Council the Parliamentary Committee reported that a letter had been received from the secretary of the Electrical Power Distribution Company Limited, accepting the terms on which the Council gave their consent to the grant by the Board of Trade to the company of a provisional order authorising the company to supply electrical energy for public and private purposes in the borough. The committee further reported that notice had been given by the Gateshead and District Tramways Company of their intention to apply, in the next session of Parliament, for a Bill authorising the company to construct the tramways within the borough, with all necessary machinery and works. Statutory notice to apply to Parliament was also reported to have been given by the Electrical Power Distribution Company, Limited, for power to produce, store, and supply electricity within the borough, in accordance with the arrangement with the Corporation. The committee had received a deputation in support of an extension of the tram system to Wrekenton, and had instructed the town clerk to write to the secretary of the company upon the matter.

Great Horseless Carriage Company.—The announcement made that the shareholders of this Company, whose works are at Coventry, are to receive a return of £8 per £10 share, or 16s. in the pound on their holdings, terminates a long cause of threatened litigation. The Great Horseless was one of the several companies Mr. H. J. Lawson brought out in 1896, and the original directors were Messrs. H. J. Lawson, J. H. Mace, T. H. Lambert, Hon. E. H. Ellis, E. J. Pennington, T. Robinson, G. Daimler, and H. Sturmey. The Company was formed for "carrying on the horseless carriage industry in the United Kingdom, and to purchase a licence to use the patents and patent rights of the British Motor Syndicate for all vehicles other than cycles," and the capital was three-quarters of a million of money. Part of the old cotton mills at Coventry became the works and premises. This time last year "reconstruction" took place, by which cash was to be handed over to the British Motor Syndicate, but the shareholders were to find another 30s. per share. It is now announced that the London Steam Omnibus shareholders—this company was also brought out by Mr. Lawson last summer—are taking action with the view of recovering their money.

Greenock.—Mr. Fedden, the borough electrical engineer, has prepared a report on electric tramway haulage in the district. With reference to the proposal to take over the tramway company's undertaking, he estimates the amount payable to the existing company for their lines from Rue-End-street into Port-Glasgow at £45,000, while the conversion of lines from end of Port-Glasgow to Ashton would require a capital of £150,800. Mr. Fedden believes that all the conditions of the service would be improved if the tramways were in the hands of the Police Board. In the event of the Board renewing the lease to the company, they should make it a condition that the company should repair the whole of the streets from kerb to kerb, which would amount to a saving of £600 per annum to the town. The company should also have to pay to the Police Board £2,000 per annum, or some similar amount to be agreed upon; and, besides such a price per unit for electricity as to give reasonable profit to the Board's electrical department. Mr. Fedden further advises that if the Board should think of taking over the tramway line, they should take over the whole of it, and in the near future extend the line considerably to the south.—*Glasgow Herald.*

Beckenham.—The following report of the Electric Lighting Committee has been adopted by the Urban District Council: "A memorial from inhabitants of South Hill Park asking for the consent of this Council to the provision of a temporary supply of electricity from the Bromley (Kent) Electric Supply Company, Limited, was submitted, together with a report by the clerk and surveyor on an interview with the secretary of the Bromley Electric Company. It appears from the latter, and from the correspondence, that the Council have the option either of taking a supply of electricity in bulk from the Bromley Electric Company and distributing it themselves, or allowing the Bromley Electric Company to treat South Hill Park as within the limit of the Bromley electric lighting order. In the latter case the company would carry out the necessary works, supply the electricity, and receive payment direct from the consumers. The committee instructed the clerk and surveyor, in conjunction with the Council's electrical engineer, to prepare and submit a draft agreement, embodying proper provisions and safeguards, for the supply by the company of electricity in bulk." The agreement between the Council and the National Telephone Company has now been settled.

Bentley.—At a special meeting of the Parish Council, the Clerk said that it was proposed to construct a light railway or tramway from Bentley to Doncaster, and it appeared that the British Electric Traction Company were the first party to make a movement in the matter. He produced correspondence from the company similar to that submitted to the Doncaster Corporation and Wheatley Parish Council. He had no correspondence from the Corporation, but he had seen the town clerk, who had shown him the plans of the routes which the Corporation proposed to take, and which were exactly like those of the British Electric Traction Company. The gauges of the former would be 4ft. 8½in., the standard, and of the latter 3ft. 6in. The British Traction Company intended to ask the Commissioners who would sit upon the matter for power to use electricity, steam, or any other power, but the Corporation were going in for electricity only. They were going to light the town with electricity through an expensive plant, and the town clerk had informed him that the Corporation intended to work these tramways from the same source. Resolutions were passed to the effect that the Bentley Parish Council assents to the tramway scheme, and that the Corporation's scheme have the preference.

Coventry.—At the beginning of the year the City Council adopted the following instruction with reference to the method of construction of the new tramways: "That where it is impracticable to carry the overhead conductor by means of span wires fixed to the houses, standards with brackets be approved for that purpose." Difficulties having arisen in the application of the bracket system to the Binley-road, between Far Gosford-street and the city boundary, the tramway company have applied for permission to use the span-wire system with a double line of poles, on this length of road. The city engineer has suggested an improvement of this road, which would make it practicable to adopt the bracket system, the poles being erected on the south side of the road. The suggestion was that the lines of the footpaths on both sides of the road should be improved, kerbs and channels laid where they do not now exist, and the footpaths laid with tar asphalte. For the kerbs and channels old materials removed from the centre of the city would be used, and the cost of the work carried out on these lines was estimated at £290 for the north side of the road and £350 for the south side. It is not proposed that the whole of the work should be carried out at once. The scheme of improvement has been approved by the Council, and it is proposed to do the work as the material came to hand in the course of effecting improvements in the centre of the city. The south side of the Binley-road will be taken in hand first, in order that the tramways may be completed.

Barrow.—A sub-committee has been appointed to superintend the erection of buildings and the carrying out of works in connection with the electric light undertaking. Tenders for the supply, delivery, and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches and fittings have been referred to Messrs. Kincaid, Waller, and Manville for report. The Electric Lighting Committee recently received a letter from Mr. Aslett, forwarding copy of an estimate he had received for carrying out certain additional work in connection with the cables and wires at the Furness Abbey Hotel, in pursuance of the requirements of the borough electrical engineer, and stating that, as the work was originally carried out without the Furness Railway Company being furnished with a specification by the Corporation, he thought this expenditure should be borne by the committee. The committee have replied, regretting their inability to agree with him that the expenditure to be incurred by the company in carrying out the additional work in connection with the above installation should be borne by the Corporation; that the alterations are only such as would be required by almost every central-station engineer in the country supplying current at 220 volts, and that they are practically for the exclusive protection of the consumer, and are consequently entirely in his interest; that, as an illustration, if the works are not carried out, a slight defect in any one lamp would result in the extinction of all the lights in six or seven rooms, and that after this explanation the committee trust he will see his way to have the work in question carried out.

Torquay.—It was reported at the last meeting of the Town Council that when the electric works opened there were 40 consumers, now there were 95. Fourteen applications were in hand. The revenue from March 17 to Sept. 29 amounted to £1,091. A report was read on the cost of the electric lighting undertaking, stating that now the works would afford a constant supply of electricity. The total outlay was £24,867, an increase of £1,726 over the estimated cost. From the total of £24,867 had to be

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deducted £920, the value of the material available for the extension of the mains, thus reducing the total actual cost of existing works to £23,946. The amount sanctioned and borrowed for the undertaking was £22,300, so that the works have cost £1,646. 16s. 1d. more than the sum borrowed. The cost was made up of the following items: 20,050 yards of cable and laying £5 589, an increase of £208 over the estimate; 52 arc lamps fixed £1,346, less by £437 than the original estimate, which was for 70 arc lamps. Of the machinery at the stations, the transformers, switchboard, rectifiers, engines, boilers, etc., cost £13,011 being £840 over the estimate. The builder's account amounted to £1,139; work carried out by Mr. Garratt cost £545; the two together being £1,115 over the estimate. Sundry small items cost £18, consumers' services £428, meters £501, materials provided but not used £920, engineer's fees £1,184—making the total expended on the works £24,867. Mr. W. H. Trentham, the consulting engineer, wrote explaining that the difference between the contract price and the amount actually expended was justified by additional work having been done, and pointed out that the cost per kilowatt was only £53, which was a much lower figure than in any other public works in the kingdom.

Lambeth.—The Lighting Committee have recommended the Vestry to adopt the proposals contained in the letter of the South London Electric Supply Corporation, Limited, of Oct. 21, 1898, except that the arc lamps be continued in lighting until one o'clock in the morning instead of midnight, as proposed by the corporation, and that whenever the new lamps take the place of a refuge or other large lamp, then either the arc lamp be continued all night, or else that the incandescent lamps (to be lit when the arc lamps are put out at 1 a.m.) be of not less illuminating power than the lamp displaced, and subject to a proper agreement being entered into to the satisfaction of the clerk to the Vestry. The letter mentioned in the resolution sets forth that the company are willing to enter into terms for the erection and maintenance, from a date to be agreed upon, of 50 arc lamps in the neighbourhood suggested by the committee, on the following terms and conditions: The company to erect 50 lamps (which are to be of a capacity for 600 watts each), lamp posts and fittings free of all charge to the Vestry. The said arc lamps to be lighted daily from dusk till midnight, when they are to be replaced by 100 32-c.p. lamps till dawn. The charge to the Vestry to be at the rate of £22. 10s. per annum for 25 of the lights, the remaining 25 to be lighted and maintained in accordance with the terms of the Vestry's transfer of the order. At the expiration of one year from date of commencement of supply, the Vestry to have the option either of discontinuing the 25 lamps, for which they pay the annual charge of £22. 10s. each, upon giving three months' notice of their intention so to do; or of placing with the company an order for at least a further 200 lamps, which 200 lamps are also to be erected and maintained at the company's expense and supplied with light, at £22. 10s. per annum apiece. But in the event of the Vestry exercising the option to discontinue the 25 lamps, or in the event of their failing to increase their order to a minimum of 250 arc lamps—the number suggested in previous correspondence—they shall pay the capital cost of the 25 "free" lamps at the rate of £32 per lamp, and the remaining 25 shall be removed at the company's expense.

Fulham.—With reference to the report mentioned in our issue of the 2nd inst., the report of the Lighting, Electric Lighting, and Dust Destructor Committee, which has been adopted by the Vestry, states that the committee finds that by the time the necessary consents and contracts are obtained and made to enable the current to be taken as a temporary expedient from Hammersmith, the Vestry will itself be in a position to give the supply, and further, if the Vestry were to resolve to give the temporary supply by the means suggested, they would have to face a probable loss of some £2,000, a course which they think the Vestry would be extremely unwise to adopt. With reference to the proposed increased output of current, the extra cost to the Vestry of doubling the output would be upon a fair and careful estimate about £6 000 if carried out now. Whereas if the original scheme be first carried out, and then after completion the output of the station be doubled, and the capacity of the mains be correspondingly increased, the cost to the Vestry would be, upon a fair estimate, about £11 500, so that by adopting the increase now there will be a direct saving to the Vestry of the estimated sum of £5,500, with the added advantage that the Vestry will be able on completion of the works to supply consumers up to 28,000 8-c.p. lamps, instead of only 14,000 8-c.p. lamps, and thus avoid the necessity and consequent loss of keeping other would-be consumers waiting several months whilst new plant is being erected. The committee had also ascertained that the parish of Hammersmith, who started their installatien in 1897 with engines equivalent to a maximum demand of 7,500 8-c.p. lamps, had, in 1898, to increase their plant to an equivalent of 30,000 8-c.p. lamps, and on Nov. 14 they had customers waiting whose demands amounted to 9,000 8-c.p. lamps. It has therefore been resolved (1) to inform all present and future applicants that, whilst the Vestry view with favour the desire for an immediate supply of current, by taking it from Hammersmith, owing to the difficulties of time, and the probable heavy loss to Fulham, the Vestry regret that they are unable to accede to their request; and also (2) that the report of the engineer, recommending an increase of engine power to supply 28.000 8-c.p. lamps, be adopted. At the meeting on Wednesday last a report of the Lighting, Electric Lighting, and Dust Destructor Committee was submitted, stating that the consulting engineer's plans for the generating station, etc., had been presented to a sub-committee for consideration and report. The consulting engineer had staked out the ground which he proposes to cover with generating and disinfecting works, and he was also preparing a block plan of the Town Mead-road site for the permanent use of the committee. Eight lamps were being erected on the footpath leading from the Town Mead-road to Broomhouse Dock at a cost of £28. A sub-committee was preparing a circular to builders and others in the parish, giving particulars of the electric lighting system in order that they may prepare the necessary wiring to their buildings; also setting out an approximate time when the Vestry will be prepared to supply current, and inviting applications from intending consumers, notifying that such applications will be duly dealt with in proper rotation.

Chiswick.—The District Council have adopted a report of the Electric Lighting Committee, stating that, with the advice of Messrs. Asburst, Morris, Crisp, and Co., they have met representatives of the Aberystwyth and Chiswick Electric Supply Corporation, Limited, and arranged with them as under: (1) Site of generating station.—The area of the site to be leased for a generating station to be increased from 5,000ft. to 7,500ft. The lease of the 5,000ft. area to be abandoned, and a new lease of the whole area of 7 500ft. to be granted at a rent of £100 per annum. The lease of the larger area to be *mutatis mutandis* the same as the agreed draft lease for the 5,000ft. area, but, like the latter, not to be granted until the company has completed the work to be carried out under the deed of transfer of July 25, 1893. (2) Right to lay pipes and use jetty.—The Council to grant to the company the right to lay two pipes (one suction and one discharge) from their generation station to the river. Also to allow the company the use of their jetty for landing coal and other materials for use at the generating station. The Council to have priority of use of the jetty for their own purposes at all times. The right to use the Council's crane not to be included. This agreement may be determined at any time on either side by 12 months' notice. The company to pay for the above rights £100 per annum, also half the cost of maintaining the roadway between the jetty and the generating station. The company to make arrangements with the Thames Conservancy for the taking of water from the river. Reinstatement of roads.—The company are to open the roads, lay their mains and fill in the trenches in accordance with their statutory obligations; but the Council will reinstate and make good the surface of the roads over the trenches. The company to pay the Council for this work on the basis of the schedule of prices paid for similar work by the gas and water companies. The company to pay the Council's bills for the above work weekly. The deposit of £200 to be always maintained, and, if owing to the default of the company the Council should have recourse to the deposit to repay moneys expended, the deposit is to be at once made up by the company. The report concluded by stating that a proposal that the committee should accept a document signed by three gentlemen, undertaking to expend a sum of £20,000 forthwith in carrying out the obligations of the provisional order and the deed of transfer, was not entertained.

Whitechapel.—The District Board have received a letter from Mr. Renwick, secretary to the County of London and Brush Provincial Electric Lighting Company, Limited, intimating that that company had made an application to the Board of Trade for a provisional order to light the district with electricity, and asking for the consent of this Board to the grant of an order. The communication has been referred to the Electric Lighting Committee. The Electric Lighting Committee's recommendation, which has been adopted, and which was shortly summarised in our last issue, reads as follows: "That the proposal of Mr. Arthur Wright, the electrical engineer for Brighton, for the supply of electricity in the district of Whitechapel, for lighting and supply of motor power purpose, by an installation upon the premises of the Board in and adjoining George-yard and Angel-alley, Whitechapel, in the manner suggested by the report of Mr. Wright as shown upon certain plans prepared by him, be adopted, or any necessary modifications of such plan, to the intent that arrangements be forthwith made to carry out the portion of the work contemplated by the report to be performed within the first two years, at the estimated cost of £60,500, and that arrangements be also made for reconstructing the destructor for generating steam power in aid of the intended installation." Mr. Wright's report briefly summed up is as follows "The district of Whitechapel forms a most promising field for the supply of electricity for lighting and motive power purposes. The electricity undertaking can be made to be self-supporting in two or, at the most, three years, but its profits must not be looked upon as a means of relieving the general rates. A supply of electricity could be given to the principal streets by the autumn of 1899. A large development in the future must be provided for in the design of the generating station. A sliding scale of charges ought to be adopted, so as to obtain the custom of the many late users of artificial light in the district. Electricity can be profitably supplied at less than 4d. per unit to all consumers in Whitechapel who regularly use their lamps later than 8 p.m. The capital required during the first two years will probably be £60,500. The site selected for the work is suitable. The steam from the destructor boilers will materially help to reduce the cost of electricity for street-lighting and motive power. Sufficient plant for the supply of next year's requirements can be temporarily laid down in one of the present buildings on the site. The continuous-current three-wire system is the best suited for the electricity supply of Whitechapel." In the course of his report, Mr. Wright points out that it is now well known that the most important conditions determining the lowest price at which electricity can be supplied to any district without financial loss are the density of the demand in, and the compactness of, that district, coupled with the average number of hours per day the

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supply is made use of by the inhabitants, and it is well to bear in mind that these conditions have far more influence on the cost of supplying electricity to the general public than the cost of such items as fuel, labour, etc. The custom of keeping open shops in Whitechapel to a late hour every evening, taken in connection with the district's very compact nature, makes it, in his opinion, a most promising field for an electricity undertaking, as a supply could safely be given at an average price low enough to at once remove the common impression that electricity is still an expensive luxury, and more suited to the West-end than the East-end of London. In fact, there is every reason to suppose that owing to the much longer daily use likely to be made of the supply in Whitechapel than in the other districts of the Metropolis which are already supplied, electricity can there be given to the ratepayers at an average lower cost than it is now being offered anywhere else in London. The business, however, must be handled in an energetic manner, and not merely left to develop itself under the impression that the natural advantages of the electric light are sufficiently well known as to do away with all necessity of having to actively push the undertaking. In this connection it must be remembered that the electricity business, being the supply of something which has to compete with very powerful rivals actually in possession, must not, to be successful, be treated in the leisurely manner frequently met with in the municipal supply of water, gas, etc. Mr. Wright adds that the streets in which the distributing mains ought to be laid down in the next two years are as follows: Whitechapel-road, High-street, Leman-street, Commercial-street, Commercial-road, Middlesex-street, Wentworth-street, Church-lane, Brick-lane, Osborn-street, Great Alie-street, Little Alie-street, Cable-street, Brushfield-street, White Lion-street, and Norton Folgate.

Kensington.—At the meeting of the Kensington Vestry on Wednesday last, the Law and Parliamentary Committee presented a report dealing with the proposed Kensington and Notting Hill Electric Light Bill, in which they stated that the scheme contemplated the purchase of land in various parts of the parish for the erection of generating stations, and that the Vestry would be returned as dissenting from the scheme with the object of securing their *locus standi*, and the committee had given directions for the notice and plan to be brought before the Special Electric Light Committee for their consideration in connection with the negotiations which are at present proceeding between the committee (on behalf of the Vestry) and the company. It was stated that a large number of protests had been received with regard to the site scheduled, comprising property in Kelso-place, Stanford-road, Tarn-mews, Logan-mews, and South End-row, situate to the east of the Midland Railway depôt. The district was one of the most highly rented in the locality, and the value would greatly depreciate if a large chimney was erected there. More strenuous action should be taken than appeared to be suggested. It was proposed that this particular site should be referred to the Law and Parliamentary Committee to consider the serious objections which were likely to be urged by the residents, and to report as to the Vestry offering this portion of the scheme the most strenuous opposition. This motion was seconded, and the proposal was described as one of the most audacious ever made. It was pointed out, however, on behalf of the committee, that it would be premature to do any more than place on record the dissent of the Vestry, as the Bill was not yet deposited, and, further, it was not desirable to place on paper at present the details of the opposition to be offered. The chairman of the committee said that full effect would be given to the object of the motion when it became necessary to deal with the Bill in the event of the company going on in a hostile spirit and rejecting the negotiations at present proceeding with reference to another site. The motion and report were then agreed to. A report of the Works and Sanitary Committee was submitted, stating: "That with reference to the agreement entered into in November, 1897, between the Vestry and the National Telephone Company for the laying of pipes for underground telephone wires in this parish, the committee have for several months past had before them plans furnished by the company, showing the route of the proposed pipes. The element of uncertainty which has surrounded the question of the telephone service in the Metropolis and of the country generally, has led the committee, apart from other reasons connected with the plans themselves, to defer reporting at an earlier date on the plans submitted; but it is now felt that whatever the ultimate decision may be as to the taking over of the service by the Government, or the construction of a new competing system, the company may reasonably be regarded as entitled to proceed with their works in the parish under their agreement with the Vestry. The plan which the Vestry are now asked to approve shows, at the request of the committee, the whole scheme for the company's underground pipes in the parish, the route of such pipes following on lines indicated by the surveyor as being open to the least objection and avoiding as far as possible interference with the main thoroughfares in the parish. The committee also think it right to mention that the engineer of the company has attended before the committee and explained that, on the execution of the agreement with this Vestry, the company at once proceeded with the laying of their pipes in the adjoining parishes of Hammersmith, Fulham, Chelsea, and Paddington, and that these works will be useless until these pipes can be connected through Kensington parish and with the large telephone exchange which the company contemplate erecting in the south portion of this parish. The company have also, it is stated, a great number of applications to be connected with the telephone system, but are unable under existing circumstances to grant the desired facilities." The committee recommended that the plan and drawings of the proposed works of the company in the parish should be approved. The report also stated that on Sept. 22 last a notice was given to the Vestry by the House-to-House Electric Light Supply Company of their intention to lay pipes and mains in Redcliffe-gardens, Earl's Court-road, Richmond-road, Old Brompton-road, and Kensington High-street, as shown on deposited plans, it being intimated in a letter, covering the statutory notice, that it was anticipated that some of the pipes to be laid in accordance with the plan would be required for public lighting throughout the area, whilst the remainder would be used as private lighting feeders. As no arrangement had been arrived at which in the opinion of the Vestry would justify the breaking up of the public way for the laying of pipes for wires to be used for public lighting, the company were requested to send in amended plans showing the route for pipes to be used for private lighting purposes only. The company have since intimated that pipes for the private lighting purposes will be required over the whole of the route shown on the original plans, and they have therefore furnished an amended statutory notice eliminating the pipes for public lighting. Permission is to be given for the works to be proceeded with in accordance with the plans and amended notice referred to, but it is to be pointed out to the company that if they deem it expedient to lay down, at their own risk, pipes for public lighting purposes in accordance with their original proposal, the Vestry will offer no opposition to their doing so, although it must be clearly understood that this sanction must not be used to prejudice the Vestry's application for a provisional order under the Electric Lighting Acts, and that the Vestry must not be regarded as having undertaken to use for public lighting purposes any of the mains so laid. Notices and plans having been received from the House-to-House Electric Light Supply Company relative to extensions of their mains in Pembroke-square and Philbeach-gardens, permission has been given for the works to be proceeded with, subject to the usual conditions.

PROVISIONAL PATENTS, 1898.

DECEMBER 5.

25592. An improved fusible cut-out for electric circuits. F. W. Heaton and Hy. Smith, Salford Switch Works, Salford, Manchester.

25632. Improvements in electric arc lamps. James Stephen Blackwell and William Arthur Charles, 322, High Holborn, London.

25657. Improved electrical signalling devices for railways. Louis Jacob, 18, Buckingham-street, Strand, London.

DECEMBER 6.

25667. Improvements in electrical resistance coils. Samuel Wells Cuttriss, 6, Fieldhead-terrace, Leeds.

25670. Improvements in electrical induction apparatus. Thomas Curton Kinraide, 55, Chancery-lane, London. (Complete specification.)

25710. Improvements in dynamos. John Edward Fuller, 78, Fleet-street, London. (Complete specification.)

25734. Improvements in secondary batteries. William Schlothauer and Albert Edward Preece, 171, Queen Victoria-street, London.

25746. Improved means for electrically heating ovens, hot chambers, rooms, and the like. Frank Christy and Leonard Fell Christy, 55, Chancery-lane, London.

25747. Improvements in or connected with incandescent electric lamps. Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

25752. Improvements in electrometers and in keys for operating the same. George Leonard Addenbrooke, 53, Victoria-street, Westminster, London.

25764. Improvements in devices for making and breaking surface contact on electrical tramways. William Frederick Stamp, 46, Lincoln's inn-fields, London.

DECEMBER 7.

25863. Improvements in and in connection with radiating axles for electrically-propelled railway or tramway cars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

25877 Improvements in or relating to contact devices for electric igniters of explosion engines. Alfred Julius Boult, 111, Hatton-garden, London. (Société Nouvelle des Etablissements Decauville Ainé, France.)

DECEMBER 8.

25895. Improvements in and relating to electric switch or key lampholders or sockets. Percy Garniss Ebbutt and Veritys, Limited, 104, Colmore-row, Birmingham.

25896. Improvements in connection with electric lampholders or sockets. Percy Garniss Ebbutt and Veritys, Limited, 104, Colmore-row, Birmingham.

25961. Improvements in insulator brackets for electric conductors. Carl Pellenz, Norfolk House, Norfolk street, Strand, London.

25985. Improvements in methods and means of electric ignition for explosion motors. Philippe Pichard, 18, Buckingham-street, Strand, London. (Complete specification.)

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DECEMBER 9.

26014. Improved electric stop motion for drawing-frames. John McQueen and Dyson Barker, 17, St. Ann's-square, Manchester.

26020. Improvements in and relating to electrical switches. Harry William Cox, Brougham-chambers, Nottingham.

26026 Improvements in and relating to galvanic batteries. William George Heys, 70, Market-street, Manchester. (Siegfried Silberberg, United States.) (Complete specification.)

26033. Improvements in connectors for electrical cables or wires. Herbert Woodville Miller, William Turvey, and George Cambridge Weston, 4, Aubrey-walk, Campden-hill, Kensington, London.

26038. New or improved means for electrically operating clocks. William Beaumont Buer, Thomas Whorlow Legge, and Joseph Tabrar, 306, High Holborn, London.

26063. An improved switchboard for use in connection with electrically-illuminated signs and display frames. William Alfred Gent, 11, Burlington-chambers, New-street, Birmingham.

26067. A new or improved holder for electric glow lamps. Henry Charles Gover and Charles Faraday Proctor, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26068. Improvements in electrical glow lamp fittings. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

26073. Improvements in or connected with the arrangement of conductors for transmitting electrical energy from a generating station upon land to a movable structure in water. Arnold Frank Hills, 4, South-street, Finsbury, London.

26074. Improvements in or connected with electromotors. Arnold Frank Hills, 4, South-street, Finsbury, London.

DECEMBER 10.

26092. An improved mode of winding for the armatures of dynamos and electromotors. Alexander George Gordon Cumming, 8, South Fort-street, Leith, Scotland.

26116. Improvements in and relating to galvanic batteries. William George Heys, 70, Market-street, Manchester. (Siegfried Silberberg, United States.) (Complete specification.)

26136. An improved electrical measuring instrument. Karl Lehner, 6, Lord-street, Liverpool. (Complete specification.)

26145. Improvements in continuous-current dynamos, motors and motor-dynamos. Arthur Osborne Berry, 23, Fitzwilliam-road, Clapham, London.

26153. Improvements in and in connection with telephonic microphone apparatus for electric signalling. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

26164. A resistance switch for electric motors. Cecil Burman Callow and Justus Eck, 5, Priory-road, Bedford Park, London.

SPECIFICATIONS PUBLISHED.

1897.

26671. Electrical indicating apparatus for use in hotels, restaurants, workshops, and for analogous purposes. Boult. (Moutardier and Boudet.)

26732. Systems of electrical distribution. Andrews.

26733. Magnetic cut-out apparatus. Andrews.

27433. Electric cables. Nisbett and Batee.

28519. Electrical tumbler switches. Watson.

30947. Centreing motion of arc lamps and limelight jets. Stuart and Barton.

1898.

121. Electric meters. Batault.

1145. Electric cables. Allingham and Fennell.

1735. Electrical accumulaters or storage batteries. Adamson, Allan, and Allan and Adamson, Limited.

6992. Improvements in electrical measuring instruments. Weston.

14362. Rising and falling pendants for gas, oil, or electric lamps. Shaw.

17418. Electric tumbler switch appliances and their base-plates. Markt.

19936. Controllers for electric motors. The British Thomson-Houston Company, Limited. (Case.)

21045. Means for driving the speed indicators of electric motors. The British Thomson-Houston Company, Limited. (Berg.)

21940. Telephone call counter. Richter.

21941. Telephone switchboards. Richter.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Dec. 10	3 867	3,436	+ 436	—	—
Blackpool and Fleetwood Tramroad	Nov. 18	211	—	—	13,566	—
Bristol Tramways and Carriage Co.	Dec. 9	2,558	2,256	+ 302	—	—
City and South London Railway	,, 11	1,117	1,101	+ 16	23,754	22,982
Dover Tramways	Dec. 10	142	81	+ 61	8,069	—
Dublin U.T., elec. cars	,, 9	560	†517	+ 43	15,630	13,055†
Dublin S.D. Electric Tramways	,, 9	652	387	+ 265	21,646	14,629
Halifax Corporation Tramways	,, 7	236	—	—	6,067‡	—
Liverpool Overhead Railway	,, 12	1,383	1,296	+ 87	—	—
South Staffordshire Tramways	,, 2	599	550	+ 49	30,949*	30,976*

* Receipts since Jan. 1. † Horse cars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	19-20
Bournemouth and Poole Electric Supply, Limited, Ord.	10	11-11½
—— 4½ per cent. Cum. Pref	10	10¾-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-13½
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2¼ 2⅜
—— 4½ per cent. Debenture Stock	100	111-116
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	111-114
—— Ordinary	5	9¼-10¼
Central London Railway, Ordinary	10	9⅞-10¼
——	6	5¾ 6¼
—— Pref. Half-Shares	1	1¼-1⅜
—— ,, ,,	5	4¼-4⅜
Charing Cross and Strand	5	11½-12⅛
—— 4½ per cent. Cum. Pref.	5	6-6⅛
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	24-25
—— ,, 90,001-100,000	10	24-25
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	65-68
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	134 136
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co. Ord.	10	12½-13½
—— ,, ,, No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅞ 2¼
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	99-101
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	2⅝-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-107
Elmore's Copper Depositing	1	¼-⅜
Elmore's Wire Company	2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	20½-21½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-23½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
—— 6 per cent. Pref.	5	7⅞-8½
London Electric Supply, Ordinary	3	3½-3¾
—— 6 per cent. Pref.	5	6-6½
Metropolitan Electric Supply, Limited, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1⅜-1⅝
—— £5 Shares	5	7-7⅛
—— £4½ Shares, New	4½	6⅛-6⅜
Oriental Telephone and Electric Company	1	⅜-½
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	155-160
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2¾-3⅛
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	112-115
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

The Salomons Scholarship.—The David Salomons Scholarship for 1899 has been awarded by the Institution of Electrical Engineers to T. R. Renfree, student in the Siemens Engineering Laboratory at King's College.

Electric Lighting at Kandy.—Progress appears to be the order of the day in Ceylon's old capital. The sanction of Government to the proposed lighting of Kandy with electricity will, says *Indian Engineering*, be made known shortly, the matter having been considered by the Executive Council.

Litigation.—We have received from Mr. Heyl Dier some particulars of the points at issue in a lawsuit pending between himself and Messrs. W. T. Glover and Co., Limited. As the matter in question may be disputed by the defendants, we think it best to wait for the action before publishing anything.

Institution of Junior Engineers.—This active society is not taking the customary holiday, but will hold on Tuesday next, the 27th inst., an ordinary meeting, when Prof. J. A. Ewing, honorary member of the Institution of Junior Engineers, will deliver a lecture on "Measurements of Elasticity."

Christmas Lectures.—Sir Robert Stawell Ball's series of six lectures to young people at the Royal Institution will commence on Tuesday next, 27th inst. The subject of the lectures is astronomy, and with the above lecturer to expound the subject, there is no doubt as to the attraction of the lectures. The second lecture will be given on Dec. 29, and the third on Dec. 31. In each case the lecture will commence at 3 p.m.

Fire-Alarm Indicators. — The London County Council has written to all the local authorities in London suggesting that vestries and district boards should, in addition to painting lamp-posts nearest a fire alarm a red colour, place a strip of red glass with the words "fire-alarm" at top of such lamps. The idea is a good one for Christmas, when many people like to paint the town red.

The Telegraph in Africa.—Mr. Rhodes has declined to visit the Grahamstown Exhibition (South Africa) on the ground that he must proceed to England on Dec. 29 to arrange financial matters in connection with the Tanganyika Railway and the transcontinental telegraph. We also note that in connection with the transcontinental telegraph, after Lord Kitchener's arrival at Omdurman, the construction of telegraph lines will be begun to Fashoda and the Sobat River, and also between Kassala, Gedaref, and Sennar.

Luigi Galvani.—This great anatomist of the Bolognese school, and better known for his discovery of animal electricity, received on Sunday, Dec. 4, at Bologna, the honour of a centenary celebration. The date chosen was, says the *Lancet*, that of his death, which took place on Dec. 4, 1798. The occasion evoked the presence of the leaders of the local medical school, and its orator was Signor Erminio Vitta, representing the committee of Italian telegraphists now organising a similar commemoration of Alessandro Volta. The proceedings were highly successful.

City Electric Lighting.—The *City Press* understands, on the very highest authority, that there is every possibility of a conference taking place in the near future between the Streets Committee of the Corporation and the City of London Electric Lighting Company with reference to the purchase by the Corporation of the company's undertaking. The directors, it is understood, are quite prepared to sell their property if the terms offered are sufficiently tempting. "Naturally," says the paper named, "we are unable to give any indication of what the views of the Board are as to the sum they will feel disposed to accept."

Railway Station Lighting. — The outrage at Queen's-road Station on the Underground, on Monday last, in which a passenger and his wife were robbed by a crowd of ruffians, again calls attention to the poor way in which these stations are lighted. The last time we referred to the fact was when in one station naphtha lamps had to be suspended from the brackets to assist the feeble light given by the gas. There is no doubt that all these stations should be provided with at least four times their present illumination. Experiments in electric driving between Kensington High-street and Earl's Court are being conducted, and both these stations should be lighted electrically from the traction plant. In this way the directors would see an additional advantage in the use of electricity as a motive power.

A Magnetic Lampholder.—There is described in all the American electrical journals a peculiar lampholder. The device is manufactured by Jenkins Bros., of New York, and consists of an electromagnet fitted in the socket of an incandescent lamp, and it is particularly valuable for machine shops. The magnet is of considerable strength, so that it may be placed against any iron surface holding the lamp in any position. The poles of the magnet project from the rear end of the socket. The cores through which the magnet is energised are within the base; the lamp current supplies the energy as it passes through the magnet coils on the way to the filament. The result is a strong magnet, which readily adheres to the inside of a boiler, the interior of a ship, or any dark corner where any iron surface is exposed. It is not necessary to have a lamp especially designed for use with the holder, as any socket may be inserted in the magnetic holder.

Luminous Discharge in Geissler Tubes.—In the current number of the *Journal* of the Chemical Society the following abstract is given of a paper read by Mr. Alfred Kalähne on the "Spectra of some of the Elements with a Constant Luminous Discharge in Geissler Tubes." He says: "The spectra of iodine, bromine, mercury, cadmium, sodium, tin, and lead were examined under a constant discharge from 600 accumulator cells, giving an E.M.F. of 1,200 volts. The appearances obtained were qualitatively similar to those which are given by weak intermittent discharges. The proportionality between light intensity and current strength which Angström noticed with nitrogen and hydrogen, was not observed, with mercury or cadmium vapour. In the case of cadmium, the intensity of the lines increases more rapidly, with mercury less rapidly, than the current strength. With a constant current the lines in the mercury and cadmium spectra decrease in intensity with increasing pressure."

Personal —A grateful tribute has been paid to the zeal with which Mr. John F. C. Snell has superintended the electric lighting undertaking in Sunderland by the decision of the Corporation to extend his responsibilities with corresponding increase in his remuneration. The tramway question in Sunderland is the cause of the move. Mr. Snell has written a most able report on the best method of working these tramways, and the Corporation have voted him 100 guineas for the same. They also unanimously agreed that he should be appointed engineer for the construction and subsequent running of the tramways under the Bill now before Parliament. Mr. Snell also has in hand the large extensions to the present lighting station, both for lighting and traction purposes, and is changing the existing system over to 440 volts. A new five years' agree-

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ment is being entered into between the Corporation and Mr. Snell, under which his salary will commence at £600 per annum, and rise to £800. We congratulate both parties to the above agreement.

Tesla and His Complaints.—Our contemporary the *American Electrician* sums up the points at issue between Mr. Nikola Tesla and another American journal in the following concise terms: "The truth plainly stated is, that for several years Mr. Tesla has only escaped similar criticism in professional and scientific journals on account of the high esteem in which he is held personally, and through recollection of the magnificent boon he bestowed on the world by the invention early in his career of the polyphased system. The manner in which he has permitted himself to be exploited by the sensational newspaper Press has been a source of pain to his friends, and has largely alienated from him the sympathy of the electrical profession. Moreover, his periodical promise of being on the point of accomplishing some wonder that would revolutionise electrical science has had an untoward effect on the electrical industry, for among laymen it has tended to produce the belief that at any moment one of Tesla's great discoveries may materialise and destroy all present investments."

Transmission of Electric Power.—Prof. George Forbes, writing to the Society of Arts *Journal*, says that since his paper was read on Nov. 23 he has learnt that the great advantge of raising a mortgage on the copper used for long-distance transmission of electric power had been referred to in 1892 before the Manchester Association of Engineers by Mr. B. H. Thwaite. He also adds that the African Concessions Syndicate informs him that a concession was eventually granted to them for the water power of the Victoria Falls and the Zambesi River on Dec. 17, 1896. His paper had led people to think that the negotiations for such concessions were permanently closed by the troubles in 1895-6 in Rhodesia. This mortgage on copper, although to a certain extent reasonable for transmission of power schemes, is absurd if applied to telegraph lines. Since Prof. Forbes's paper the Canadian, British Columbia, and Dawson City Telegraph Company, Limited, has tried to carry the principle to excess. This company, as pointed out last week, tries to work on debentures only, and with no copper to speak of on which to raise the debentures.

Electric v. Hydraulic Lifts.—In the agenda for last Tuesday's meeting of the London County Council attention was drawn to the unsatisfactory nature of the lift in the Council's offices. The present hydraulic lift is of an obsolete kind, the motive power being supplied by a large water storage tank. This tank also supplies the fire-main throughout the building, and as the lift requires a waste of 120 gallons per journey as motive power, it has been found necessary to discourage its use as far as possible in order to maintain pressure in the tank in case of fire. In addition to this disadvantage the present lift works so slowly that frequently little or no time is saved by using it, and considerable inconvenience is thereby caused to members of the Council, the staff, and the public. In a report received from the architect, it is stated that a new lift worked by electric power would cost about £450. The Establishment Committee states that the greater convenience that would result fully justifies an expenditure of that amount, and add that the cost of the electric power required for working the lift would be, it is estimated, considerably less than that of hydraulic power.

The Conductivity of Aluminium.—Mr. Edwin F. Northrup contributes to the current issue of the *Electrical World* an interesting article on some accurate measurements of the conductivity of some aluminium rods manufactured by the Pittsburg Reduction Company. A potentiometer method was used on account of the great accuracy obtainable. Full diagrams of the connections employed are given, and the results obtained with five different samples are compared. In every case the percentage conductivity is worked out, in which the specific conductivity of the sample is compared with that of pure copper at the same temperature. In the three samples of pure aluminium the percentage conductivity was found to vary from 61·45 to 61·59. A sample containing 0·5 per cent. of copper had a percentage conductivity of 58·16. In the final sample, containing 0·75 per cent., the conductivity had fallen to 56·37. It is interesting to note that alloying with copper, a better conductor for an equal cross-section than aluminium, reduces the conductivity of pure aluminium. The writer believes that these results can be relied upon by users of aluminium to within certainly one-half of 1 per cent., and probably a little closer.

More Use for Niagara Power.—It is announced by the Niagara Falls Power Company that on Nov. 21 they closed a contract with the Union Carbide Company for 15,000 e.h.p., which power is to be used in a fine new carbide plant to be at once built on the power company's lands. The present plant will be continued in operation, but the new works will be erected on a new site. The cables for carrying the power from the power-house to the new works will be laid in a conduit underground. Work on the new plant will commence very soon, in order that it may be ready for the current next summer, for that is the time the contract calls for its delivery. This contract for 15,000 e.h.p. means the product of three of the immense generators in the central station of the Niagara Falls Power Company. The Niagara Falls Power Company also announce having made a contract with the Electric Lead Reduction Company. As their name indicates, they will engage in manufacturing by an electro-chemical process. The industry is expected to grow to great importance. The Oldbury Electro-Chemical Company have also organised a new company which will erect a new plant on the Niagara Falls Power Company's lands, east of the present plant of the Oldbury Electro-Chemical Company, and will use 800 h.p. The buildings of the new plant will be of a substantial character, and will be commenced at once, the power contract calling for delivery of power by March 1, 1899.

Telephones on Fire-Alarms.—The London County Council on Feb. 1 last accepted an offer of the Post Office to provide plug-holes for portable telephones on fire-alarm posts, with a view to enabling the apparatus to be utilised by firemen for the transmission of telephonic messages. The chief officer of the fire brigade has since obtained provisional protection for an improved appliance to effect this object, and the apparatus has for some months been tried, with very satisfactory results, with a fire-alarm connected with the chief station. The officials of the Post Office are also quite satisfied with the result of the experiments, and the chief officer now suggests that an extended trial should be made with the fire-alarms connected with 10 stations. The number of fire-alarms connected or ordered to be connected with the 10 stations in question is 166, but it is thought that five portable telephones per station will be sufficient. The committee recommends that the Council should accept the offer of the Post Office to fit fire-alarm posts with microphones and plug-holes for telephones, and to provide plug-holes in the corresponding indicators in the fire stations for an annual rent of £31. 15s. per 50 posts; that in the first instance the acceptance be limited to fire-alarms in connection with the chief station and the Hampstead, Hammersmith, Holloway, Hackney, Stoke Newington,

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Shooter's Hill, Lewisham, Wandsworth, and Tooting stations. The Council will purchase the portable telephones direct. The above plan is certainly much better than several others we have seen suggested, and will be of great value in ordering up additional help or material to a fire.

The London County Council Tramways.—The London County Council have not yet succeeded in getting a chief officer to work their tramways for them at the beginning of next year. As pointed out in our last issue, Mr. Young, of Glasgow, after due consideration, declined the position, and at last week's meeting Mr. Baker, of Nottingham, was appointed at a salary £500 below that offered in the London County Council advertisement. The Tramway Committee of the Nottingham Corporation now decline to release Mr. Baker from his present duties before the six months' notice, which he is obliged to give, has expired. We see no reason why the Nottingham Corporation should be inconvenienced for the benefit of the London County Council, but if they can oblige Mr. Baker himself by allowing him to go sooner, we think that they should do so. In the meanwhile the London County Council will have full opportunity of airing its members' ideas on tramway management before Mr. Baker comes on the scene. At their meeting last Tuesday the following members were selected to act as a special sub-committee to manage the tramways: Mr. Benn (chairman of the Highways Committee), Sir John Hutton, Mr. Westacott, Mr. Alderman Hubbard, and the vice-chairman (Mr. Parkes). Certain prominent officials of the old tramway staff will be kept on, in order to tide the matter over until the advent of Mr. Baker.

Electrical Oscillations.—A paper on this subject was read recently by Mr. Hugo Kauffman before the Chemical Society, and an abstract of it is reprinted in the current issue of their *Journal*. The abstract reads as follows: "When the vapours of various chemical compounds are exposed to the influence of electrical oscillations, various results may occur: (1) the vapour may become luminous; (2) it may be crossed by spark discharges, usually of a green colour; (3) it may remain dark, at least until a very high tension is reached. The behaviour in this respect of over 50 compounds was investigated, and, although general deductions cannot be drawn from so few observations, yet some constitutive influences are indicated. Thus, almost all the aromatic amines become luminous, and present more or less similar appearances, whilst the ease with which luminosity occurs appears to be in part dependent on the basic character of the amine, as compounds which, by substitution, have lost their basic nature (for example, nitraniline or tribromaniline) are no longer rendered luminous. This rule, however, cannot be extended to cyclic compounds containing nitrogen. Amongst hydrocarbons, the aliphatic compounds and the simple benzene compounds remain dark until a very high tension is reached; but most of the hydrocarbons containing two or more benzene rings readily become luminous. In all cases it was observed that during luminosity the vapour acted as a conductor.

An Accumulator Exhibition.—The Automobile Club of France announces that it is organising an exhibition for electric accumulators suitable for driving automobiles. In the notice issued by the club attention is drawn to the fact that the extensive trials carried out in Paris last June had not afforded any evidence as to which was the best accumulator for such work. It is now proposed to organise trials, in connection with the exhibition of such accumulators, which will open on the second Sunday in April, 1899. On this occasion trials will be made on the durability of the plates and on the commercial efficiency of the battery, by which is meant the ratio between the energy put in in charging and the energy obtainable on discharging. A comparison of the weight of the various accumulators with their capacity will be also made. In all these trials the accumulators will be subjected to vibration and variations of load, such as they will have to undergo when working on motorcars. The entrance fee for each battery to be tried will be £20 if application be made before Jan. 31; after that double fees will be charged on all batteries entered during the month of February. Each battery complete should not weigh more than 240lb., and should be able to give 120 ampere-hours at a discharge rate of 24 amperes for five hours. The trials will be continued for six days, with one day's rest, and will extend over a period of about six months. It appears to us from the text that five cells are to be included in each battery, as a limit of 8·5 volts is spoken of as the lowest admissible discharging pressure. The whole organisation is under the Automobile Club of France, from whom further particulars may be obtained.

Untechnical Reporting.—If the reporter of the *Standard* had tried to introduce technical errors in the report he gives of a recent action between Mr. C. H. Wild and the County of London and Brush Provincial Electric Lighting Company, he could hardly have been more successful in his endeavours. The case was tried before the City of London Court on Tuesday last, when the plaintiff endeavoured to recover damages for personal injury sustained. In the report as given in the above paper, "From the evidence for the plaintiff, it seemed that on July 22 last, having been in the service of the defendants for three or four years, he was told by the foreman to go to a transformer box in John-street-road, Clerkenwell, and do certain electrical work in connection with high-tension mains. While there an explosion of electricity occurred, and the plaintiff was very severely hurt on the left arm and hand. Had he been a little taller, the electricity would have struck his head, and he must have been killed instantaneously. As it was, he went to St. Bartholomew's Hospital, and was away from work for 10 weeks. As an unskilled electrician, his case was that he should not have been put to do the work which was the cause of the accident happening. The defence was that the plaintiff brought the accident about by not wearing indiarubber gloves, as provided by the rules. He himself caused the explosion by applying a screw-driver to an arc. The plaintiff admitted having taken off his glove because of the intense heat then prevailing, but declared that the explosion would have occurred had he been wearing it." It is clear from the above that short men are less liable to dangerous shocks than their taller brethren, and that arcs should not be adjusted by means of a screw-driver. The verdict was that the accident was caused by a combination of circumstances which no one could foresee, and the plaintiff received £15 and costs.

Enclosed Arc Lamps.—Our New York namesake, speaking of the enclosed arc lamps, states that, in spite of the few years they have been on the market, there are already in the neighbourhood of 75,000 lamps of the enclosed type in daily use in the United States alone. The influence of the new lamp is making itself felt decidedly, and it would be difficult to estimate how many incandescent or gas lamps it has displaced in interior lighting. Now that success has been achieved, one is apt to forget the earlier obstacles with which the introducers of this type of lamp had to contend. They had to overcome not only the conservatism of central-station managers, who are ever reluctant to discard their existing outfits, but, what was still worse,

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they met with the shortsighted, unfortunate enmity of labour towards all labour-saving devices. In the present case it was the trimmers who saw their occupation gone, as they thought. Yet in this case, as in many previous instances, it has turned out that the device intended to reduce the labour of attendance has actually increased the total number of hands employed owing to its introduction in large numbers in situations where it had never been used before. Now that the enclosed arc is a demonstrated success, it is not strange that it should have become a subject for litigation. The present owners of the patents claimed to be controlling are to be commended for the course hitherto pursued by them in licensing manufacturers—one we have always urged in such cases—but it would seem that their rights are disputed in some quarters, and it looks as if the fraternity might soon be treated to another electrical *cause célèbre*.

High-Speed Gas-Engines.—Practically all the American papers reaching us during the present week have contained a description of the gas-engines manufactured by the Westinghouse Company. The extensive experiments carried out since 1886 by Mr. George Westinghouse towards securing a steady-running gas-engine have been several times referred to in our columns. We gather from the present articles that these engines are now being manufactured on commercial lines, and that they are stocked in sizes varying from 10 b.h.p. up to 280 b.h.p.; in fact, a 650-b.h.p. engine has been built and installed in the power-house of the Westinghouse Electrical Manufacturing Company for regular service. The engines operate on a modified form of the Beau de Rochas cycle. They draw in a charge of gas and air on the first down-stroke, then compress it into the clearance on the up-stroke and ignite it near the top centre. The piston then moves down during the second down-stroke under the pressure of the exploded gases, and these are exhausted during the second up-stroke. They depart from the Beau de Rochas cycle in that the incoming gas and air are throttled to a greater or less degree by the action of the governor, according to the load on the engine. This method of governing insures an explosion with every other revolution in each cylinder, or one per revolution for the two-cylinder and one each two-thirds revolutions for the three-cylinder type, instead of a reduction of the number of explosions, as with the so-called "hit or miss" governors. The frequency and regularity of the impulses insure such steadiness of running that it is possible to mount a dynamo rigidly on the engine shaft and obtain perfectly steady electric light. The illustrations given in the articles show some interesting examples of direct coupling, but we note that in the 225-b.h.p. size springs are introduced into the coupling. The indicator cards taken from some of these engines show that great care has been taken in their design.

Municipal Authorities as Undertakers.—The curious state of affairs with regard to electric lighting in Stoke Newington is, we believe, without parallel in the United Kingdom. The district controlled by the Stoke Newington Vestry was in 1893 part of the Hackney Vestry's district, and hence is scheduled in the area of the provisional order granted that year for electric lighting purposes. Since then by a rearrangement of areas the district has been split up, but we believe that at the time no alteration to the electric lighting order was made. Hence we find the Electric Lighting Committee of the Hackney Vestry considering a letter from the secretary of the North Hackney Tradesmen's Association, stating that some members of that association are desirous of having electric light in their shops in the High-street, and that he had been instructed to ask the Stoke Newington Vestry to request the Hackney Vestry, when laying their main in that thoroughfare, to carry it over to the west side for the convenience of Stoke Newington ratepayers. The committee recommended that the secretary be informed that, as the Vestry are proposing to supply electric light in the parish of Stoke Newington, they would be glad to receive the names of those in the parish desirous of using the light, and the probable amount of their consumption. So far so good, but the Hackney Vestry have up to the present shown themselves utterly incapable of conducting any electric lighting business, and beyond a few lawsuits and charges of corruption have nothing to show for five years' work. Still, granting that their present consulting engineer does bring them to business, Stoke Newington stands as an outside authority, and will have no representation in the management of the undertaking. The profits of the concern will be taken by Hackney, and the price may be kept up for that reason. The street repairing may cause trouble, and, on the whole, it is a pity that Stoke Newington cannot be electrically lighted by its own municipal authority.

Electro-Dynamometers on Switchboards.—In our issue of Nov. 18 this year we referred to an article in the *American Electrician*, which recommended the use of instruments on the electro-dynamometer principle for switchboards. We then pointed out the fallacy of the proposition and the fact that the conductors on the switchboards would render such instruments useless. We note in the issue of our contemporary for this month that Mr. J. F. Stevens has written to point out these defects, and yet the editor sticks to his guns. He replies that while "the dynamometer is susceptible to external fields, this is true of any instrument. Even a highly magnetised D'Arsonval type is also thus susceptible, and must be carefully placed on the switchboard with reference to minimising such an effect." The editor forgets that the effect of the external field varies inversely with the strength of the field used in the measuring instruments, and that thus what may cause a 1 per cent. fault with the D'Arsonval type of instrument may vary the reading of the dynamometer by 25 per cent. The question of screening is then discussed, and it is stated that an iron shield will protect the instrument, but that this shield "should be properly made so as not to introduce errors." Just so; but will not this "properly-made shield" cost money, and also require adjustment in each special position? The crowning point comes when the editor states that "when used for alternating currents, the dynamometer is unaffected by magnetic fields, and needs no shield." This is quite untrue. Alternate-current conductors on the switchboard will set up alternating magnetic fields, which will strongly affect the dynamometer, and it is on such boards that we have seen the instruments tried and discarded. In conclusion, we can only repeat that, while measuring instruments having strong magnetic fields are liable to time and ageing errors, they and electrostatic instruments are the best known for switchboard work. The hot-wire type comes next, and instruments with the electro-dynamometer principle last of all.

Electrical Heating Apparatus.—That electrical heating has a wide field of usefulness, in spite of its considerable cost per British thermal unit, no one can now deny. There are many places, says the *Electrical World*, where "the best is none too good," regardless of expense, and electrical methods of heating are undoubtedly the best. In spite also of its high cost per thermal unit, the heat so developed can be made much more effective in local applications than that developed by such a crude piece of apparatus as, for example, a cooking range. Cooking processes, it should be noted, are not essentially endothermic, and do

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not in themselves require the delivery of much, if any, energy. It is only, as a rule, the waste or external radiation that must be provided for, the cooking requiring simply that its ingredients be maintained at a certain temperature difference above that of surrounding objects. The whole secret, therefore, of economy in electrical cooking is protection against loss. If the radiation of an electrical oven, for example, can be reduced 90 per cent. by careful laggging, the current necessary for operating that oven will be reduced in the same proportion. Electrical heaters for raising the temperature of water, however, and particularly air heaters, are not subject to this possible economy, and no improvements can be expected of them in this respect, their transforming efficiency being, of course, in all cases 100 per cent. The greatest limitation of electrical heating, however, is perhaps the danger of burnouts. An electrical sad-iron capable of maintaining its proper temperature when run rapidly, as it is in regular service, over moistened cloth, is certain, if left on the cloth with the current on, to start a fire. An electrical urn, tea-kettle, or coffee-pot, if capable of heating its contents to the boiling point in a reasonable length of time, will invariably burn out if it boils dry. If there is one thing that the average kitchen attendant may be depended upon to do, it is to forget to turn the power off. What is needed to prevent accidents under this condition is the use of a resisting element with a very high temperature coefficient, and preferably a temperature coefficient turning up sharply at about the temperature at which it is intended to be worked. Automatic thermostats might, of course, be incorporated, but are much more suitable for laboratory than for kitchen work.

Cooling Towers.—The use of cooling towers to reduce the temperature of condensing water is comparatively rare in this country. Several alternatives, such as evaporator condensers, etc., have been tried with more or less success in London and the provinces. The great objection to many of our English installations of this type is that in windy weather a considerable amount of water is carried bodily on to the neighbouring premises, causing a great amount of nuisance. Such installations are also liable to freeze up in winter unless kept continually in use. There was an interesting paper on a cooling tower and condensing installation read before the American Institution of Mechanical Engineers this month. In the installation described the cooling tower is of the twin type, having two chambers, with a pair of fans supplying a strong draught of air to each chamber. The interior dimensions are 12ft. 3in. by 18ft. by 29ft. 6in. high. The tower is mounted on a sub-structure of steel columns and I beams, supported on substantial foundations. The hot water from the condenser discharge is delivered through a 10in. wrought-iron pipe, extending the whole length of each chamber, slotted on top, and perforated at the bottom, giving equal distribution to a series of 96 distributing pipes, extending across the tower, each pipe being slotted and perforated, thus ensuring a very uniform distribution of water. The hot water falls from the distributing pipes over 42 galvanised wire mats, made of No. 19 steel wire, woven to No. 5 mesh. Each mat is 12ft. by 15ft. 6in., affording a total of 8,064 square feet of cooling surface. The circulation of air is furnished by two pairs of 8ft. diameter fans, each pair of fans being mounted right and left on a $2\frac{1}{16}$ diameter shaft, and the four fans being capable of delivering 360,000 cubic feet of air per minute when driven at a speed of 150 revolutions per minute. The air entering the tower chambers at the lower section is deflected vertically from each fan, thus avoiding cross currents, and affording a uniform blast through and between the mats. The rated capacity of each section of this cooling tower is to cool the circulating water needed to condense 12,500lb. of exhaust steam, from an initial temperature of 132deg. F. to 82deg. F. when the atmospheric temperature does not exceed 75deg. F., nor the humidity 85 per cent. The paper also includes the tests on this tower for six different occasions, commencing in January of this year and concluding on Nov. 4. These show that in every case the cooling arrangement was effectual, and that it enabled, with a limited supply of condensing water, a good vacuum to be maintained.

Co-operative Electro-Technical Research.—The council of the American Institute of Electrical Engineers has appointed a committee on "co-operative research," whose duty it will be to suggest problems for research and submit them for investigation to the various colleges and other laboratories, the results to be published by the institute. The following is a list of the investigations thus far suggested, which also may be useful to our English Institute: (1) The effect of sustained high temperature upon the insulation resistance dielectrics; (2) the influence of sustained high temperature upon the dielectric strength of insulated metals; (3) the influence of sustained high temperature upon the hysteretic coefficient of commercial iron; (4) the influence of chemical impurities in iron or steel upon the hysteretic coefficient; (5) the hysteretic coefficient of magnetic alloys; (6) the temperature coefficient of resistivity in commercial copper wires; (7) the temperature coefficient of resistivity in commercial aluminium wire; (8) the temperature coefficient of resistivity in alloys commercially employed (it is desirable to include analysis of the alloys tested as well as their physical properties); (9) the highest conductivity obtainable in copper wire at any standard temperature; (10) the highest conductivity obtainable in aluminium wires at any standard temperature; (11) the analysis of dielectric losses between parallel copper wires maintained at high E.M.F.—(*a*) alternating and (*b*) continuous—into component parts, such as chemical, electrical, and mechanical; (12) the influence of wave form of alternating E.M.F. upon the dielectric strength of dielectrics; (13) the influence of wave form of alternating E.M.F. upon the sparking distance between needle points in air; (14) the influence of the room temperature upon the temperature elevation of dynamo machines under a given load as computed from their increase in resistance under load; (15) the distribution of temperature elevation in field coils of dynamo machines as dependent upon their form and dimensions; (16) the relations between the "load lost" and "short-circuit core loss" of an alternator; (17) the counter E.M.F. of electrolytic deposition cells at potential differences ranging between the maximum polarisation voltage and zero; (18) the seat of the increased counter E.M.F. in storage cells during rapid discharge; (19) the magnetic properties of alloys containing iron, nickel, and cobalt; (20) the magnetic retentivity of powerful twisted iron and steel wires or of magnets composed of such twisted wires; (21) the permeability of magnetic materials at low values of magnetising force; (22) the dielectric strength of different substances employed for insulating at different frequencies of alternation; (23) the influence of very high frequencies of voltage upon the sparking distance between needle points in air (the highest attainable frequencies preferred); (24) the dielectric strength of vapours of different substances; (25) influence of wave form upon efficiency of rotary converters; (26) the influence of magnetic field upon electrolytically-deposited bismuth; (27) the conditions giving rise to sparking at commutators.

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CORK ELECTRIC TRAMWAYS AND ELECTRICITY WORKS.

The completion of the electric tramways at Cork is a fitting occasion for a full description of the electrical works established there by the Cork Electric Tramway and Lighting Company, Limited. A few words about the city itself may not be out of place to commence with. Its history is interesting and ofttimes thrilling. Its geographical position is at the head of one of the finest harbours in the world, and if the country round were a mining or a manufacturing district its trade would be enormous. As it is, its trade is limited, the exports being mostly of agricultural produce, with perhaps a greater diversity in its imports. Cork, which in extent and importance is the second city in Ireland, is distinguished for its fine harbour, and derived its ancient names—Corcach and Corcach Bascoin, signifying in the Irish language "a marshy place"—from its situation on the navigable River Lee. The original city was built on a limestone rock, on the margin of the south branch of the river, and appears to have grown up around the cathedral and westward as far as the monastery called Gill Abbey. But what from a very early period has been more especially regarded as the city was erected on the island formed by the Lee; and its origin is ascribed to the Danes, who, after repeatedly plundering the old city and its religious establishments for more than 300 years, settled here in 1020. They did not, however, long retain possession, being 18 years afterwards defeated with great slaughter, and the whole of their property destroyed by fire. In 1080 the city is said to have been destroyed by lightning; and eight years subsequently the Danes of Dublin, Waterford, and Wicklow united their forces to recover it; but were defeated by a large body of the natives of Oneachach, now forming the district of West Carbery. According to other accounts, Dermot, the son of Foirdhealthach O'Brien, in the same

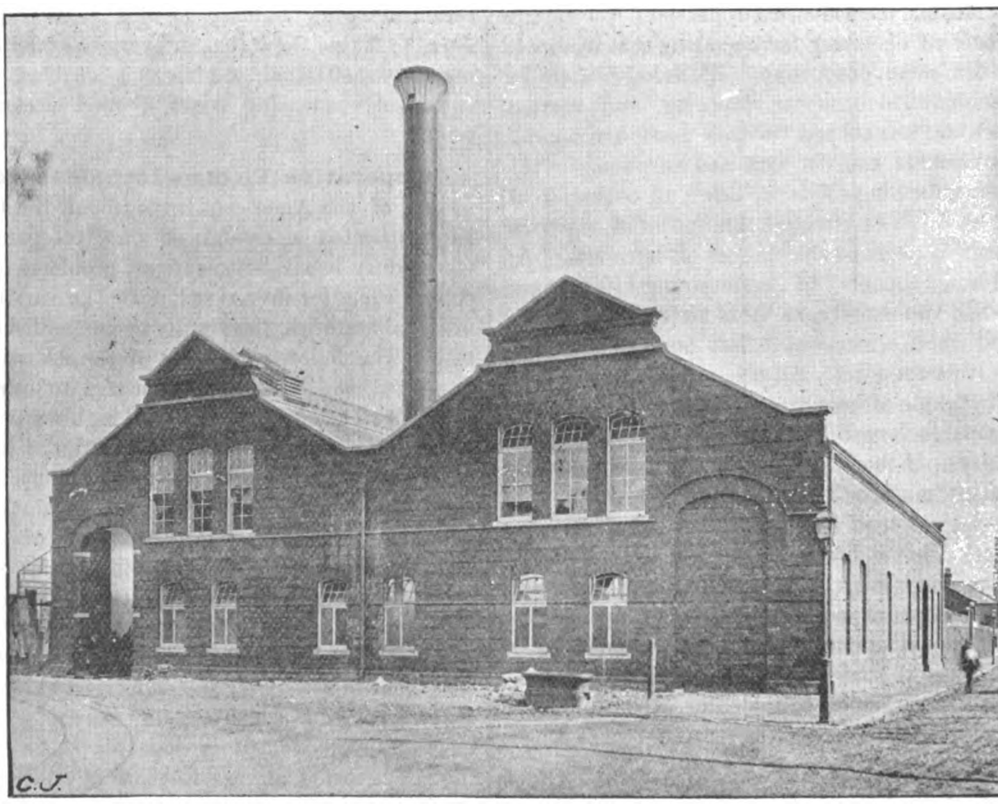

Fig. 1.—Outside View of the Electric Power Statio i at Coik.

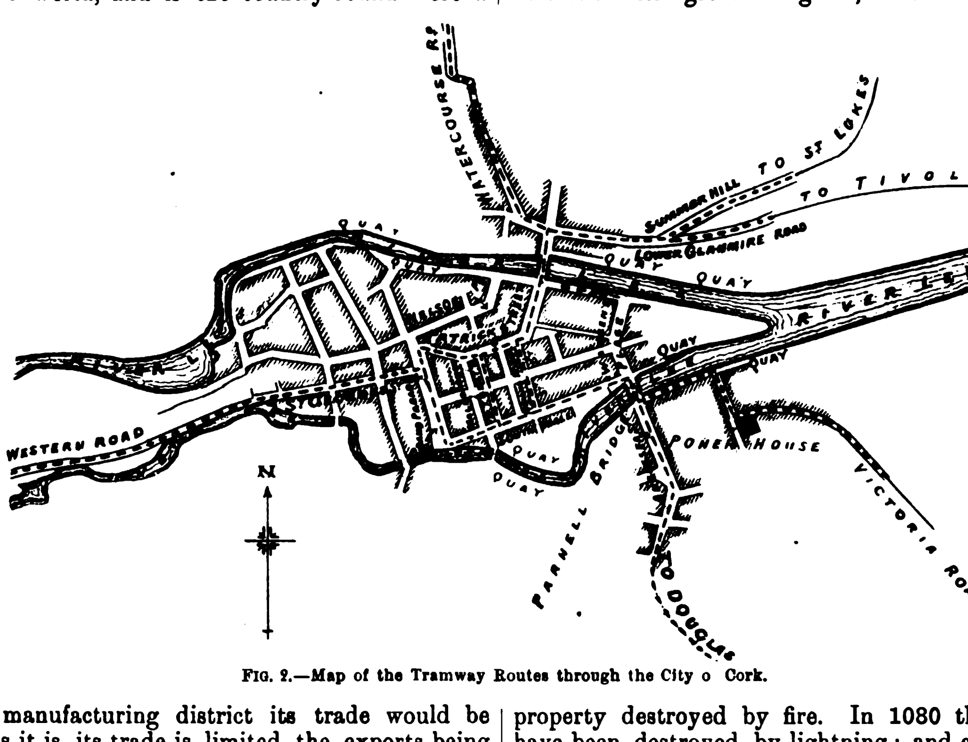

Fig. 2.—Map of the Tramway Routes through the City o Cork.

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year laid waste and plundered the town, carrying away the relics of St. Finbarr.

Coming now to the history of the electric lighting movement, the Corporation obtained a provisional order in 1896, and in the same year appointed Messrs. Kincaid, Waller, and Manville to advise them as to the best system to adopt

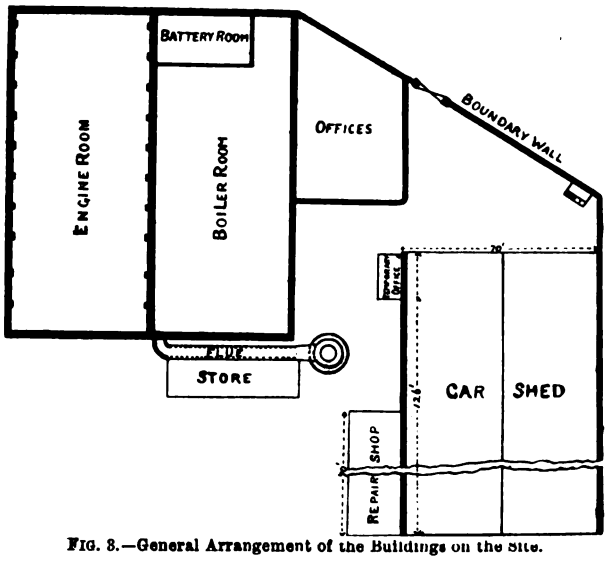
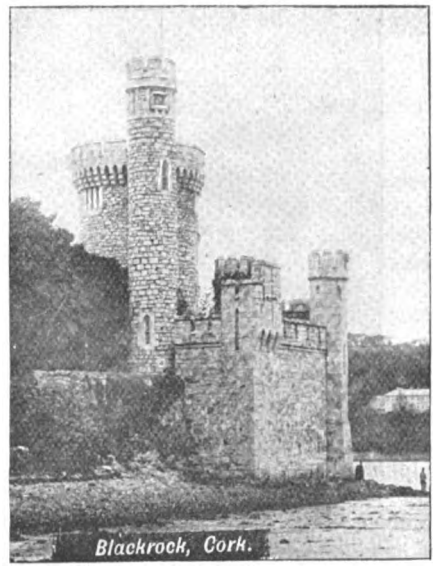


FIG. 3.—General Arrangement of the Buildings on the Site.

for both lighting and traction. As the Corporation did not care to undertake the necessary work required to carry out the scheme, it was decided to advertise for tenders on lines laid down by their consulting engineers. The advertisement stated the Mayor, aldermen, and burgesses of the city or borough of Cork invited tenders from persons or companies willing to carry into effect the powers conferred upon the Corporation of Cork by the Electric Light Provisional Order of 1896, and that the Corporation of Cork had made arrangements with a tramway company for installing an electric tramway system in Cork, whereby the supply of current for the tramways must be taken by the tramway company from the assignees of the electric light provisional order, and the advantages of this arrangement were specially pointed out to the intending tenderers. In answer to this several replies were received, and that of the present company, who had previously arranged to construct the tramways, was accepted as being the most favourable. By the agreement entered into, an equitable system of



repurchase by the Corporation has been arranged. The works were put in hand last year, and, but for some interference by the harbour authorities, were executed quickly.

The power-house (Fig. 1) is situated in Albert-street at a distance of about 220ft. from the river. As will be seen from Fig. 2, the map of the tramway lines, this site is about a central one. In this map we have been compelled to give only the commencement of the suburban tram routes on account of our limited space. The site of the works was originally a swamp, and so to obtain foundations it had to be piled. Some 137 pitch-pine piles, 1ft. square, were driven in 37ft. below the surface-level of the street at 5ft. centres. These were placed zigzag, and upon them a heavy

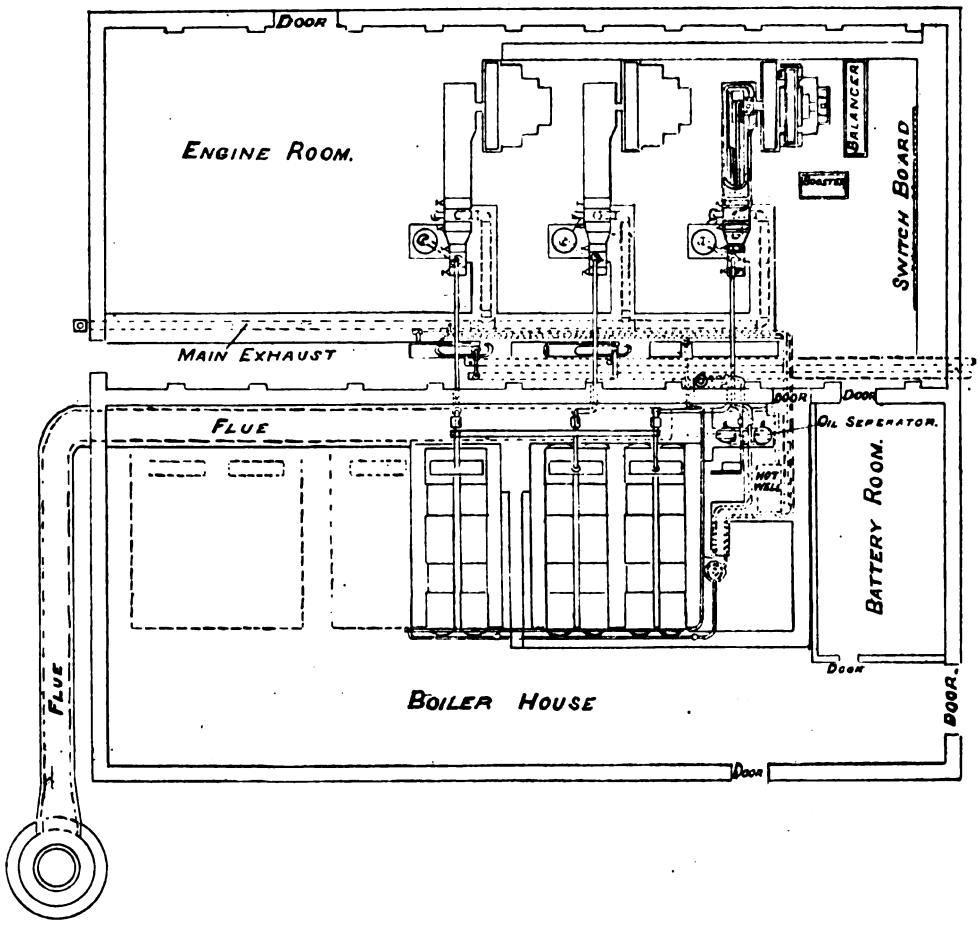


FIG. 4.—General Plan of the Electrical Machinery at Cork.

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block of 6 to 1 concrete was laid. The walls, as can be seen in Fig. 1, are of brick, the frontage being faced with Ruabon bricks. The chimney is of American type and construction. It is made entirely of steel and is self-supporting; it is 130ft. high and of 7ft. internal diameter, is lined with 4½in. firebrick, and is erected on a concrete foundation on piles. The thickness of the steel plates at the base is $\frac{7}{16}$in., each plate being about 4ft. by 6ft. in size; there are thus three plates to each ring. This method of construction gives a very light chimney, and hence is specially suitable in this case, where there was difficulty in getting good foundations. The general plan of the buildings on the site is shown in Fig. 3. The generating station is 100ft. long by 104ft, and consists of engine and boiler room and the usual additions, such as an accumulator room and offices.

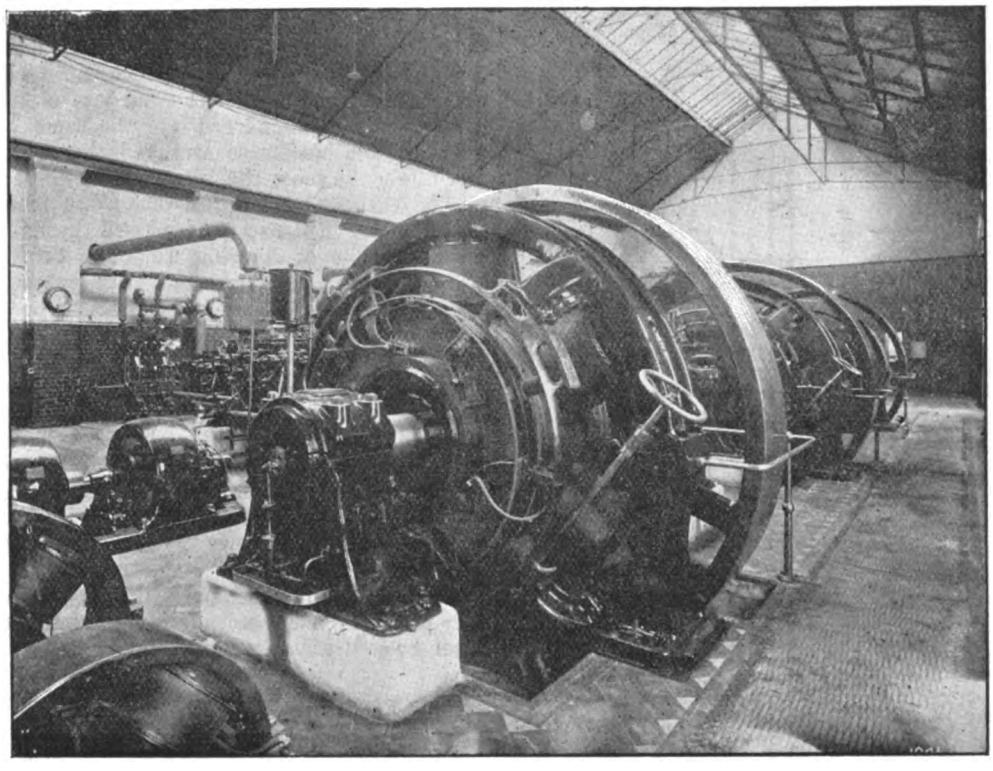

FIG. 5.—The Engine-Room, with Multipolar Dynamo in Foreground.

GENERATING PLANT.

There are at present installed three Babcock and Wilcox boilers, each having 2,531 square feet heating surface, and capable of evaporating at least 8,000lb. of water per hour at a normal working pressure of 150lb. The feed heater was made by the Wheeler Condenser and Engineering

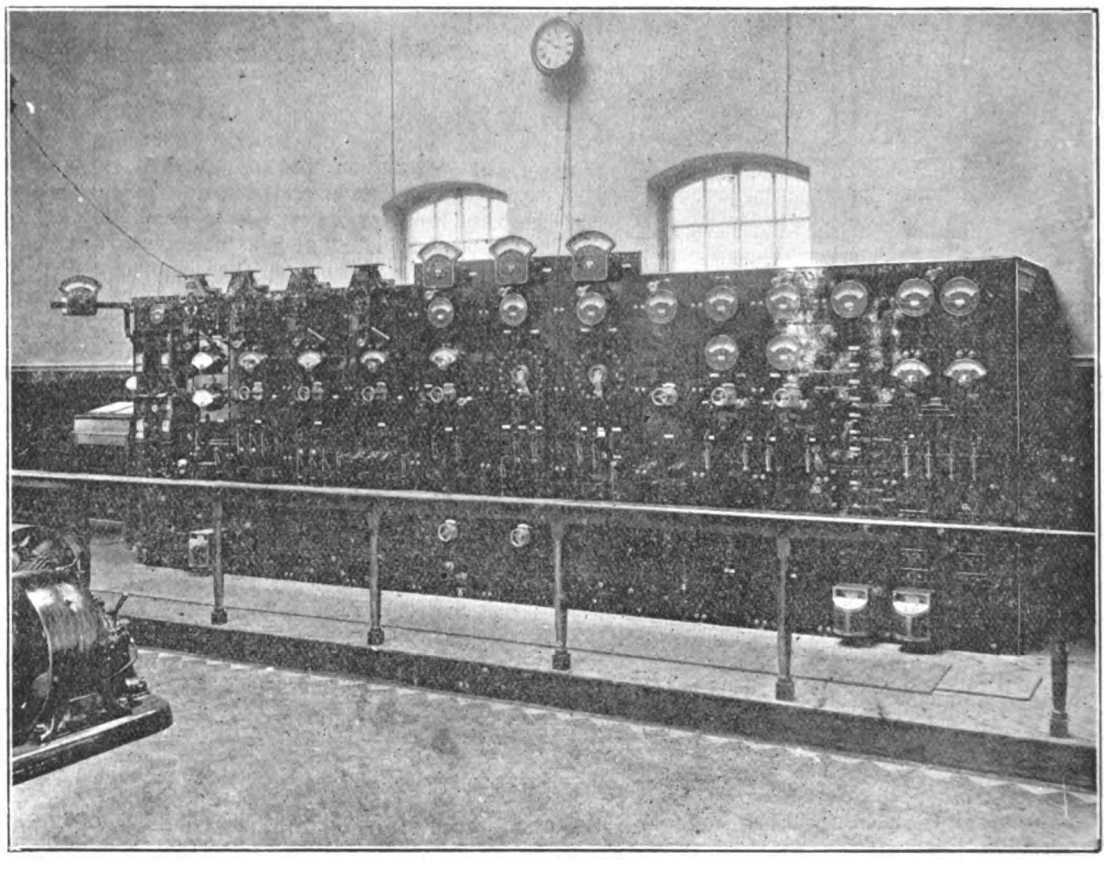

FIG. 6.—The Cork Switchboard, for both Lighting and Traction Circuits.

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Company. The feed water is heated by the exhaust steam from the feed pumps and the condenser pumps. The feed pumps are of the Blake and Knowles type. The steam

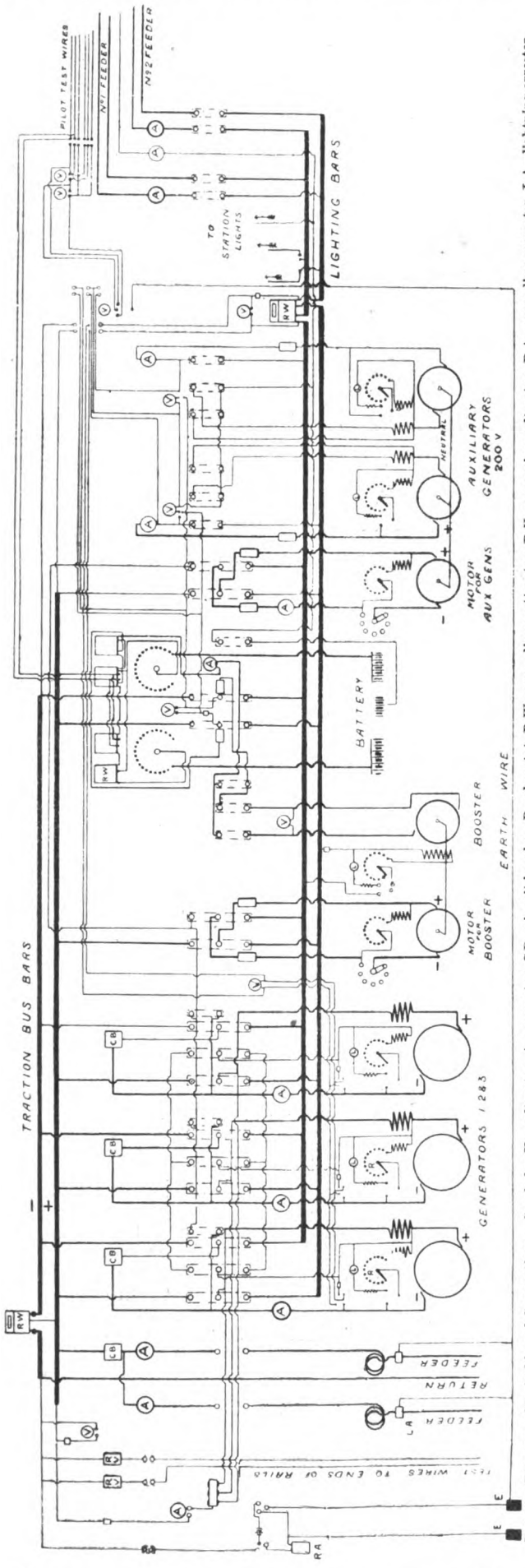
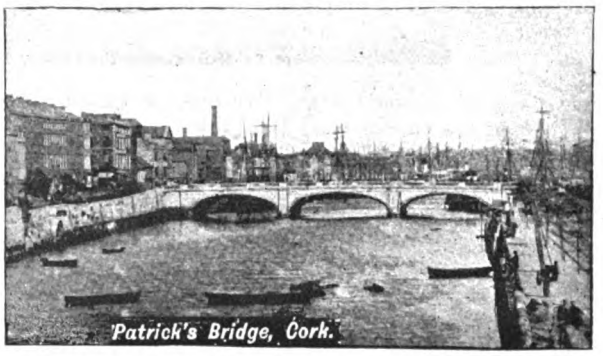


Fig. 7.—Diagram of Switchboard Connections. Symbols: V = voltmeter, A = ammeter, CB = circuit breaker, R = rheostat, R W = recording wattmeter, R V = recording voltmeter, R A = recording ammeter, L A = lightning arrester.

cylinders are arranged compound, with a diameter of high-pressure cylinder of 6in. The low pressure steam-cylinder is 9in. in diameter, and the water-cylinder 4in. in diameter, with 8in. stroke. The steam-cylinders of these pumps are fitted with an improved outside valve gear, so that they can be adjusted to give a full length of stroke under all conditions of speed. The steam connections of these pumps are so arranged that, in case of any repairs being required, either pump can be worked independent of the other. The hot-well is situated in the boiler-house, and is fitted with baffle plates, the divisions in which can be filled with coke and straw, if desired, for the purpose of intercepting any oil that may be discharged into the same. It is also fitted with suitable outlets so arranged that, by opening a valve and filling the tank, the oil which will be found floating on the surface can be run off. The feed water before entering the boiler can be passed through two Edmeston filters capable of filtering 16,000lb. of water per hour. These filters are arranged on a twin system, fitted with the necessary valves to enable the filters to be used on either range of feed pipes.

The steam-piping is steel, fitted with heavy screwed steel flanges. The pipes (Fig. 4) are so arranged that any engine can be fed direct from the boiler immediately behind it without any connection to the other boilers. Necessary valves are, however, inserted in cross connecting pipes to enable any faulty section in the piping being cut out. The exhaust piping is fitted with an automatic atmospheric valve, which, in the event of there being any pressure, due to the failure of the condensing plant, will immediately allow the engines to exhaust direct into the atmosphere. The piping on the atmospheric side of this valve is of thin steel, riveted together in spirals.


Patrick's Bridge, Cork.

In the engine-room there are three McIntosh and Seymour side-crank tandem compound condensing engines, running at 135 revolutions per minute. These are fitted with expansion governors and separate exhaust valves on both high and low pressure cylinders. The high-pressure cylinders are steam jacketed and exhaust into a receiver, in the interior of which are fixed three copper coils, which can be heated with live steam. These engines are coupled direct to six-pole 200-kw. compound-wound generators (Fig. 5), giving 500 volts at 135 revolutions. Two of Wheeler's Admiralty type of condensers, with engines in the centre and air-pump at one end, have been installed. These have circulating water-pumps at the other end, each capable of dealing with 12,000lb. of steam per hour. Water is taken direct from the river through 12in. cast-iron pipes, there being an auxiliary supply from the waterworks, which can be laid on to start the pumps in the event of the suction pipe being emptied through the retaining valve not being perfectly watertight.

The battery-room contains 256 Tudor cells mounted in three tiers, each cell containing six positive and seven negative plates, the capacity of the battery being 770 ampere-hours at a normal rate of discharge of 110 amperes. The maximum rate is 210 amperes. The battery stands are of pitch-pine, protected with acid-proof paint, and mounted on large oil insulators. This battery can be charged either from the traction or the lighting 'bus bars as desired. The necessary extra voltage for charging is supplied by a booster, which can also be driven from the traction or lighting 'bus bars.

The switchboard (Fig. 6) is situated at the end of the engine-room, and contains three generator panels, fitted with automatic circuit breakers with magnetic blow-outs; also the necessary switches, so arranged that the generators can be connected direct to either the lighting or

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traction 'bus bars. The diagram of connections is shown in Fig. 7. The two battery panels are fitted with the necessary regulating switches and magnetic blow-outs, and so arranged that the battery can be either charged from or discharged to either the lighting or traction circuits as desired. The two balancer panels are so arranged that the balancer can, if desired in the daytime, be driven direct from the traction bars or used as an ordinary balancer, the two motors being in series across the outers, the junctions being connected to the neutral; in this case the set being run up to give its correct voltage by means of the motor

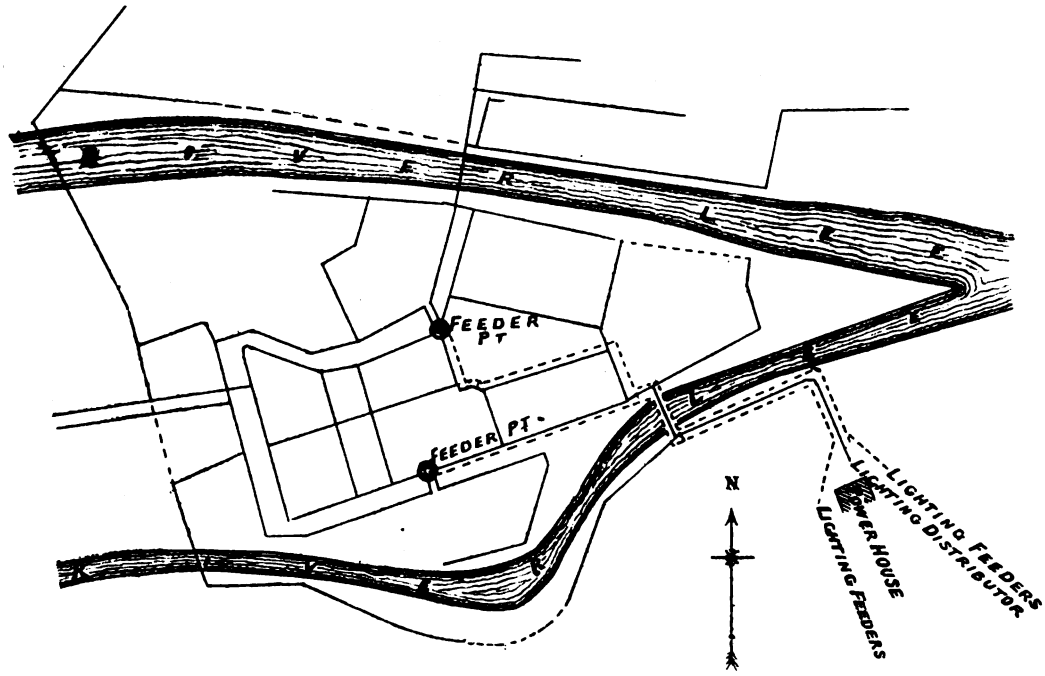

FIG. 8.—Map showing the Electric Lighting Mains at present laid down at Cork.

(Fig. 8) (of which there are two at present) and the station being just under half a mile. In their course from the power station to the feeding points the cables cross the River Lee, and as there is only a swingbridge in the route, the cables had to be laid in a trench excavated in the bed of the river. Callender's vulcanised-bitumen wire-armoured cable was used in this case as most suitable for the purpose. Four additional spare feeder cables, each of ·7in. sectional area, have been laid across the river at this point to cope with future extensions. The vulcanised-bitumen cables are brought together in a pit on each side of the water

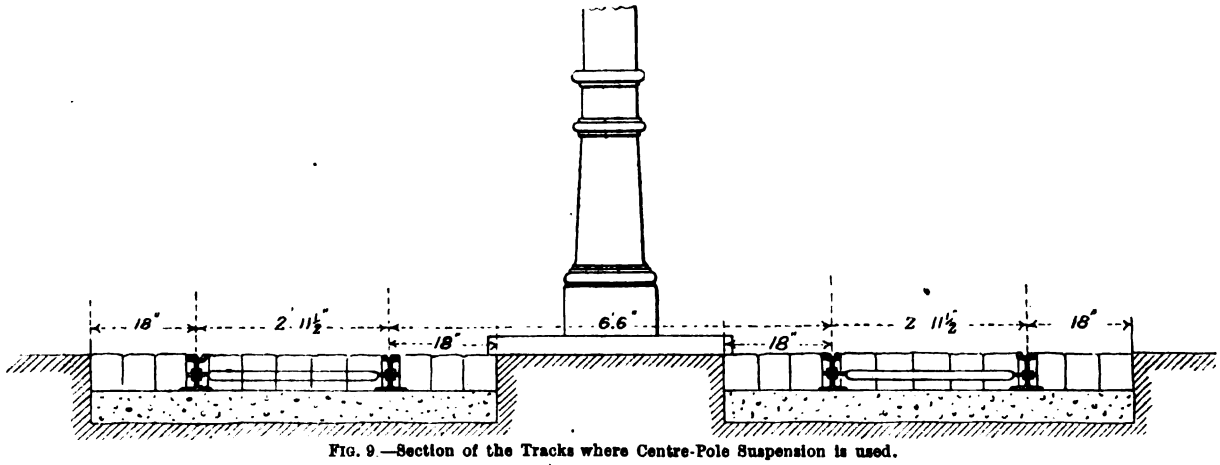

FIG. 9.—Section of the Tracks where Centre-Pole Suspension is used.

placed in the centre, the electrical connections to which are disconnected after the balancer sets are connected to the network. The switchboard is also fitted with a panel containing the necessary instruments required by the Board of Trade for purposes of testing (shown at the left side of Fig. 7).

where they are connected to the ordinary jute-covered, tape armoured cable laid in the streets. The greater proportion of the distributing cables in the centre of the city are of the three-core type, the largest distributor used having a sectional area of ·15in. In all the outlying districts three single distributing cables are used, and, in addition to their

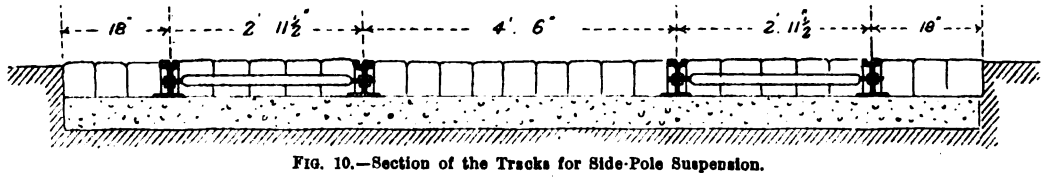

FIG. 10.—Section of the Tracks for Side-Pole Suspension.

CABLES.

The lighting distribution is on the three-wire system, with 460 volts between the outers, the mains being all of Messrs. Callender's manufacture, and in the majority of cases consisting of jute-covered, lead-sheathed, tape-armoured cables, laid direct in the streets. Altogether over 20 miles of cable for the lighting and traction systems have been laid, the distance between the feeding points

armouring, they are further protected by a covering layer of bricks. At the crossing and junction points of the network Callender's disconnecting boxes are fixed, and of these 19 are at present installed.

THE TRAMWAYS.

The centre of the city of Cork is on an island (Fig. 2), formed by two branches of the River Lee. The routes of

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the tramways in the city are shown on this plan. Double tracks have been laid through principal streets; the branch lines run to Tivoli, St. Luke's, Western-road, Blackpool, and Douglas. The longest branch is to Douglas, a village about two miles south of Cork. The tramway crosses the river twice, first over Parnell Bridge, a steel swingbridge, and the second time over Patrick's Bridge, which is built of stone. The rails in the city are laid on a bed of concrete, and the roadway paved between the rails, and 18in. outside, as shown in Figs. 9 and 10. Outside the city boundaries, the rails are laid on creosoted sleepers, 6ft. by 4½in. by 9in. The rails are of girder type, weighing 83lb. per yard, with steel fishplates 26in. long, weighing 56lb. per pair. The tie-bars are of wrought iron, 2in. by ⅝in., weighing 10½lb., and they are double screwed at ends. The rails are fixed to the sleepers by 30 dogspikes and 14 fang bolts and chips to each rail length; the points are of cast steel, made by Miller and Co. and Dick, Kerr, and Co., Limited. The crossings are built up as the work proceeds. The rails form the return circuit, and are electrically connected at each straight joint by two No. 000 B. & S. Chicago bonds, 35in. long. At every point there are two 13ft. bonds spanning the steel casting, and there are also for each point four 35in. bonds, arranged as shown in sketch (Fig. 11). At each crossing there are four No. 000 B. & S. 35in. bonds. The rails are cross-bonded for every 240ft., and where double track the tracks are also cross-bonded in every 240ft. These track cross-bonds are placed halfway between the rail cross-bonds. Where double track with central poles the cross-bonds between the two tracks are 7ft. long, and where double track with side poles 5ft. long. All the cross-bonds on single track are 42in. In all the loops on the single line there is a cross-bond between the two tracks. The return circuit is continued over the river at Parnell Bridge by four 5in. cables, connected by bonds to the rails on either side

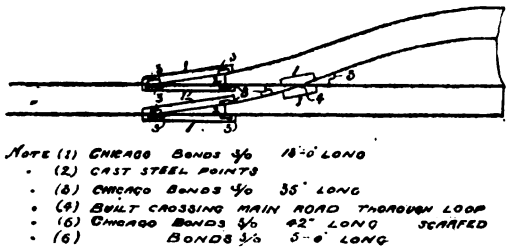

FIG. 11.—Diagram of the System of Cross-bonding used at the Points.

of the water, this arrangement being necessary to avoid any interruption in the circuit when the bridge is swung open.

OVERHEAD CONSTRUCTION.

For this, centre poles with double bracket arms (as shown in Fig. 12) are used in the principal streets. Side poles with single bracket arms are used on the rest of the line, and span wires are only employed in a few places. The poles are 31ft. long, and are built up of three sections, with joints overlapping. The sections are put together and shrunk at the joints while hot. In the principal streets an arc lamp is fixed on every alternate pole. The lamps are of the enclosed arc type, connected up five in series. They are also connected so that the consecutive lamps are on different circuits. Switches and resistances are contained in the bases of the poles, so that a resistance can be placed in the circuit instead of a lamp if necessary; also, each circuit can be controlled from any lamp in its circuit.

The trolley wire is of hard-drawn copper, and is double throughout. The portion of the trolley wire over the swing part of Parnell Bridge is supported on special poles and brackets fastened to the movable part of bridge, the connections on the trolley wire being heavy spring clips, which allow the bridge to be moved in either direction.

Some 18 top-seat cars (Fig. 13), each capable of seating 44 passengers, have been supplied. They were manufactured by the Brush Electrical Engineering Company, Limited, and are mounted on single Peckham trucks. The motor equipment consists of two G.E. 600 motors with series-parallel controllers, the motors being specially designed for this work on account of the very narrow gauge—namely, 2ft. 11½in.—in other respects the car equipment follows the standard practice.

The British Thomson-Houston Company, Limited, were the contractors to the Cork Electric Tramways and Lighting Company, Limited, for the work as a whole—construction, building, machinery, etc.—in connection with the system, and themselves supplied complete electrical equipments of the power station and cars. The following were the chief sub-contractors to the British Thomson-Houston Company, Limited: Permanent way, power-house buildings, etc.—Mr. W. M. Murphy, Dublin; engines—Messrs. R. W. Blackwell and Co., London; boilers—Messrs. Babcock and Wilcox, Limited, London; auxiliary apparatus, pumps, condensers, etc.—the Wheeler Condenser and Engineering Company and the Blake and

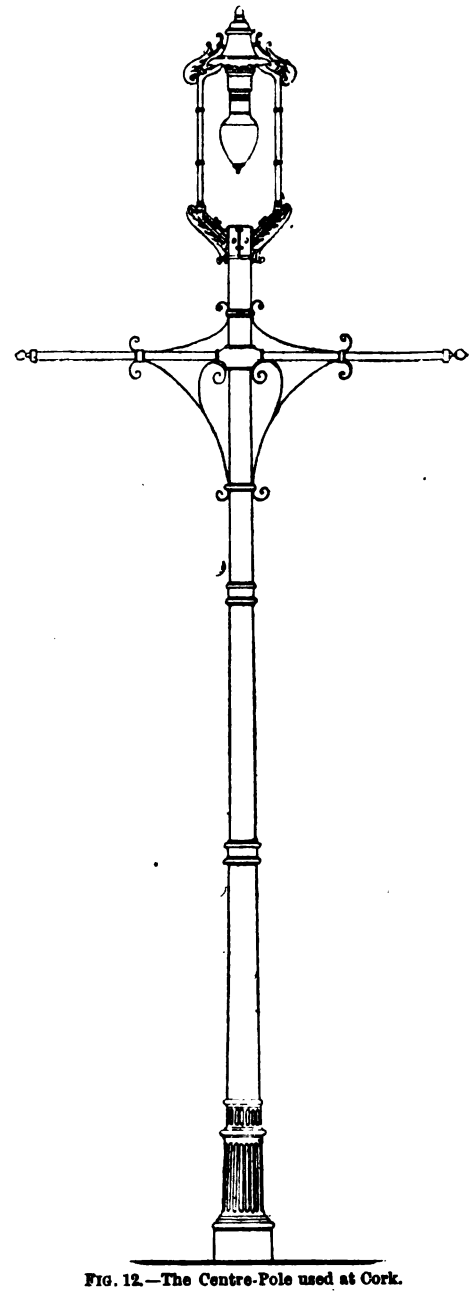

FIG. 12.—The Centre-Pole used at Cork.

Knowles Steam Pump Works, Limited, London; battery—the Tudor Accumulator Company, Limited, London; traveller—Messrs. Jessop and Appleby, Leicester; cars—the Brush Electrical Engineering Company, Limited, Loughborough; Peckham trucks and overhead line construction—Messrs. R. W. Blackwell and Co., London; lighting network and cables—Callender's Cable and Construction Company, Limited, London; arc lamps and hoods—the General Electric Company, Limited, London. Alderman Fitzgerald, of Cork, was sub-contractor to Mr. W. M. Murphy for the buildings in connection with the power-house.

THE WORKING OF THE COMBINED SYSTEM.

The supply of current for lighting and power distribution purposes was started about the beginning of September, and since then about 130 customers have been connected to

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the mains. Many further applications have been received, so that at present the total number of consumers to be supplied is 217. These will use an equivalent of 11,622 8-c.p. lamps. Besides these, some 18 motors of an aggregate of 113 h.p. have been applied for. This brings the total load applied for in 8-c.p. equivalents up to 14,447. The public arc lighting has not yet been permanently started. There will be altogether about 100 arc lamps used, most of which will be placed on the tramway poles. Two 32-c.p. incandescent lamps will be placed on each pole, and these will be used to light the streets after midnight, when the arc lamps are extinguished. In some side streets incandescent lamps are also to be used for the public lighting. The tariff for private lighting is 5d. per unit for the first two hours, and 1d. afterwards, on the Brighton system of charging. This is very favourable to the consumer, but the company goes farther and supplies all lamps required as well, and also trims and recarbons the arc lamps. The regulations on this point read as follows: "Of the sum of 5d. per unit, ½d. per unit is charged in the case of incandescent lamps in respect of the supply of such lamps by the company, and in the case of arc lamps in respect of recarboning and cleaning the globes of the same, provided they are of the long-hour burning type. In consideration of such payment the company undertakes to supply all the incandescent lamps required by the consumer necessary to complete his installation, and to renew them as soon as they are worn out or become defective, and they also undertake to recarbon and clean the globes of arc lamps provided they are of the long-hour burning type. The bulbs of incandescent lamps presented for renewal must not be broken, and to replace lamps with broken bulbs new ones will be supplied by the company at cost price on the cap of the broken lamp being given up. In order to prevent any single special demand for electricity raising the number of units chargeable at 5d., the consumer may, in the event of his intending to use an amount of electricity in excess of his usual maximum, on any such occasion, not exceeding once in each month, give 24 hours' notice in writing to the company, and they will thereupon take steps to prevent the consumer's demand indicator from registering the demand on the occasion so notified." Motors will be supplied with power on the same system at 4¼d. per unit for the first two hours' average use and 1d. afterwards. With these prices, and gas at 3s. 4d. per 1,000 cubic feet, the success of the company is assured as far as lighting is concerned.

The tramways are also to be run on similar progressive lines, with moderate fares. There will be a 10 minutes' service maintained on all the routes, except the one to Douglas, where the cars will run at slightly less frequent intervals. The whole of the work, both on the track and in the station, has been carried out under the supervision of Mr. Charles H. Merz, who is now acting as the resident engineer of the Cork Electric Tramway and Lighting Company, Limited, and he is to be congratulated on the successful issue of his labours. After seeing the success of the Croydon electric lighting station (also equipped by the British Thomson-Houston Company, under Mr. Merz's directions), the Cork Company must congratulate themselves on their engineer.

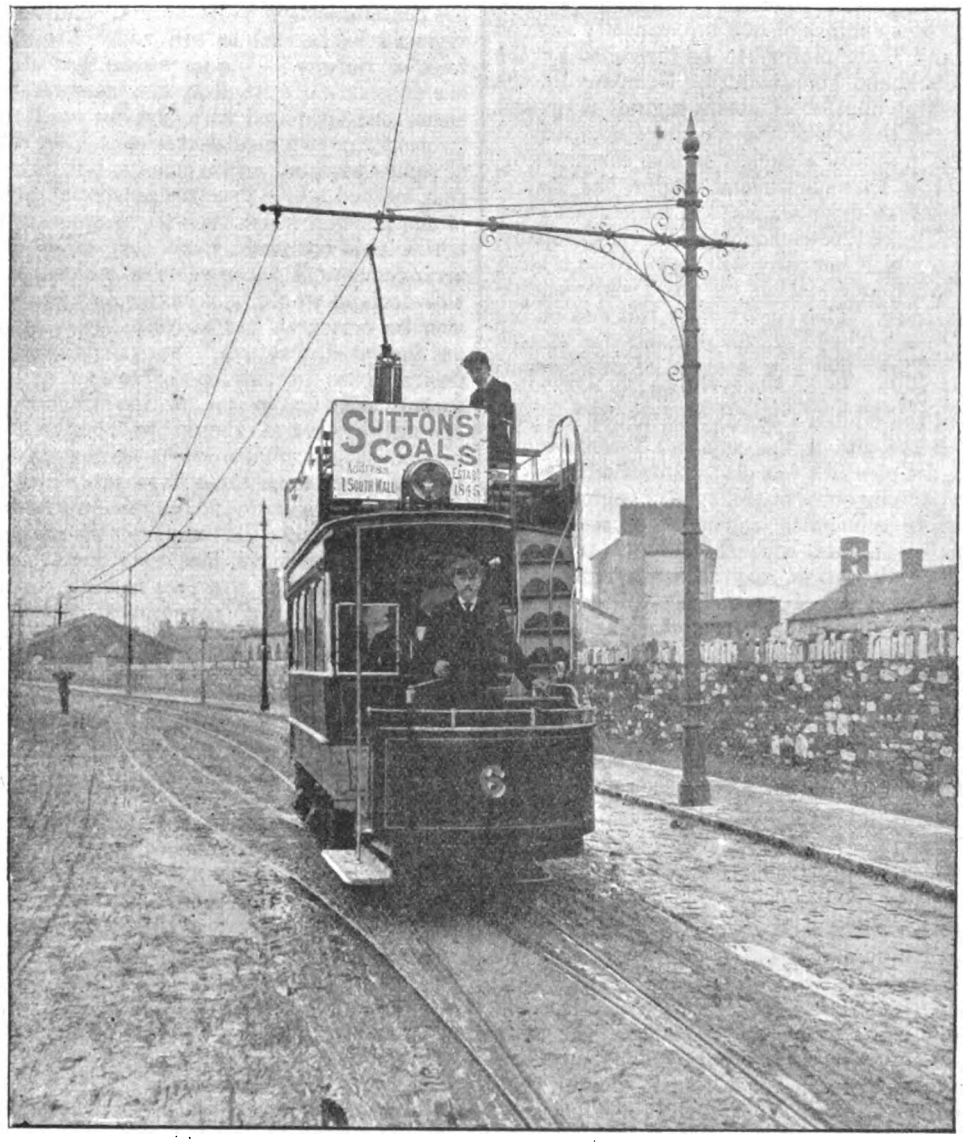

FIG. 13.—View taken on the Cork Electric Tramway, showing Side-Pole Connections.

Hastings.—A poll has been demanded with regard to the proposed Tramway Bill.

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THE PARSONS STEAM-TURBINES.

The following extracts from the *Pittsburg Times* of Dec. 2 shows that the Parsons steam-turbines are finding great favour in America: "The Westinghouse Machine Company has just received contracts for what are probably the largest turbine-engines in the world. This is practically the first introduction into the States of this wonderful engine, and its manufacture promises to result in the establishment of one of Pittsburg's greatest industries. The remarkable success attained by Charles A. Parsons with his turbine-engine on the English torpedo-boat "Turbinia" has demonstrated the surprising capacity and economy in their use over ordinary steam-engines, and in consequence the Westinghouse Machine Company, which owns the patents for the United States, has determined to push their manufacture and to introduce them in the States. The Westinghouse Machine Company is now building three turbine-engines of 500 h.p. capacity each to drive generators and Tesla motors to be furnished by the Westinghouse Electric and Manufacturing Company for the replacement of a large number of steam-engines at present used to drive the machinery of the air-brake company at Wilmerding. The machine company is also constructing, under a rush order, a Parsons turbine engine, the first of five of 2,500 h.p. each, to drive a 1,500-kw. multiphase generator for use by the United Electric Light and Power Company, of New York City, which company will instal it on a block of land adjacent to its new station, on the Twenty-eighth-street and East River. The capacity for this station has already been fully absorbed by the demand for electric light and power. These five new outputs, of an aggregate capacity of 12,500 h.p., will raise the Twenty-eighth-street station capacity of the United Company to 20,000 h.p., and will leave available the site of the adjacent Twenty-ninth-street station, the use of which was discontinued on Wednesday. Mr. Parsons, the inventor of this type of engine, claims that it is much more economical in the use of steam than the ordinary type of engines, with the further advantage that the water, or condensation, may be safely returned to the boiler, since no oil whatever enters the engine while it is in operation. An advantage from the use of these turbine engines and generators may be appreciated from the fact that the five engines and generators of aggregate capacity of 12,500 h.p. can be placed in about one-half the space now occupied by eight vertical engines of 1,200 h.p. each with Westinghouse generators, now in operation at the Twenty-eighth-street station."

INSTITUTION OF ELECTRICAL ENGINEERS.

Electric Intercommunication in Railway Trains.

BY W. E. LANGDON, VICE-PRESIDENT.

(Concluded from page 783.)

The means adopted for raising the alarm in the trains running on the Midland forms a marked departure from the course generally pursued hitherto. A flexible steel wire (Fig. 15) is carried inside a metal tube along each side of the carriage over the doors and quarter lights. This wire has one end made fast at, say, B in each compartment, or at the end of the coach. The other end, C, is attached to the lever of a commutator capable of being operated in either direction. The wire, covered by a fabric suitable for handling, is exposed for some 12in. or 15in. at A, over each quarter light. On the wire being pulled from any one of the exposed parts the commutator lever is operated, a disc on the outside of the carriage is discharged, the circuit is closed, and the bells set ringing. Each compartment has thus four points from which the communication may be brought into operation. Each coach has an indicator on either side, and if necessary each compartment may be so provided. The commutator, at the moment of sounding the alarm, becomes locked, and can only be released by the guard, either from the outside or the inside of the vehicle. The object in view in this arrangement has been to place at the disposal of the passenger a means of communication, accessible from the interior of the vehicle at not less than four points of the compartment, in such a p[illegible] shall be out of the reach of irresponsible p[illegible] preferred, the cord might be entirely enclosed and [illegible] by a pull-down knob or handle, but it would, of co[illegible] more costly.

CONSIDERATIONS.

We have now arrived at a point when we may, perhaps, with advantage take into consideration the material points. We have before us, broadly, the principles of the electric systems in use, as well as those experimentally established. What, then, are the principles which may be suggested as those which should underlie the provision of this means of communication? Experience tells us, and the Board of Trade report suggests, that the communication should be of such a character as to lend itself readily to the interchange of carriages between different railways. This involves not only the electrical principle, but the mode and form of coupling, as well as the means of restoring the communication to its normal condition. The electrical system must be such as will conform to that in use on other lines of railway! We have seen that all those systems in use do practically stand upon a common basis. They have either one insulated wire, and an earth or an uninsulated "return," or two insulated wires. They differ to the extent of some switching arrangements, but it will be clear that that method which involves no special provision in respect of the position which the van occupies in the train is that which must commend itself for adoption. To modify the arrangements of those vehicles which do not conform to this demand would be an extremely small matter. It would also be better, as has already been explained, to employ an insulated "return," but it is possible, though not desirable, to use an open "return." That the coupling for any electrical communication which might be established on railway trains should be combined with one of the mechanical couplings seems to be a sort of tradition handed down from those days preceding the period when railway companies found marshalling sheds indispensable. We have seen that the companies who have used an electrical communication have for years employed an independent coupling, and that they are now supplementing this by a second. The "cord" communication calls for coupling up, and certainly the time required for connecting together an electrical coupling cannot be so great as that now incurred in connecting up this "cord" communication. The question, moreover, is one which, in respect of the majority of trains, does not in any way affect platform work, for the reason that the trains, as a rule, come to the platform ready coupled up. It may, and very naturally, be asked: but why, if the two couplings—the electric and the brake—can be combined, should they not? The question which here arises is mainly one of responsibility. A question on the cost and convenience will naturally also present itself, but that of responsibility is unquestionably the most material. Will such a combination lessen the responsibility which attaches to the efficient maintenance of the brake? When a failure arises in a brake coupling or tube, how is it to be dealt with without the presence of the electrical attendant, and *vice versâ*? Are these men to hunt in couples, the one tied to the other? What does such a combination entail? It means the replacement of some 150,000 brake couplings and tubes. Will the cost prove more economical, or so economical as if the two were established and maintained independent the one of the other, leaving the two departments freedom of action and individual responsibility? I advance these remarks from conviction, after mature consideration, that to combine the electrical with the brake coupling is, on many counts, undesirable. It has already been demonstrated that but one coupling for the two wires composing the communication is necessary. That the handling of this coupling is a perfectly simple and easy matter will be evident from an examination of the sample on the table.

In the early portion of the paper it was suggested that, in their adoption of the mechanical cord, railway companies were animated by a desire to provide for the possibility of a derangement of the train more than with a view to the question of outrage. Improvements in the lubrication of axles, in points and crossings, in the permanent way, and in the rolling-stock generally render the conditions of

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way travelling to-day incomparable with those of 1868. Derangement of a passenger train in motion is now a most unusual occurrence. Unhappily, violence and outrage still exist. In viewing this question it would appear that that which has now to be chiefly provided for is the protection of the traveller from outrage. Is this adequately provided for by the provision of a means of raising an alarm from one position only in each compartment? It is due to the conviction that this is not so, and that the only effectual mode of doing so is the provision of a means of communication in the neighbourhood of each corner of a compartment, that I have endeavoured to evolve the method referred to as that which has been applied to a Midland train.

Although seemingly a very small matter, there is another phase of the question which is material to the adoption of an universal system—viz., the means by which the communication, once used, is restored. This is done by a key carried by the guard. It is usually of private construction, and differs with most companies. It should be common to all, otherwise guards will require to be furnished with a key applicable to each of the companies' stock which may pass over the line upon which he is engaged. Other points of equal, although not of universal, importance will no doubt present themselves: the description of wire to be used, whether it shall be insulated with guttapercha or rubber; the character of the indicator, of the commutator, the description of battery, etc.—all questions of moment, but not vital to the question of interchange of stock. In relation to that, we have to bear in mind that it involves three fundamental principles—viz.: (1) the electrical system; (2) the form of coupling; (3) uniformity of releasing key. That one system should be adopted throughout, even in matters of detail, is, of course, to be desired, but uniformity in the three points named are essential to an interchange of stock.

There remain but two more points at which to glance—viz., communication with the driver, and provision for calling attention to the division of a train when in motion. There is no difficulty in providing for communication with the driver, but it is desirable the battery on the engine should be dispensed with. This it is possible to effect by providing each guard's van with a coupling applicable to the locomotive. The cost of adopting this course would be less than that attending the provision and maintenance of a battery on the engine. Another point is whether it would not be better to sound a whistle on the engine rather than operate a bell. The whistle would probably be easier to maintain. In the earliest established electric communication systems a means was provided for claiming attention should a train become severed. There is no difficulty attending this, but it would appear that the need for it no longer exists. Since those days the automatic brake has been introduced, and if a train should at any moment become divided, the progress of all portions of it would at once be arrested.

The title of this paper indicates that its purpose is to treat of the subject from an electrical point of view. Reference has, however, been made to the fact that there is in use another means of claiming the attention of the guard—viz., a partial use of the automatic vacuum brake. Each compartment of a carriage is provided with a means of opening a small valve connected with the brake pipe. To what extent this is effective—whether it varies with the speed of the train, or other conditions, or whether such a system is a desirable one—I am not in a position to say, and I only refer to it here in order to point out that, should an electrical system be adopted, carriages provided with this means of applying the brake could be looped in on electrically fitted trains by means of a loose coupling; but there would be a difficulty in dealing with electrically fitted vehicles interposed in trains worked under this partial application of the brake system. In concluding this paper, I desire to tender to the general managers, and to my *confrères*, the electrical engineers, of the various railways, who have so kindly assisted me with information, my most hearty and respectful thanks.

DISCUSSION.

Mr. J. W. Swan (president) said that the subject of Mr. Langdon's paper was one with which the name of Mr. Preece was closely connected. It gave him great pleasure to see that that gentleman had entered the hall, as he knew that Mr. Preece had just returned from a long journey. It gave him much pleasure to ask Mr. Preece to give them his views upon the subject.

Mr. W. H. Preece said that he had missed his train at Birmingham, and had thus only arrived to hear the finish of the paper. It seemed to him like raking up an old fossil to bring up that subject. It was now some 34 years since the subject engaged any great amount of his attention. The system Mr. Langdon had shown in the first diagram was that used on the London and South-Western Railway, and he (the speaker) read a paper in 1866 on that very system before the Institution of Civil Engineers. At that meeting the room was full of the howling swells of the railway world. He then also described a method of signalling to the guards and drivers when a train parted, and he showed them an experiment illustrating this. But, unfortunately, that experiment did not work, and he excused himself with the lame excuse that some dust must have got on the contact stud, and the contact was thus made imperfect. This, of course, made them say that if a little dust could put the apparatus out of order, it would not do for railway trains, where it was liable to get all sorts of dirt, grease, etc., on it. He found out afterwards that his assistant, to prevent people from tampering with the apparatus before the experiments were made, had stuck a piece of paper on the contact stud, and that was the cause of the failure. For all that, however, the manager of the South-Western Railway took it up. His second failure in that direction was the stopping of a train near Clapham Junction. The train had been fitted up by him with the proper batteries, bells, etc., but suddenly the bells started ringing and the train was brought to a standstill, there being at the same time nothing the matter with it. That failure was owing to the linesman in charge of the apparatus, thinking the bells did not ring loud enough, putting in an extra battery and thus disturbing the balance of the system. Those two accidents established a prejudice against electric signalling on trains. He did not take so great an interest in the matter now, as he had, as he had said, dropped it for about 30 years, but it was a great pleasure to him to find Mr. Langdon reviving it and thus preventing it from being lost sight of altogether.

Mr. W. Leonard said he should like to correct Mr. Langdon on one or two points. He said that Fig. 2 was the arrangement introduced by Mr. Walker. That was an error, as he (the speaker) had introduced it himself, and it had been in use for several years. Again, he said that a "three-way switch has to be provided in each van," etc. That was not correct, as although the three-way switch was advisable, it was by no means a necessity. What was the object of the switch? If the train was stopped mischievously, the system could thereby be thrown out of use, and that would effect a saving of the batteries. Again, there were times when the empty train was being moved about, when it would be desirable to keep the system ready, but not actually in use. Mr. Langdon had not fully described that system. There was but one indicator in each carriage where it was used. He (the speaker) was not so much taken up with the system now as he was. The officials did not like having to go into several compartments to find where the alarm had been raised. All the outfit for signalling the driver were on the South-Eastern Railway placed on the tenders. They were formerly placed over the firebox, but it was a very awkward position to get at when it was necessary to stop the bells ringing. The discs on the outside of the carriages were not now used, as formerly they used to be stolen for the sake of the brass of which they were made. The brass discs were replaced by wooden ones, but these were not found to give satisfaction. As regarded rail return, a difficulty was only experienced when the trains were standing, as after standing in sidings, etc., the rust prevented a very good connection. The method of coupling on the South-Eastern Railway was the solitary remnant of the system introduced by Mr. Walker. It was in the form of an iron bow and coupling. He himself had used that form of coupling, but had made it of copper and not of iron. This improved form had now been in use for years. If any other form was to be introduced, he certainly thought that Mr. Hollins's would be found the most useful.

Mr. Winter said they should be much indebted to Mr. Langdon for bringing that paper before them. He was glad to see that he condemned the system of rail return, and also any interference with the vacuum brake. No allusion had been made to the system which his late brother had introduced on the Madras line, and which had been used since 1879. Why the author said that side chains should not be used he could not conceive. Experiments had been made with the use of these, and after being tarred, greased, etc., connection was still obtained. The great thing in using these was that no additional work was put upon the officials in charge of the train.

Mr. Wolff said he had come as a representative of the Midland Railway. There was one point which he thought called for attention, and that was the question of the alarm on the locomotive. The arrangement should be something like that shown in Fig. 14, and instead of the whistle that was now in use, a bell should be used. He should like to say that any method of alarm inside the compartments should be kept separate as far as possible from the other arrangements. He once saw a lady, in endeavouring to raise the alarm, turn on hot water instead, and then she complained that these alarms never worked.

Prof. S. P. Thompson said he had discovered a specification which might be of interest to them in connection with the present subject. It was drawn up by Mr. J. Mirran in 1859. That gentleman was the inventor of the trembling bell. In the specification three wires were recommended for train connecting. He had no

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wish to detract from the excellent paper before them, but he thought that it was one of the great advantages of such an Institution as that that they were able to exchange ideas. The word "commutator," which Mr. Langdon used throughout the paper, was not a commutator as electrical men understood it—it was merely a short-circuiting switch. Again, he spoke of an open return. They usually took "open" to mean in electrical work "disconnected," and not "uninsulated." Thus the railway people might find it possible to use terms as the electrical people used them. A paper on this subject could only be written in this hemisphere. On the other side there was no need for it, all the trains being composed of corridor cars, but at the same time the cars were very comfortable. Although this kind of electrical arrangement was not needed, they used electricity on the trains much more than the European railways did.

Mr. W. E. Langdon, in reply, said that his object in presenting the paper had been to draw their attention to the present condition of electrical communication between passengers and guards, as far as its adoption throughout the country was concerned. To Mr. Preece it must have been like going back to his schooldays. He was the pioneer in the establishment of that form of communication. If one battery ran down below the others, then that one would not have the same opposing force, and the circuit would be opened through that battery. If one uninsulated wire were used there might be a leakage from it to any other metal work, and the batteries would by that means be run down. He was obliged to Mr. Leonard for pointing out his errors. He certainly put down what he understood from the correspondence with that gentleman. When trains were standing in sidings it was of course a temptation for porters and others to try the apparatus to see how it worked. As to the connection by the side chains on the Madras Railway, he felt somewhat at a loss to understand how a current could pass through the chains after being treated as Mr. Winter had described. With regard to Mr. Wolff's idea, it was not advisable to have an apparatus like Fig. 14 on an engine, but whatever was used it should be very strong and simple in construction. He was much obliged to Prof. Thompson for giving him the opportunity to examine the plan of Mr. J. Mirran. He had always heard that "switch" called a commutator; and were not overhead uninsulated wires called "open"?

INTERRELATION OF COLOUR WAVES AND THOUGHT.

Mr. Howard Swan writes: "On Dec. 17 last year I announced in this paper a discovery (which was immediately afterwards independently corroborated by Prof. Scripture, of Harvard) of the interrelation between sound waves and thought, as shown in the movements of the 'faint rolls of curdling luminosity' seen before the eyes in the dark. I now announce the corollary of this in the discovery made on Dec. 10, 1898, of a relation between *colour* and mental state, a matter which, if found to be true, will certainly serve, to a great extent, to explain that enigmatical function, the 'personal equation,' in testing lamps and in delicate astronomical observations. Lying down," he states, "with one eye hidden by the pillow, I caught sight with the other eye, which is very short-sighted and astigmatic, of the dull blue colour of the end of a Swedish safety match-box. It appeared a most brilliant diffused blue colour, almost radiant. Then it slowly changed, got less brilliant, and finally disappeared to the right, leaving the perception only of the other eye (white pillowcase), and a confused whitish golden colour on that eye which had seen the blue and was still looking straight at it. This slowly changed, and again the blue came into focus—a brilliant blue. I leapt," says Mr. Swan, "to the conclusion that I had made a further discovery—the relation between colour and thought. As I thought and looked, so the colour changed, and this change was due to my own interior subjective state or the thoughts I chose to think. I watched the change occur several times. I tried repeating certain ideas, 'love, kindness, justice, peace on earth, help,' etc. Rolls and rings of the inner brain light (mentioned Dec. 17, 1897) apparently obscured the blue or heightened its colour as they passed, the periodicity being noticeably regular. I counted first intervals of five pulse-beats between the alternations blue, whitey-gold, blue; then a period of 15 seconds; and on a third and later trial 25 to 30 seconds; but with a half-wave interval of 12 seconds thus: 30, 42, 72, 84 seconds; sometimes with still slighter waves between. The reappearance of brilliant blue—startlingly brilliant—after no colour, was most marked. In attempting to repeat the experiment it is probable (*a*) that it should be made after starting the interior thought waves either by reading or by thinking, preferably emotionally, and (*b*) by having a slight magnifying or diffusing glass between the blue paper and the eye for those of normal sight to so as to diffuse the blue rays. Similar experiments may be made with peacock green and with Turkey red, the fundamental light sensations, and with varying states of mental feeling—hope, fear, love, and so forth. It can be seen that by such means a theoretical possibility at least is shown of the means of testing the speed of vibration of thought waves by superposition of the brain waves on ordinary colour waves whose speed of known, and then measuring the extent of heig obscuring. The mere possibility that thought may be subjected to mathematical treatment has hardly until even theoretically considered possible."

LIFT CONTROLLERS.

The General Electric Company are putting on the mark very efficient lift controller and reversing switch with mag control. A few of the special advantages offered by the adopt of this apparatus, which is patented, are: a perfectly accelerated start, free from jar or jerk; the impossibility of the elevator being forced to start under an overload, and blowing a fuse from this cause; no oil or air dash-pots are required to act as governors, as the elevator controls the movement of the resistance contacts; substantial mechanical construction in the piece of delicate wiring and connections; the impossibility of the armature being burnt out by overload.

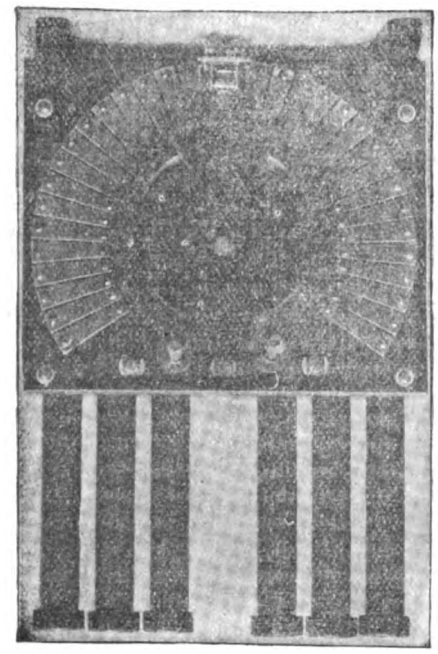

FIG. 1.

Special attention is drawn to the form of resistance used with this controller. It is of tubular radiator type, with enclosed coils, and will be found capable of withstanding very severe service, without deterioration, and being of compact and massive construction it is most suitable for elevator work. In the construction of this reversing switch (Figs. 1 and 2) the most approved plan for reducing the destructive sparking, which is so disastrous to the circuit-controlling mechanism of elevators, is adopted. The arrangement is similar to the method employed

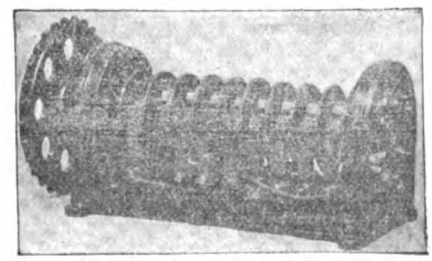

FIG. 2.

in the best tramcar controllers, and consists of opening the circuit at 24 different points simultaneously, thereby dividing the sparking into many small arcs, which are not capable of burning the contacts. The reversal of the current is so accomplished by a half turn of the sprocket wheel, which by means of a chain connector is readily adapted to any form of elevator mechanism now on the market. The wearing parts of this switch are renewable, each current-breaking clip being readily detachable. The wiring between switch, rheostat, and motor is particularly simple, only three wires being used to connect them. With this apparatus it is possible to change over any ordinary belt-driven elevator into a direct electric one, it being only necessary to fit small sprockets on the winding drum and belt-shifter shafts, and connect controller and switch to a reversible motor to derive the full economy of a direct-connected installation.

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APPRECIATIVE AND SUGGESTIVE.

The late firm of Woodhouse and Rawson had many sins to answer for, but in one direction it deserved nothing but praise. It made several and not altogether unsuccessful attempts to provide apparatus for use in directions not generally looked after except by specialist firms. We have in mind the apparatus required by the medical profession. The medical profession is eager to take advantage of everything that will assist in the humane work of healing, and this fact was borne most strongly to our minds whilst listening to a few remarks by the medical officer of health of Salisbury on the occasion of the opening of the Salisbury station last Monday. This gentleman, who is evidently a member of the hospital staff, spoke strongly of the necessity of electric light in hospitals. He pointed out that the best anæsthetic under which to perform operations is ether, and ether is so volatile that it cannot possibly be used in the presence of naked lights; hence operations that have to be conducted at night where the electric light is not installed have to be conducted with anæsthetics not so good as ether. The moral deduced, of course, is that, wherever possible, hospitals should be provided with the electric light. Its utility in minor operations such as getting foreign objects out of the eye was also referred to. Before considering this subject further, we may mention another matter which cropped up in the course of the after-dinner speeches. It was that of ventilation and contamination of the air, and this is very important in hospital work. Perhaps such views as these are more important when authoritatively expressed in places where the light has yet to make its way. The power of simulation (we had almost written "fashion," but the latter word will not correctly express the idea) is enormous. When the doctors are all for the light and fail not to point out its advantages, when they urge its adoption in the hospitals and use it in their own consulting rooms, the laity will undoubtedly be impressed and will follow in its adoption. In the house it is not the question of "operations with the best known anæsthetic," but it is a purer atmosphere that is required. Just now, again, medical evidence is brought forward to show how valuable the electric light is in public halls. We read in a contemporary, "the difference in the condition of the throats of public speakers and singers since the introduction of the electric light is most marked; they have less irritation and less weariness during and after their performances." Assuming this to be true, it forms another incentive to instal the better light. Long ago those who carefully studied the subject—and among the first to emphasise it was the president of the Institution of Civil Engineers, Mr. W. H. Preece—contended that even if electric lighting cost a few pence or shillings more upon the bills, it was indirectly the means of saving far larger sums than this extra cost. But as the light becomes more generally adopted, its actual cost approximates more to that of competing illuminants, and the indirect gain is so much to the good. According to the laws and by-laws which regulate the cubic air space per person in most public buildings,

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the quantity taken as a minimum necessary is calculated more from the amount vitiated per individual rather than from the total vitiation of humans and lights. Many rooms become unbearable when the gas is lighted which are passably healthy before the lighting takes place. We trust that the managers of electric light installations, whether on behalf of local authorities or companies, will seek the aid of the medical profession in preaching the value of the light under all circumstances. It must be remembered that the incandescent gas lamp is now the competing light against electricity, and that we no longer have to compare with the ordinary burner. Gas managers are not slow to influence shopkeepers to instal the incandescent gas lamp, and maintain, with some show of justification, that they will not get a better light if they go to electricity. We might combat this view, but instead of appealing to photometry we should suggest that even an incandescent gas burner was sanitarily very bad.

NOTES ON THE DISTRIBUTION OF ALTERNATING CURRENTS.

BY SIDNEY E. T. EWING.

(*Continued from page 775.*)

The Installation of Transformers, Pits, and Sub-Stations.—The high-tension main ends either at a sub-station or transformer pit, or on a consumer's premises. As the latter is the simplest case we may consider it first. The Board of Trade regulations provide that when a high-tension transformer is installed on private premises it must either be placed in a brick chamber provided with an iron door, or that it and all the high-tension apparatus be completely enclosed in an iron case, which case is to be permanently and efficiently connected to earth. In a majority of cases in house transformer work the brick chamber is the better plan, particularly if the transformers in use are not supplied in iron cases. The great advantage of this method is that the high-tension mains can be brought in and taken out again through a pair of fuses or connectors, giving a ready means of breaking up the circuit for testing. It is generally advisable, when a fair-sized chamber close to the roadway can be arranged for, to lay two or three pipes into it from the street, whereby it may sooner or later supply other neighbouring consumers through a low-tension main. Many makers now supply small and moderate power transformers fitted with an earth shield, and with high and low tension fuses complete in a cast-iron case, and these require little more than the simple connection of the cables through the watertight glands and a good earth connection. Where, however, unprotected transformers have to be installed hurriedly, a galvanised iron tank of ordinary stock pattern, with a few holes tapped for a cover to be screwed on, makes a convenient substitute for a cast-iron case. In all cases the iron pipe containing the high-tension mains must come right up to the transformer case, be metallically connected throughout, and be properly earthed. A stout water-main forms the best earth. Gas-pipes, particularly compo., should never be used. The pipe containing the mains should not be used as an earth unless it is of considerable length, or unless it is metallically connected to the other iron pipes of the system in the service box. When a number of house transformers are in use, the earth shield to each transformer costs less than the Cardew earthing device. For banked transformers in sub-stations the Cardew device is the better, as one serves for several transformers, and allows of inspection wherever necessary. When a sub-station is being built, it is a good plan to bury a large earth-plate in the surrounding soil, together with a load of moist coke, and bring a stout connection therefrom into the chamber. This brings us to the subject of sub-stations.

Space forbids any attempt to describe the complete equipment of even a few representative of actual practice, but the main features of design that are advisable may be mentioned. In the first place, there is the choice between sub-stations proper and transformer pits. The sub-station either under or above ground is on many accounts greatly to be preferred, but in many cases the cost, which may amount to anything up to £60 or £70 for a moderate-sized chamber, exclusive of equipment, renders it out of the question when the lamp density is small. It is, we believe, somewhat generally considered among station engineers that the largest-size transformer which it is advisable to use in average town distribution is about 30 kw. No important saving in magnetising losses accrues from using a larger size, and considerations of weight and size, and consequent ease of handling in crowded streets, render this about the limit of size which can readily be got in and out of underground pits and chambers Consequently it may be said that whenever the probable future demand renders it unlikely that more than 30 kw. can be economically distributed from one transforming point, a transformer pit of ample size should be put down, but whenever this demand is likely to be exceeded a sub-station is advisable. Of course, in a few cases suitable room can be found on corporation property, or something of that kind, which saves a great portion of the expense, but companies have usually nothing to choose save between underground work or the rental of a cellar or portion of a back garden or yard, if such can be obtained at reasonable rental in close proximity to the street. Assuming, then, that it is decided to put down a transformer pit, the question of its design offers many points on which great differences of opinion exist. It can without difficulty be made practically watertight, and an unprotected transformer can then be used, but this means that it is also more or less airtight, and with a fairly large transformer a dangerously high temperature will be attained. The better plan is to use a transformer provided with a watertight case, and allow the pit to ventilate freely into the neighbouring switch or connection box. A few inches of water in the bottom will do no damage, and can be easily removed with a hand pump. In either case the switch and fuse gear should be contained in a separate box alongside the transformer pit, or, if it can conveniently be arranged for, in an iron box sunk into a recess in an adjoining wall. If the transformer feeds in parallel with others on to the distribution mains, both high and low tension switches and fuses will be necessary to enable it to be isolated. These switches are preferably worked by a common controlling handle. In closing, however, the low-tension switch should make contact an instant before the high-tension, allowing the iron to be magnetised by the current from the secondary mains before the primary current enters. This prevents the current rushes in the primary, which may take place if the iron be oppositely magnetised at the instant the current is put on, though this is not a common trouble save in the case of large transformers. In the case of a transformer which is not in parallel with others on the secondary side, the low-tension switch may be dispensed with. These combined high and low tension switches and fuses are supplied by several makers, fitted with cast-iron cases and watertight glands for the cables, and actuated by an outside handle. They are, however, complicated and expensive, and a further objection is that there is no guarantee that the current is really off the transformer upon which the work has to be done, save the audible snap of the spring switch gear inside the case, and the position of the controlling handle. It is greatly preferable to be able to see the switch open, or the fuses taken out by hand, as is possible when a wall box is used or in a sub-station, but in cases where the work must be put into a street box their use is indispensable. One leading firm who have had great experience in alternating-current distribution have lately designed and put on the market a most excellent cast-iron transformer box, in which all the switch and fuse gear is contained in the space above the transformer, is well protected, and worked by a handle outside the box. Provision is made for a maximum demand meter, which should be of the greatest value, and, before working on the box, the inner of the high-tension main and

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the earthed outer can be plugged together. Of course, this box is made for the standard type of transformer made by the firm.

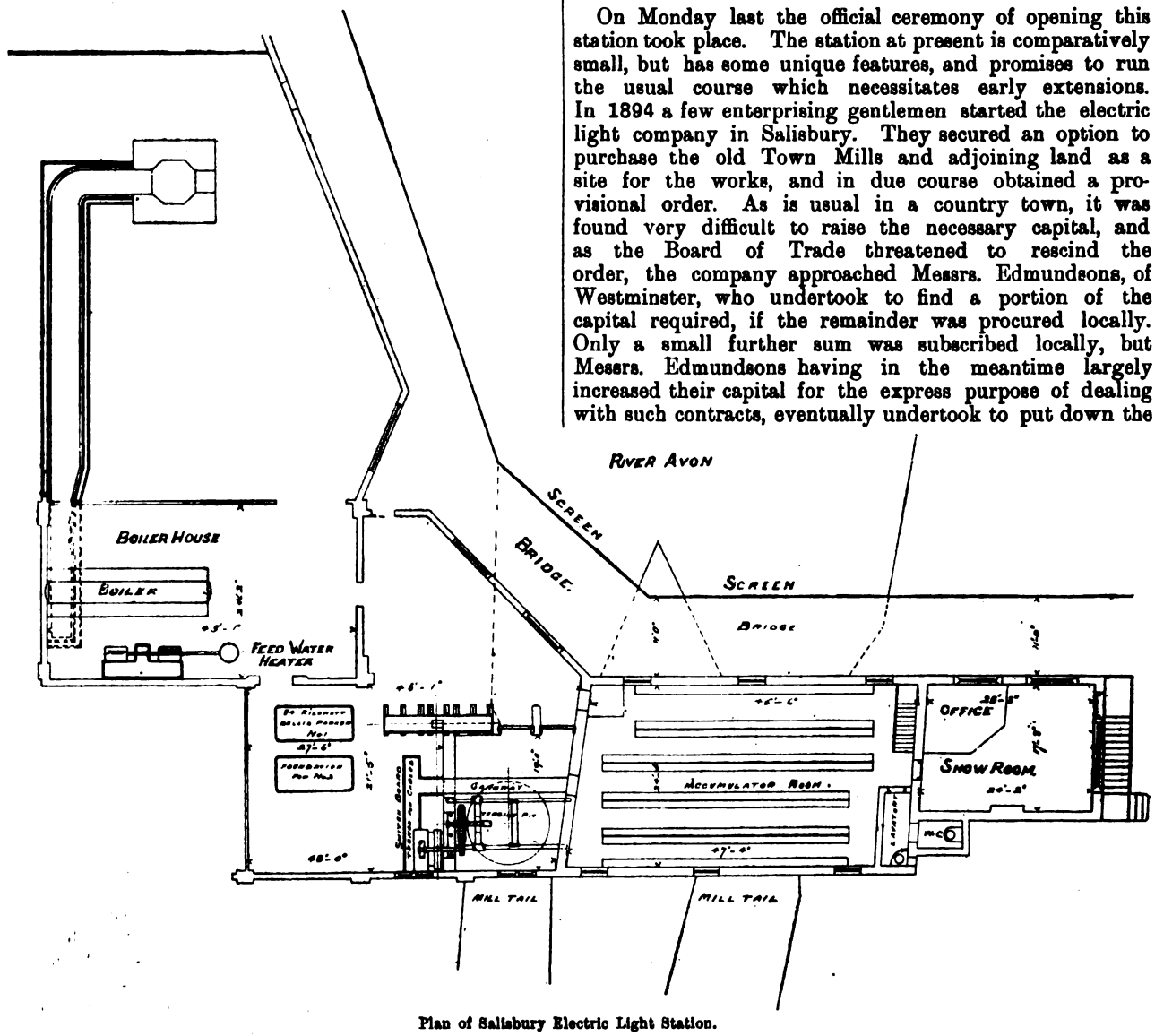
If a sub-station be built underground, the point requiring especial care is to ensure that it shall be dry and well ventilated. Its size will depend entirely on the number of transformers and their size that will eventually be installed. In any case it is advisable to err on the side of roominess. The walls should be double, with the internal space of about 1in. filled in with asphalte, which asphalte should be jointed to the asphalte covering of the floor. The roof may be of iron joists and concrete, of iron joists and brick arches, or a variety of other forms between which there is little to choose save on the score of cost and local convenience. Ventilation is a most important point. One of the best and simplest methods that has come under the writer's notice is to have an upcast and downcast pipe, the former near the roof and the latter near the floor, both carried up a foot or two above the ground against a neighbouring wall, with a grating at the mouth. The heating of the air in the chamber by the transformers gives a steady and continuous flow into the chamber and out again. The construction of the walls and floor, with their asphalte lining, should render the chamber absolutely gasproof, and if a careful joint is made with the asphalte round the bell-mouths of the incoming pipes, the only source by which gas can enter is through the pipes themselves, and these, when the cables have been drawn in, can be plugged with Vulcan cement. Whatever precautions are taken against gas and flooding, it is advisable that sub-stations should be inspected at least every day or two. The manhole, and the ladder to which it gives access, should be in the corner farthest away from the high-tension work, and the best plan is to arrange for a small manhole for giving access to the chamber for inspection and so on, and a larger one for use when transformers are to be taken in or out. Some designs for these manhole covers have a drip pan to prevent leakage of surface water into the chamber, but this is not really necessary. If the cover is a fairly close fit to its frame, and beds on to a little yarn placed in the lip or groove, no appreciable amount of water will find its way through, provided that the surface of the pavement is well drained.

(To be continued.)

SALISBURY ELECTRIC LIGHT STATION.

Hards, L. A., the resident engineer to the Salisbury Electric Light and Supply Company, was educated at Rugby. He served his apprenticeship with Messrs. Woodhouse and Rawson, after which he was engaged with Messrs. Edmundson's, Limited, and thus superintended the work at Salisbury, becoming the engineer to the company when it was formed.

On Monday last the official ceremony of opening this station took place. The station at present is comparatively small, but has some unique features, and promises to run the usual course which necessitates early extensions. In 1894 a few enterprising gentlemen started the electric light company in Salisbury. They secured an option to purchase the old Town Mills and adjoining land as a site for the works, and in due course obtained a provisional order. As is usual in a country town, it was found very difficult to raise the necessary capital, and as the Board of Trade threatened to rescind the order, the company approached Messrs. Edmundsons, of Westminster, who undertook to find a portion of the capital required, if the remainder was procured locally. Only a small further sum was subscribed locally, but Messrs. Edmundsons having in the meantime largely increased their capital for the express purpose of dealing with such contracts, eventually undertook to put down the works, finding nearly all the capital required. The works in Salisbury have throughout been designed by Messrs. Edmundsons, and carried out by them, and we think they have every reason to be proud of the result. Mr. L. A. Hards, who acted as their resident engineer, is now engineer to the Salisbury company.



Plan of Salisbury Electric Light Station.

A better position for a supply works than the old Town Mills it would hardly be possible to secure, it being not more than 100 yards from the centre of the city. The site is about half an acre in extent, and was the property of the Dean and Chapter of the cathedral for seven centuries. The old Town Mill is on the site where a mill probably already stood when the city was moved in the thirteenth century from its first position on the top of a neighbouring hill* to its present situation at the junction of the Avon and the

* An explanation of this remark may perhaps be necessary to such of our readers as are not archæologists. The original town,

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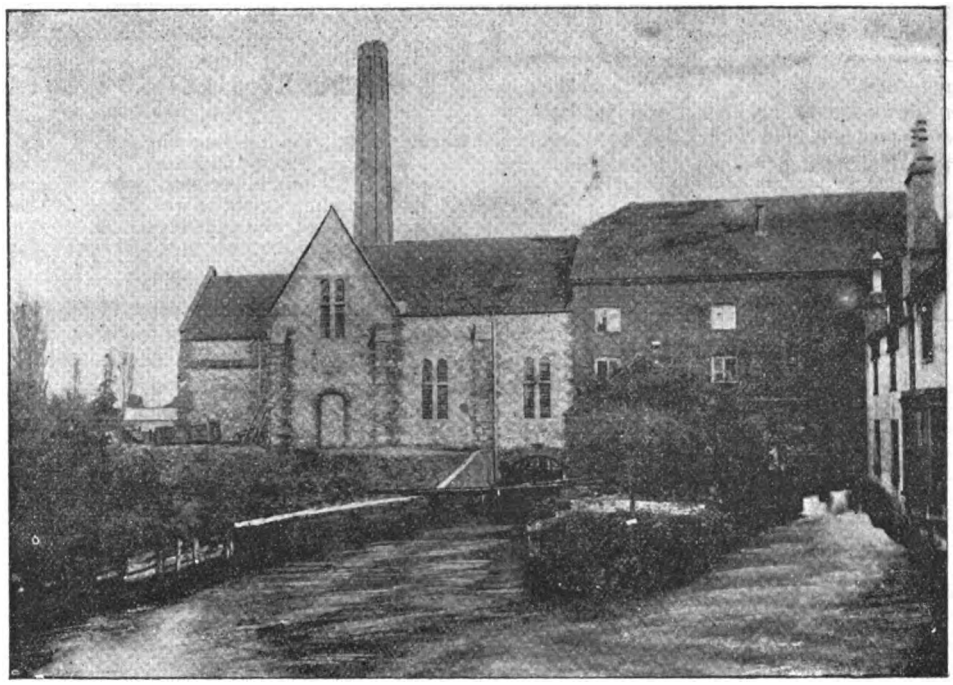
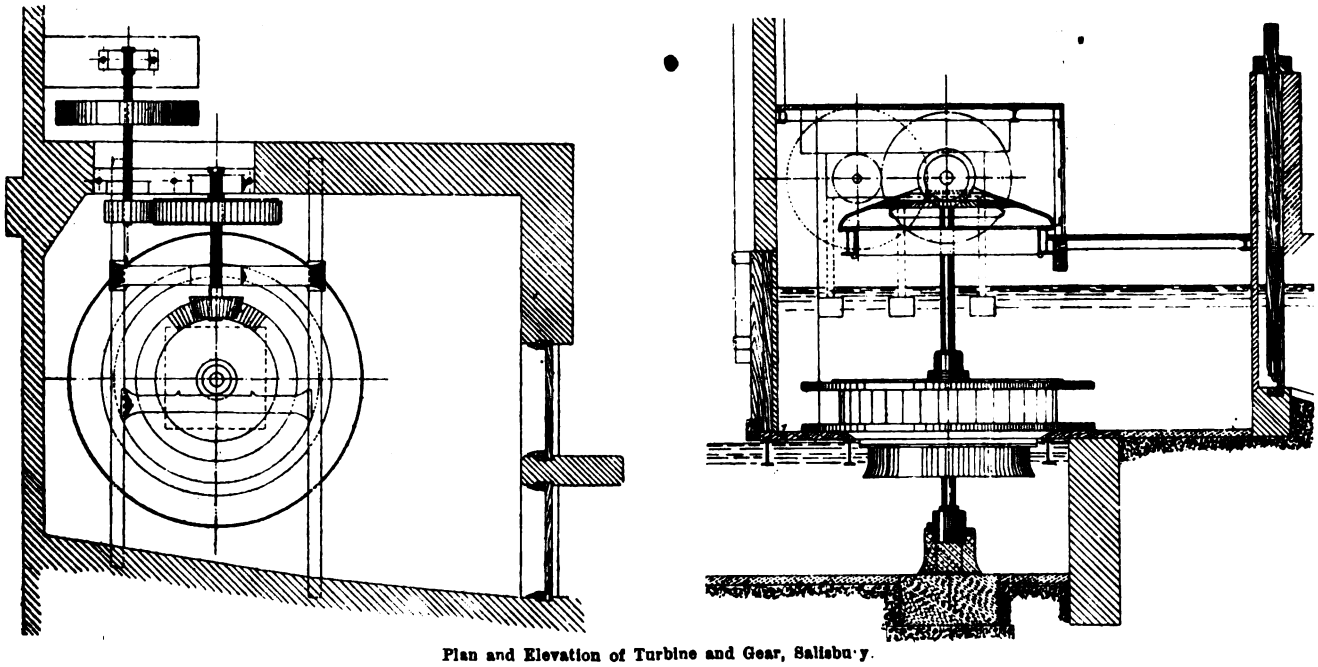
Nadder, the former of which now supplies part of the energy for supplying light in the city. Quite a number of interesting curiosities were found during the excavations.

The present mill buildings are only about 150 years old, and were fitted with four undershot wheels, which were used for flour and snuff grinding. One of these had been removed, and an iron eel-trap grating fitted in its place.



View of Salisbury Electric Light Station from the Bridge.

Fig. 1 shows the plan of the works. At the east end is a new two-storeyed building used as an office and show-room, with a store and workshop below. The next building is the old four-storey mill, having on the ground floor the eel-trap, tank, and storm-water gate at one end, and further storage room at the other. On the first and second floors are the accumulators. The upper floors are empty. The engine-room is a new building, containing the turbine, engine, and dynamos. The boiler-house is at right angles to the engine-room, and the triangular-shaped room between is intended to hold the condensers when the load on the steam plant warrants the cost of adding these. The whole of the engine and boiler house are built of fireproof materials, the roof being iron, glass, and tiles; the walls are built for the most part of flints set in cement. As the buildings are in such a prominent position in the city, Mr. E. Doran Webb, the architect, refused to have anything to do with the work unless he was allowed to design a building and chimney as little unsightly as possible, and certainly we must congratulate him on what is probably the most picturesque building of the sort in England. A siding of the L. and S.W.R. adjoins the company's property; some day, no doubt, this will be used, but for the present, as the consumption of coal is small, it is carted to the works. The builder of the works was Mr. E. Hale, of Salisbury, and of the chimney Mr. J. Thompson, of Peterborough. The chimney is octagonal, 100ft. high and 6ft. internal diameter.



Plan and Elevation of Turbine and Gear, Salisbury.

There are at present in place a 50-h.p. Vortex turbine and dynamo, one Babcock and Wilcox boiler of 1,218in. heating surface, two Worthington feed pumps, one of Joseph Wright's Excelsior feed heaters, and a Belliss-Parker set of 84 kw. output, 180 amperes and 460 volts. Space has been left and all provision made for adding another boiler and engine set when required, but it is probable that so much

"Old Sarum," was built at a considerable distance from the stream. Dr. Pope tells the whole tale in the lines:

"Old Sarum was built on a dry barren hill
A great many years ago;
Twas a Roman town of strength and renown,
As its stately ruins show."

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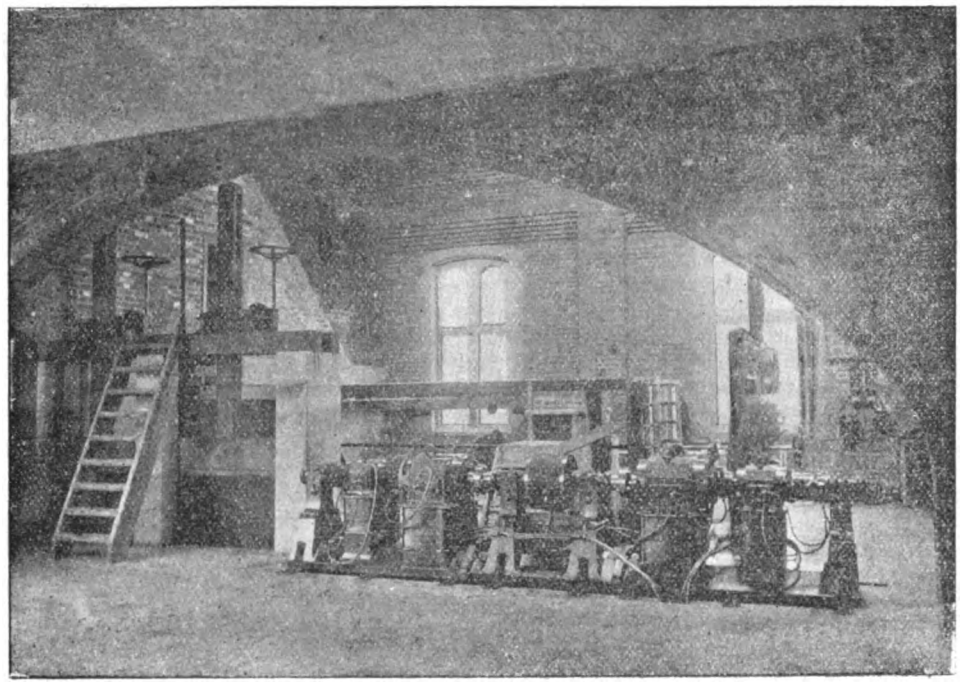
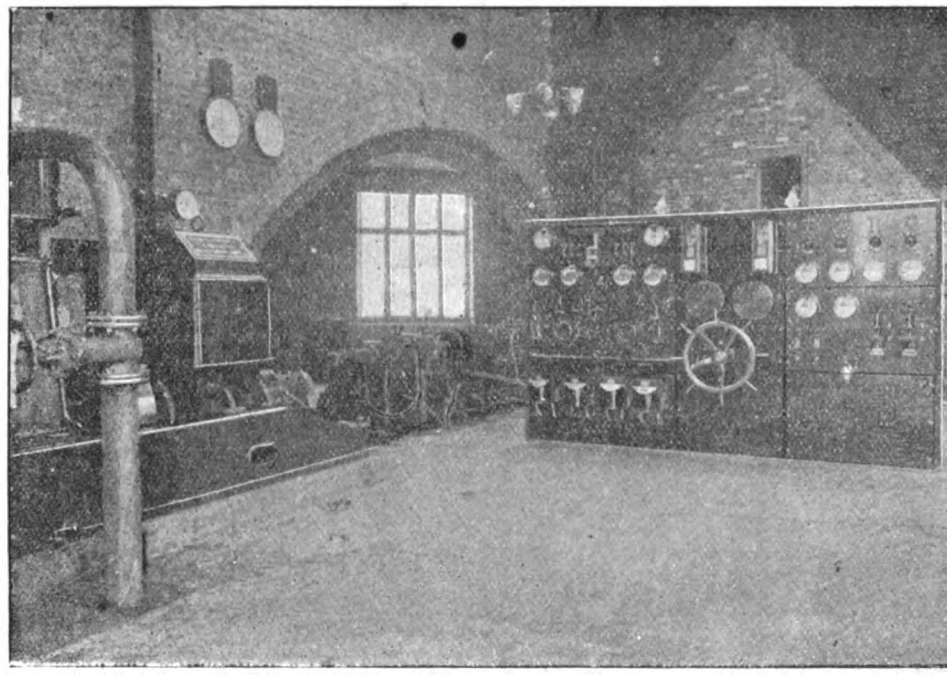
useful work can be obtained from the turbine that these will not be required for another year. The steam-pipes are on the usual ring main principle and the feed pipes, etc., in duplicate. A galvanised iron tank, capable of holding 2,000 gallons, is supported by an arch high up in the boiler-house, to give a supply by gravitation to the feed heater. The dynamo in the Parker-Belliss set is of the inverted type, with patent Eickemeyer coils, coupled to a Belliss engine; the output being 450 volts 180 amperes at 420 revolutions per minute.



Dynamos and Boosters at Salisbury Electric Light Station.

The supply in Salisbury is at present being given from the turbine, which is one of Messrs. Gilkes's (of Kendal) make, with revolving wheel 8ft. 6in. diameter, and is capable of giving 60 h.p. with 5,883 cubic feet per minute, working under a 7ft. head. It runs at 28 revolutions per minute, and drives the dynamo at 200 revolutions by gearing and belting. The turbine is fitted with movable guide-blades for adapting the entrance orifices to any quantity of water below the full supply. These are fitted with gearing for adjusting them. The hand-wheel for this purpose is placed most conveniently in the centre of the switchboard. As the plates of the turbines are very massive it is quite hard work to close them, and an electric motor is to be fitted to give the switchboard attendant a quicker and easier control. The whole of the regulation is carried out by this wheel, there being no use in inserting resistance in the field of the turbine-driven dynamo, as the wheel only runs the faster to make up for the weaker field. The dynamo driven by this turbine is composed of two machines coupled together, each capable of giving an output of 100 amperes at 230 volts, one machine being connected each side of the three-wire system. On the ends of the dynamos are coupled the boosters, to add the extra pressure for charging the accumulators. The armatures of the boosters are wound on a sleeve and slipped on to the end of the spindles of the dynamos. In the event of the turbine being out of use, this machine can be used as an ordinary balancer-booster combination by the removal of the belt.



Switchboard and Belliss-Parker Set at Salisbury Electric Light Station.

The booster set consists of four machines coupled together and mounted on slides with adjusting screws for tightening the belt. This combination is fitted with a pulley in the

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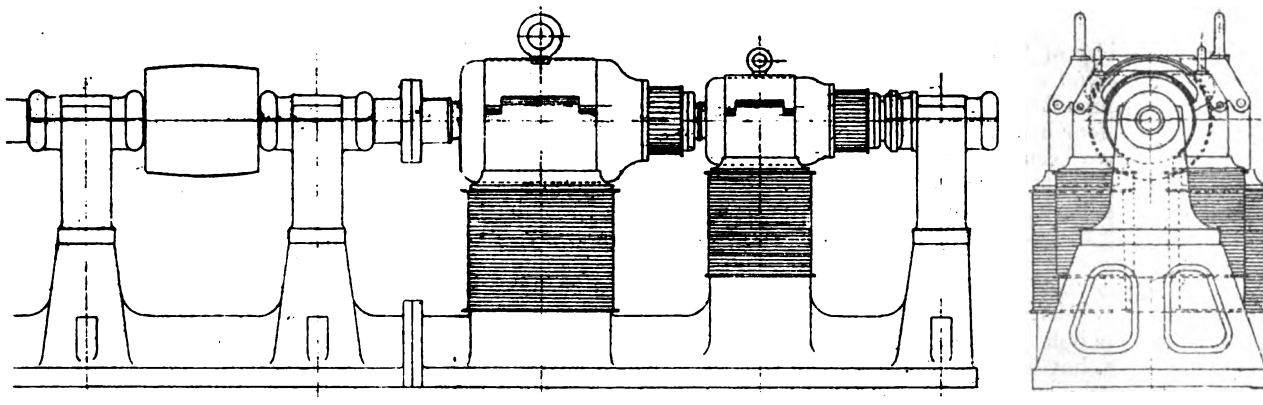
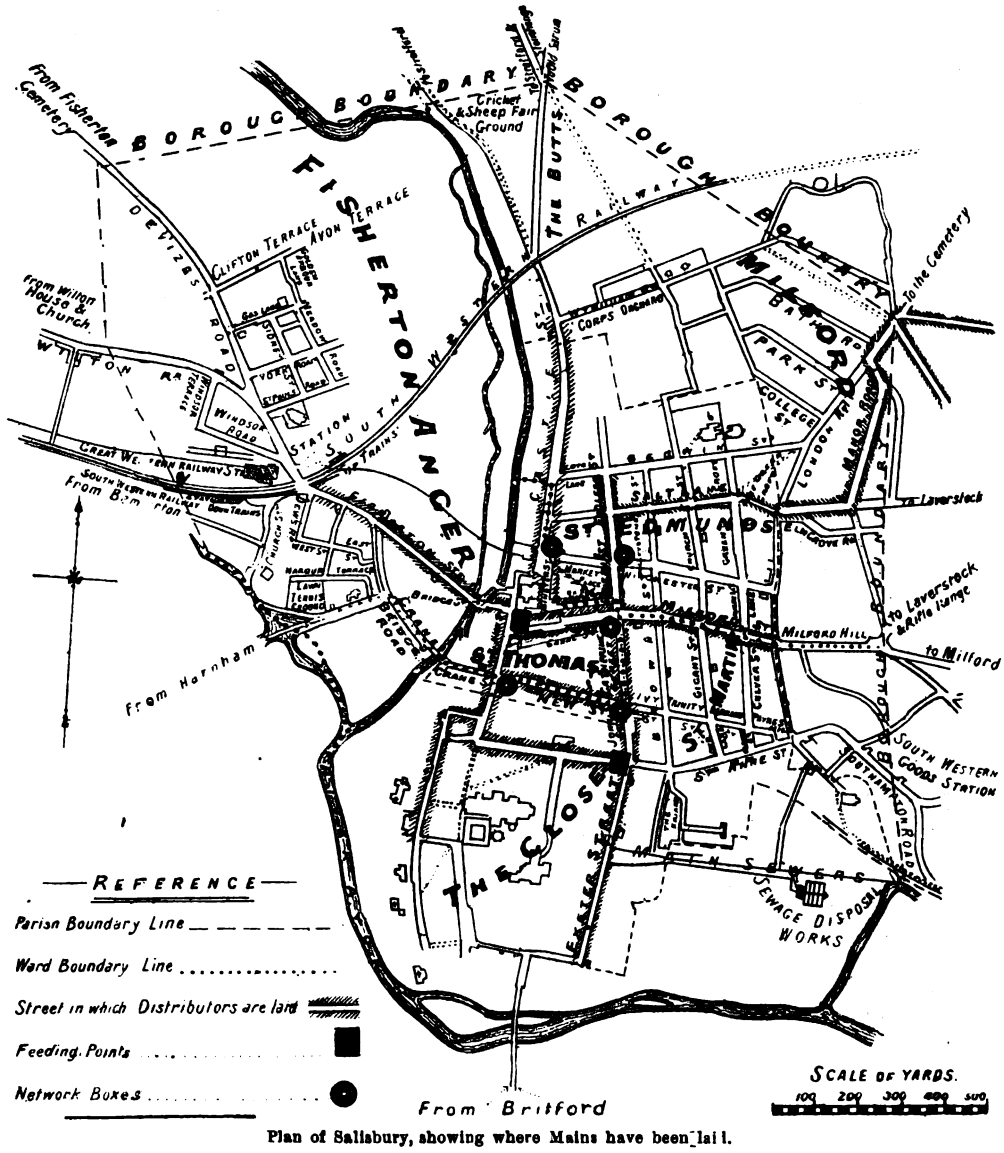
centre, arranged to be driven from a turbine when required. The magnets are fitted with patent hinged pole-pieces, allowing a direct vertical lift. The balancing machines are each wound to deal with an output of 230 volts 100 amperes at 800 revolutions per minute; the boosters, 70 volts 70 amperes at the same speed. The switchboard, as well as the dynamos, was made by Messrs. Thos. Parker, Limited, to Messrs. Edmundson's designs, and is very compact—indeed, if one may find a fault, it is a little too crowded. It is divided into three parts. On the left hand are the switches, ammeters, auto-cut-outs, etc., for the combination dynamo and booster, also the battery regulating switches and ammeters, the throw-over switches, zero indicators, etc. On the right-hand panel are the feeder, ammeters, and duplex cut-outs, the dynamo ammeters, auto-cut-outs, fuses, etc. The centre panel carries the recording voltmeters, recording ammeter on the earth connection to the neutral wire, and cut-outs, switches, etc., for testing the insulation of the main. Through the centre of this panel projects the spindle of the gear for opening and closing the blades of the turbine, and an indicator is fixed showing the position of the blades and also the level of the top and bottom water, so that at a glance the attendant can see the position of affairs. Two Kelvin large-dial voltmeters, shown in Fig. 5, one on each side of the system, are fitted on the side wall, so that they can be seen when standing in front of the switchboard or any part of the engine-room. The pressure at the consumer's lamps is 210 volts. Thomson-Houston meters are fitted on the output of the dynamos and on the battery circuits; these latter read forwards when charging and backwards when discharging, and, therefore, give the energy lost in the cells.



One Side of Balancer and Booster Set at Salisbury, showing Driving Pulley, Dynamo, and Booster.



Plan of Salisbury, showing where Mains have been laid.

The batteries are of the well-known D.P. type, having strip plates produced by an electrolytic process, which

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causes the active material to be formed out of the plate itself. The special construction affords an enormous working area, enabling the cells to be charged or discharged at very high rates without producing disintegration or buckling. The batteries consist of 53 "F" and 230 "G" type cells. The "F" type have a capacity of 585 ampere-hours, and the normal rate of charge is 54 amperes, the discharge rate being 65 amperes for nine hours, 73 amperes for six hours, or 98 amperes for four hours. The "G" type have a capacity of 715 ampere-hours, and the normal rate of charge is 66 amperes, the discharge rate being 80 amperes for nine hours, 89 amperes for six hours, or 119 amperes for four hours. The makers claim a record that D.P. cells have been used regularly for periods of six years and over without any outlay whatever, after which the positive plates have required renewing, representing a percentage during the six years of only 4½ per cent. per annum.

At present the turbine runs for about 18 hours daily—in the morning for charging and in the evening with the cells to supply the light required. The water power varies very considerably, but even in the driest weather of last autumn there was always about 15 h.p. available; the average amount is 25 h.p. to 30 h.p., and when the river is flowing full 50 h.p. to 60 h.p. With the aid of a large battery this power will be sufficient for a large portion of the current required in a small town like Salisbury, and is of great advantage as regards the cost of supply.

The mains are of Messrs. Callender's jute-insulated lead-covered and armoured type, the feeders being concentric and the distributors three-core. The lengths laid are: feeder No. 1, 117 yards; feeder No. 2, 711 yards; sub-feeder, 567 yards; distributor, 892 yards of ·100in. section; distributor, 584 yards of ·075in. section; distributor, 5,285 yards of ·05in. section. Already considerable extensions of the mains have been laid, owing to the demand for light in the residential district of the city.

In August last the Corporation advertised for tenders for street-lighting. They had previously been paying about £902 a year for gas, some of the lamps being extinguished at 11 p.m. for part of the year. The estimated extra cost of all-night lighting was £136—total, £1,038. The electric light company quoted for 16 arc lamps (and 25 incandescents after 11.30) and 245 incandescents burning all night—£704, but the gas company reduced their price to £575 for all-night lamps and secured the contract for three years. Taking into account a number of additional lamps which are to be fixed, the advent of the electric light company saved the city some £500 per annum. Salisbury is a city of about 16,000 inhabitants, and contains no very large hotels, colleges, or public buildings, so that to have secured the equivalent of 2,500 8-c.p. lamps connected since the supply was started in July is auspicious of a successful career. With the water power the running expenses should work out very small, and we shall look forward with interest to the publication of the result of the first year's working, which we are satisfied will prove a record for a supply works of this size.

The Formal Opening.

On Monday, at four o'clock, a gay company of ladies and gentlemen filled the available room at the station, which was decorated with festoons of evergreens, mingled with vari-coloured lamps and tropical palms. The plant was to be set in motion by the Right Hon. the Earl of Pembroke, and while awaiting his arrival Mr. Wigham, of Messrs. Edmundson's, explained to the assemblage the various parts of the installation. Upon the arrival of the Earl of Pembroke no time was lost, and after a few explanatory words from Mr. Wigham, and a walk round the installation, the Earl turned on steam to the Belliss-Parker set, turned on the switch of the festooned lamps, and, in fact, duly performed his share of the ceremony, declaring the station opened. All went as merrily as the proverbial marriage bells. Subsequently a goodly company dined together, at the invitation of the company, at the White Hart Hotel—loved of Dickens—and had no reason to bemoan their lot, for the dinner was excellent and well served. The chairman of the company (Mr. Gramshaw) presided, and after the toast of "The Queen" came that of "The Visitors," thus early because several gentlemen had to leave for town. Mr. T. Callender responded. After thanking the proposer and the company for the kind manner in which the toast was received, and the kind words that had been said of not only the principal contractors, but of the subordinates who actually did the work, he agreed that the laying of mains through the streets was generally a nuisance, and ofttimes led to a tinge of ill-feeling against those who had to carry out such work, but in Salisbury it seemed that no sting had been left behind, and nothing remained but goodwill and good feeling towards the workers. He ventured to prophesy, from what he knew of Salisbury, that the station would soon follow in the footsteps of most stations, and have to be considerably enlarged, and in a few years would have to be doubled in size.

The toast of "The Electric Supply Company" was then proposed by Alderman Reed, and responded to by Mr. Gripper, who gave a short history of the undertaking similar to that sketched above, and stated that up to the present between 2,000 and 3,000 lamps (equivalent 8 c.p.) had been connected.

The Chairman proposed "The Mayor and Corporation," to which the Mayor responded. "The Local Visitors" and other purely personal or local toasts finished the business of the evening.

QUESTIONS AND ANSWERS.

Questions.

126. Suppose a report is required as to the availability or otherwise of a river for purposes of generating electricity by means of water-power turbines, how would you proceed to estimate the amount of power available? Give a reliable method of ascertaining this, by measurement of the water flowing, together with any additional data essential to obtain an accurate result.—H. B. S.

127. In designing a substitutional resistance for an arc lamp, to be placed on the lamp pole or pillar and exposed to the weather, what points must be taken into consideration? Describe a form of resistance suitable for a 12-ampere 43-volt arc lamp.—J. D. P.

Answers.

Question No. 120.—Give reliable figures as to steam and coal consumption in a parallel-flow steam-turbine in pounds per kilowatt at the terminals.

Best Answer to No. 120 *(awarded* 10*s.)*.—The figures given in the accompanying table will give a fair idea of the consumption of steam in a turbine of the parallel-flow type, and were taken by Mr. W. D. Hunter from a 200-kw. direct-current turbo-generator in the early part of 1897. Besides these tests there have been several others taken by independent persons—notably Prof. Kennedy—arriving at practically the same results, but in all these the water consumption only is given, and not the amount of coal used; and the only way we could approximate to this would be to ascertain the type of boilers used in each case, their size with reference to the turbine under test, the type of coal used, and several other details, as all these would considerably affect the results obtained.

Test of 200-Unit Turbo-Dynamo.

Kilowatts.	Total water per hour. Lbs.	Water per kilowatt-hour.	—
219·2	9,466	43·2	Non-condensing.
98·7	5,848	59·23	
54·5	4,330	79·5	
0	2,092	—	
203·0	8,429	41·52	Non-condensing and superheating.
106·1	5,287	49·83	
0	1,402	—	
208·0	5,443	26·16	Condensing but not superheating.
108·4	3,037	28·02	
0	531	—	Vacuum, 25in.

In the case under consideration three tests were taken—one, with the turbine working high pressure; a second, high pressure and superheating, and a third condensing, but not superheating, and the accompanying figures and curves give the results obtained in each of these cases. The coal consump-

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tion at full load non-condensing would probably be about 4lb. per kilowatt-hour with good Welsh coal, and temperature of the feed water 212deg. F. Condensing with the same conditions existing, this would probably drop to about 2½lb. per kilowatt-hour.—F. E. B.

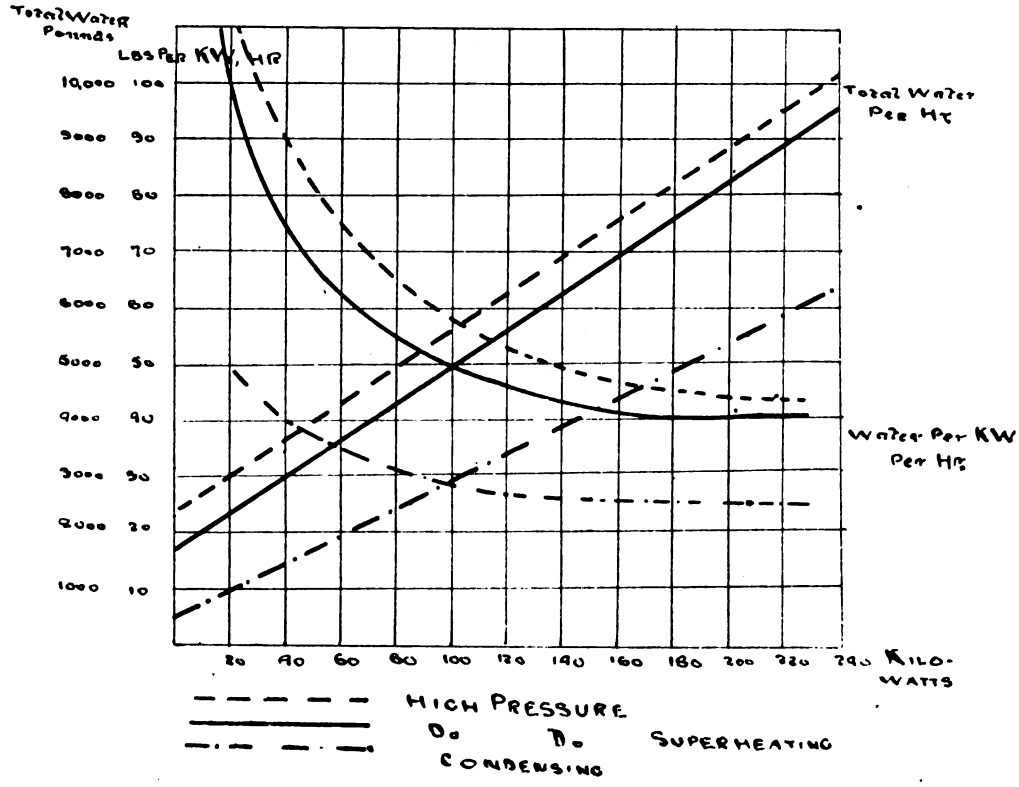
Answer to No. 120 (*awarded* 5*s.*).—The following figures were given by Mr. Jno. D. Bailie in a paper read before the Yorkshire College Engineering Society in February, 1898. A 100-kw. turbo-dynamo, using steam at a pressure of 102lb., and with a vacuum of 26¾in., consumed 27lb. of steam per kilowatt-hour at full load. A 50-kw. plant used 28lb. steam per kilowatt-hour with a pressure of 90lb. and vacuum of 28in. A 200-kw. plant used 26·2lb. steam per unit at full load and 28lb. at half load, the boiler pressure being 100lb. per square inch and the vacuum 25in. A 150-kw. turbo-alternator, one of the latest additions to the Newcastle central-station plant, consumed 23·2lb. steam per kilowatt-hour at full load, 28lb. at half load, and 29·6lb. at quarter load, the steam pressure at the turbine being 70lb. and the vacuum 26¾in. Careful tests of a 200-kw. continuous-current Parsons turbo-generator were made in January, 1897, by Mr. W. D. Hunter, M.I.E.E., for the purpose of determining the steam consumption under different conditions of service and output. The following results were obtained:

Kilowatts.	Total water per hour. Lbs.	Water per unit. Lbs.	Conditions of service.
219	9,466	43·2	Non-condensing.
98·7	5,848	59·2	
54·5	4,330	79·5	
0	2,092	—	
203	8,429	41·5	Non-condensing. 30deg. F. of superheat.
106	5,287	49·8	
0	1,402	—	
208	5,443	26·2	Condensing; no superheat. Vacuum at full load, 25in.
108·4	3,037	28	
0	531	—	

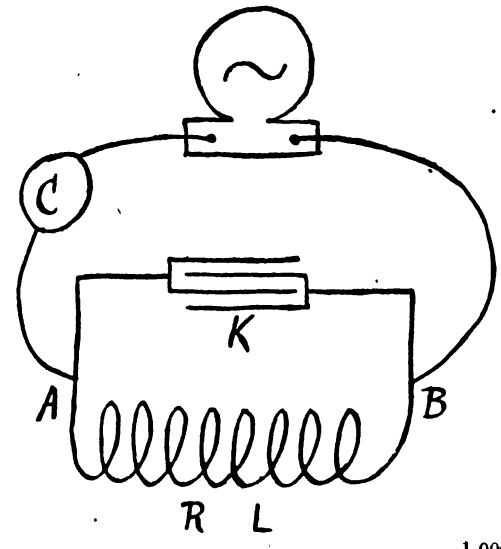
All the quoted results refer to parallel-flow turbines of the Parsons type. The coal consumption is not given in any of the above tests, and is obviously dependent on the type of boiler and furnace and the quality of coal used, as also upon the arrangement of steam-pipes, conditions of service, etc. From 5lb. to 6lb. per unit is a good average for a fairly long and steady load and using good Welsh coal.—E. M.

Question No. 121.—What is meant by the capacity and resonance effects when speaking of a concentric cable?

Best Answer to No. 121 (*awarded* 10*s.*).—The capacity



effect of a concentric cable is shown when it is connected to the terminals of an alternator which has an armature of considerable inductance, or when it is connected to the terminals of a step-up transformer, by a raising or lowering of the terminal pressure. This effect, which is sometimes also called the Ferranti effect, owing to the trouble which it caused by burning out lamps, etc., during the early working of the London Electric Supply Corporation's works, of which Mr. Ferranti was then engineer, has been completely investigated by Mr. Alexander Siemens. He found that the pressure at the secondary terminals of a transformer was increased as the length of concentric cable attached to its terminals was increased up to a certain point, and then for greater lengths of cable it diminished again, and ultimately got much less than the pressure with no cable attached. In some of his experiments the pressure was increased to 400 per cent. of its initial value, and this explained how sometimes sound cables broke down under the ordinary test, where it was assumed that the pressure was not altered by the capacity of the cable.



If R=0 resonance occurs when the frequency $= \frac{1,000}{2\pi\sqrt{LK}}$

The resonance effect is quite different from the capacity effect, although at first the two were thought to be the same. This effect does not alter the pressure in the circuit,

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but may give rise to large circulating currents. It arises in certain cases when we have capacity and inductance in parallel to one another; for example, when we have a long concentric main feeding a bank of transformers at the far end. This is shown diagrammatically in the figure. Let V denote the potential difference between A and B, and let K denote the capacity of the concentric main in microfarads, and R, L denote the joint resistance and inductance of the transformers. Then we know that the current flowing into the condenser equals $2\pi n K V 10^{-6}$, where n is the frequency, and is 90deg. in advance of the P.D. between A and B in phase; also the current in the inductive branch A B is $\frac{V}{\sqrt{R^2 \times 4\pi^2 n^2 L^2}}$, and is nearly 90deg. behind the P.D. between A and B in phase. Hence the currents in the two branches differ in phase by nearly 180deg., and, therefore, the current in the armature is nearly equal to their difference. If we neglect R, we see that the current in the armature equals $2\pi n K V 10^{-6} - \frac{V}{2\pi n L}$, and this equals nothing if $n = \frac{1{,}000}{2\pi\sqrt{K L}}$.

This is the case for resonance, and we see that in this case there may be huge capacity and inductive currents pumping into one another, although the station ammeter (C in the figure) may only indicate a very small current.—J. C. R.

Answer to No. 121 (*awarded* 5*s.*).—The virtual value of the current in a circuit having induction L, resistance R, and capacity K, is

$$C = \sqrt{\left(\frac{1}{p^2 K} - L\right)^2 p^2 + R^2}} \quad \ldots \quad (1)$$

where e = impressed alternating E.M.F. of frequency n, and $p = 2\pi n$. If no self-induction be present, the equation is

$$C = \sqrt{R^2 + \frac{1}{p^2 K^2}}} \quad \ldots \quad (2)$$

and if no capacity be present we get the ordinary formula—

$$C = \frac{e}{\sqrt{R^2 + p^2 L^2}} \quad \ldots \quad (3)$$

If in any case the resistance is very small, the term R^2 may be neglected, and the equation simplifies.

In (1) if $\frac{1}{p^2 K} = L$, the capacity and induction balance one another, and the current obeys Ohm's law. Hence the current may be very greatly increased by altering the capacity or induction of a circuit.

Let us further consider the condition $L = \frac{1}{p^2 K}$. Solving for p we have—

$$p = \frac{1}{\sqrt{L K}} = 2\pi n \quad \therefore \quad n = \frac{1}{2\pi\sqrt{L K}} \quad (4)$$

Now, it can be shown that every circuit possessing capacity and self-induction has a natural period of oscillation given by

$$t = 2\pi\sqrt{L K}.$$

Equation (4) gives the frequency which will produce a maximum current in a circuit containing capacity, K, and self-induction, L. The period of one oscillation will be

$$t = \frac{1}{n} = 2\pi\sqrt{L K}.$$

Hence we arrive at the result that maximum current is produced in a circuit when the capacity and self-induction are so related that the natural period of oscillation of the circuit is the *same* as that of the impressed E.M.F. In addition to the above, there is the resonance effect noted when switching on an alternating E.M.F. to a circuit containing capacity—say, a length of concentric cable which has usually about one-third of a microfarad per mile capacity. If resistance capacity and induction are so arranged that

$$R^2 < \frac{4 L}{K},$$

the current charging the cable will be oscillatory in character, the frequency of the oscillations being

$$\frac{1}{2\pi}\sqrt{\frac{1}{L K} - \frac{R^2}{4 L^2}}.$$

We have then oscillations of very high frequency superposed upon the normal curve of impressed E.M.F., and if the charging circuit was completed at the instant when the applied E.M.F. was a maximum, there would be a sudden rise of pressure due to this cause. The most serious rise of pressure at the instant of switching on, however, is due to the effect of the exponential term in the equation for the *instantaneous* value of current produced by switching on an alternating E.M.F. Assuming the applied E.M.F. follows a sine law, then in addition to a term similar to equation (1) we have one of the form

$$A\epsilon^{-\frac{t}{K R}}.$$

Without going deeply into this subject, it may be noted that the instantaneous rise of pressure and consequent rush of current may be many times the normal, depending on the part of the wave of E.M.F. at which we switch on.

A very clear exposition of these and other condenser effects was given by Prof. Fleming in a paper before the Institution of Electrical Engineers in 1891.—E. M.

Answer to No. 121 (*awarded* 5*s.*).—If a long concentric cable is connected to an alternator, the far end of cable being insulated, it is found that an electric current flows into and out of the cable, perhaps sufficient to light one or more incandescent lamps. This is called the capacity current of the cable—a current flowing across the dielectric from one copper member to the other. If C = capacity of the cable measured in microfarads, V = the difference of potential between the two copper members in volts, and if $p = 2\pi n$, where n = the frequency, then the capacity current, I, is

$$I = \frac{C p V}{10^6}.$$

Suppose a cable having a capacity current one-third of a mile capacity has a potential difference of 2,000 volts between its inner and outer conductors, and $p = 500$, then the capacity current is one-third of an ampere, or equivalent to the lighting current of one 8-c.p. lamp. In large concentric systems this capacity current going out of the station may be considerable.

Resonance Effects.—If an alternator is separately excited so as to give a certain potential difference at its terminals, say 2,000 volts, and if a long length of concentric cable is connected to this alternator, the far end of cable being insulated, it will be found that such cable when associated with the alternator may greatly increase the electric pressure between the terminals of the alternator, and for a certain length of the cable a marked rise in pressure may take place. The same takes place if a long length of concentric cable is connected to the high-pressure side of a step-up transformer, being excited from a 100-volt alternating circuit on the low-pressure side. In testing concentric cables, care must be taken with regard to this resonance effect. Say it is desired to test whether a certain length of concentric cable will stand 2,000 volts. The usual method of doing this is to connect the high-pressure side of a step-up transformer, raising the volts from 100 to 2,000, serving the low-pressure side of this transformer from a 100-volt circuit. It might be naturally supposed that this would invariably place upon the cable a pressure of 2,000 volts, but under certain conditions, depending upon the capacity of the cable and the inductance of the transformer, the pressure might rise far beyond 2,000 volts between the two members of the cable. Suppose, then, that a series of transformers are connected to the two copper members of a concentric cable, and that the concentric cable is, as usual, lead covered and steel armoured, with a layer of insulation between the lead covering and the outer copper members. As already stated, there is a certain capacity in the con-

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centric cable between the inner and the outer members which will be generally something like one-third of a microfarad a mile, but at the same time there will be a capacity between the outer member of the concentric cable and the lead casing or the earth, and this capacity between outer and the earth, as it is called, is very much larger in general than the capacity between the inner and outer; it may be 10 times as great. Hence, if the transformers are connected between the inner and outer conductors, we may regard the primary circuits of the transformers, which are inductive circuits, as connected in series with a condenser, which is formed of the outer members of the cable and the lead covering. If, therefore, such a cable, with transformers attached to it, the secondary circuits of which are unloaded, is switched into connection with the omnibus bars of an alternating-current station, the connection between the inner member of the cable with the proper omnibus bar being made first, then at that instant an E.M.F. is impressed upon the system, consisting of the inductive primary circuits and the condenser in series with them. For a particular phase of the impressed E.M.F. it can be shown that oscillations of potential are set up in the condenser, causing a periodic potential difference between its two sides to be greater than that due to the steady action of the periodic E.M.F. This sometimes results in breaking down the insulation between the outer members of the concentric cable and the lead covering, and as this insulation is generally in all cases made much thinner than that between the inner and outer members of the cable, it is not infrequently pierced.—A. B.

LEGAL INTELLIGENCE.

THE DANGERS OF ELECTRICITY.

In the City of London Court on Monday, before Mr. G Pitt-Lewis, Q.C., deputy judge, an action was brought under the Employers' Liability Act by Charles H. Wild, 16, Seckford-street, Clerkenwell, who sought to recover the sum of £50 as damages for personal injuries sustained by him while in the service of the defendants, the County of London and Brush Provincial Electric Lighting Company, Limited, Moorgate-court, Moorgate-street, E.C.

Mr. W. M. Thompson was counsel for the plaintiff, and Mr. Lynden Bell for the defendants.

In opening the case, **Mr. Thompson** said that the claim arose from a set of circumstances quite out of the common run. The plaintiff was in the employ of the defendants, and on July 22 last, after having been working for them at the wires in various capacities for three or four years, he was ordered by the defendants' foreman, Strahan, to go into a transformer box in John-street-road, Clerkenwell, and there to put a new fuse-pot into a high-tension switch. The plaintiff went into the room, and while engaged at his work an explosion suddenly occurred. The plaintiff was very severely injured on the left arm and hand, and was unable to follow his occupation for some time. The transformer box was about 9ft. deep and 7ft. 6in. square. It was an iron box into which men had to descend in order to do repairs which were necessary, as well as certain work where the high-tension main lines ran through London. The plaintiff was a labouring man, and no doubt ought not to have been put to do the work at which he was engaged when the accident happened.

Mr. Bell said the plaintiff was an inspector and not a labourer.

The **Deputy Judge** suggested that he would probably be called a ganger.

Mr. Thompson said that his client was not a skilled electrician, and the work was very dangerous. The defendant company drew up a series of rules, the first of which required the plaintiff to wear rubber gloves, which they had provided, when he was engaged near the high-tension mains, because of the danger. The work in question was the first the defendants had ordered the plaintiff to do of so dangerous a nature. It was really fitter's work, and should not have been entrusted to him. The fact was this, the high-tension mains should have been disconnected at the head offices or headquarters before the plaintiff did the particular work which brought about the accident. He thought the high-tension mains were disconnected, instead of which they were not. The accident was brought about by an explosion, not a shock. The explosion was heard 40 or 50 yards off, and had nothing to do with the wearing of the gloves, as had been suggested.

Mr. Bell said he would show that the whole accident had been caused through the plaintiff not wearing the rubber gloves. He had broken the rule requiring him to wear them, and he must put up with the consequences. It was idle to suggest that electricity could cause an explosion.

The **Deputy Judge**: It was a sort of a young thunderstorm?

Mr. Thompson agreed. If the electricity had been switched off, there would have been no explosion.

The **Plaintiff** was called in support of his case, and said he ought not to have been put to supply a new fuse pot. The weather was very hot at the time, and his hand was very hot indeed. To enable him to do his work better, he took one of his rubber gloves off. The explosion was a terrible one. At first he thought the place was blown away. He reported himself to the office, but the superintendent told him his injuries were nothing, and he was to keep on at work. For 10 weeks he was unable to follow his occupation. His hand was in dreadful agony at the time, and he went to St. Bartholomew's Hospital, where he was treated. In cross-examination the plaintiff denied that he used a screw-driver improperly, and by its aid formed an arc which brought about the explosion. If he did form an arc, he certainly did not know it. He had had no experience with electricity. It was true he had been with the defendants for some years, but he had never had any technical instruction.

James Wild, who had had, he said, long experience in electrical matters, gave it as his opinion that the man ought not to have been put to do the work allotted to him. Just as the plaintiff would not be allowed to go into a generating station, so no one but a fitter should have done the plaintiff's task.

The **Deputy Judge** supposed the plaintiff was getting promoted, and was generally bettering himself.

Mr. Bell said no responsibility could attach to the defendants for the accident which had happened. They provided the plaintiff with a pair of rubber gloves which would have completely insulated him from any danger, and then he went and left them off. He must have formed an arc with the screw-driver, or the explosion could not have occurred.

Mr. Child, assistant engineer to the defendant company, said it was the plaintiff's duty to do any small things such as the job at which he was engaged when the accident happened. The plaintiff was altering one of the fuses, and it was not customary then to turn off the current. It could be done, but it was not the practice. The electricity did not go through the fuse in any way. If a man was ordinarily careful and wore his gloves, there was no danger about the work The gloves were a perfect protection. The terminal was about 1½in. from the fuse. The plaintiff's primary duty was to go into the boxes and see that all the fittings were in order and that no fuses had gone. If any had gone, his duty was to replace them. In cross-examination, he said he could not class the plaintiff as a labourer, although he only received 29s. 6d. per week, which was much less than dock labourers were paid.

Strahan, defendants' foreman, said that if the plaintiff had 2,000 volts to contend with, and he was wearing his gloves, no accident would have befallen him, even if flame came out.

Other witnesses having been called,

The **Deputy Judge** then gave judgment. He said no doubt the plaintiff did not know much about electricity, but everybody must have a beginning, and no doubt he was an improver. There were certain risks which had to be borne by everyone. He did not think the plaintiff was sufficiently cautioned about the dangers which were around him. No doubt very proper instructions were given him, but only in a general way. The plaintiff might think himself very lucky that worse injuries did not befall him, for it had been shown in evidence that if he had been a little taller he would in all probability have been killed The injuries were serious, and at the same time he would like to say that he did not think any of the defendants' men were to blame. Nevertheless, he must hold that it was one of those accidental circumstances which would happen, and that as the plaintiff was not sufficiently cautioned there must be judgment in his favour for £15. He wished to add that the accident was one which no one could be expected to have foreseen, as it occurred through a combination of circumstances.

NORWICH TRAMWAYS.

On Monday the Under-Sheriff (Mr. Frank Jewson) held a Court at the Guildhall for assessing the amount of compensation to be paid Mr. F. G. Flatt, ironmonger, of Magdalen-street, for the compulsory appropriation of his business premises by the Norwich Electric Tramways Company, and loss of trade. Mr. Crump, Q.C. (instructed by Messrs. Watson and Everitt), appeared for the claimant, and Mr. F. Low (instructed by Messrs. Mills and Reeve) for the respondents. The jury awarded £375 as compensation, and they stated that they were unable to divide this sum into different amounts for the property and the loss of business.

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER, LIMITED.

The first general meeting of shareholders in the Aron Electricity Meter, Limited, was held on Tuesday at Winchester House, Sir James Pender in the chair.

The **Chairman** said that on account of the serious illness of one of the directors, Mr. Byng, in October last, Mr. Hugo Hirst, his partner, had joined the Board. Satisfactory arrangements had been arrived at for the gradual taking over of the business from Dr. Aron. They were making arrangements with the various branch managers in London, Vienna, and Paris for the purpose of securing the continuance of their services. The Company had secured the lease of 46, Upper Thames-street, which they considered the most suitable place for their testing station and stores in London, and owing to its convenient situation the directors had decided to move their offices there, which meant a saving to the Company of several hundred pounds a year. The business done

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during the last 11 months had exceeded their expectations, about 14 000 meters having been ordered during the last 11 months, in comparison with about 11,000 during the preceding year, and the sales in England had risen from about 400 in 1897 to over 1,800 for the first 11 months of this year. The most gratifying feature of this increase did not lie in the number of meters sold, but in the fact that they had been placed with about 40 different stations and other users, all of whom were beginning to repeat their orders, so that a rapid development of the business and much larger sales might be expected during the next year. In countries where high duties prevented them from doing a large business, the directors proposed to work the patents by means of separate companies. Offers from one important company were at present being considered by the directors. In Germany and Austria, where Dr. Aron's name enjoyed a very high reputation and added considerably to the goodwill of the business, the directors proposed to trade in those countries under that name. The directors had reasonable hopes that the preference shares might at a much earlier date than expected participate in the surplus profits after 10 per cent. had been paid on the ordinary shares.

A vote of thanks to the chairman terminated the proceedings.

SMITHFIELD MARKETS ELECTRIC SUPPLY COMPANY.

The report of the directors, with accounts for the first year of working ended Sept. 30 last. to be submitted to the general meeting to be held to-day, states that the trading account shows a profit of £759. The directors found it necessary at the outset to discontinue the method of charging by "lump sum" contracts which had previously been in force, because they had led in a great many cases to extravagant use of the current, and to adopt the customary fixed rate per unit, based on the actual meter consumption. In consequence of this necessary change there was a loss on trading for several months. A substantial increase in the price obtained per unit had been effected, and, notwithstanding the loss referred to, the total number of customers connected shows a net gain upon the number connected at the commencement of the Company's operations. The price charged per unit is still below that of any other London supply company, and there is now every indication of a return of the popularity of electricity as an illuminant in the Corporation markets. The staff has been to a large extent reorganised, and Mr. Eustace Ridley, who holds the position of assistant engineer to the St. James's and Pall Mall Electric Light Company, Limited, has been engaged as chief engineer-in-charge of the station. The working of the station and the conduct of the Company's business has been carried on in a satisfactory manner. All complaints of inequality of the light have ceased. The cost of production has been substantially reduced, and when the installation of the large storage battery (with a capacity of 2,000 ampere-hours), now on order, has been completed, the cost per unit will be still further reduced to a figure with which only companies with a very much greater output can compare. A careful estimate of the results of the working of the present quarter, based upon the meter readings to Dec. 10, shows that the gross profit earned in this quarter will be at least £800, or more than the total profit for the whole of the previous year. Applications have been made to the Board of Trade for provisional orders empowering the Company to supply electric current in the areas of the City of London, the parish of St. Luke, Middlesex (which includes Finsbury and a portion of Moorgate-street), and the Holborn district. All of these three areas immediately adjoin, the Company's generating station being centrally situated between them. The chairman (Mr. G. H. Brougham Glasier) has been obliged to resign his seat on the Board, owing to the fact that the Charing Cross and Strand Electricity Supply Company, of which he is also the chairman, has made an application (in competition with this Company) for a provisional order for the electric lighting of the City of London. Until the result of the applications now before the Board of Trade shall have been made known, they have not considered it necessary nor desirable to take any steps to appoint a new director. The directors have by a resolution waived any claim to payment of their fees now or at any future date in respect of the past year.

The following statement is appended:

PROFIT AND LOSS ACCOUNT, YEAR ENDING SEPT. 30, 1898.

Dr.	£	s.	d.
Interest on 4 per cent. debenture stock, paid and accrued	1,449	14	3
Proportion of preliminary expenses	136	15	4
Trustees' fees	25	0	0
Interest on deposit accrued	310	13	8
	£1,922	3	3

Cr.	£	s.	d.
Balance from trading account	759	3	1
Interest on deposits	386	3	8
Interest on calls	1	15	8
Balance carried to general balance-sheet	775	0	10
	£1,922	3	3

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY.

On Monday a dividend of 10 per cent. was declared. and a resolution passed that the Company be voluntarily wound up, having been purchased by the Corporation. The shareholders, under the purchase agreement, receive nearly £18 for every £7 of original capital.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Commissioners of the Burgh of Stirling invite tenders for boilers, engines, dynamos, etc. Tenders by Jan. 2, 1899.

Leeds.—The City Council require tenders for the supply of (*a*) underground conductors; (*b*) switchboards, etc. Tenders by Dec. 29.

Dublin.—The Corporation invite tenders for the supply of a high-tension single-pole switchboard. Further particulars appear in our advertising columns. Tenders by Dec. 28.

Sunderland.—The Corporation are prepared to receive tenders for the supply of three 125-kw. direct-current high-speed steam dynamos, 460 volts. Tenders by noon on Dec. 30.

Londonderry.—The Corporation invite tenders for the supply of arc lamp globes and carbons till year ending Dec. 31, 1899. Further particulars appear in our advertising columns. Tenders by Dec. 30.

Edinburgh.—The Magistrates and Council invite tenders for various work in their electric lighting station in Macdonald-road. Further particulars appear in our advertising columns. Tenders by Jan. 9, 1899.

Burnley.—The Corporation invite tenders for the supply and delivery at their electricity supply station of underground cables. Further particulars appear in our advertising columns. Tenders by Jan. 10, 1899.

Glasgow.—The Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Further particulars appear in our advertising columns. Tenders by Jan. 21, 1899.

Halifax.—Tenders are required by the Cash Supply Stores, Limited, for lighting by electricity the shop premises in Silver-street, now being altered. Full particulars from the Cash Supply Stores, Limited, Portland-place.

Tunbridge Wells.—Tenders are required by the Corporation for the erection of three telephonic fire-alarms within the borough. The position of the fire-alarms required will be as follows: (1) Grosvenor Bridge, (2) St. James's Church, (3) The Royal Oak. Tenders by Jan. 11.

Manchester.—Tenders are required by the Electricity Committee for the supply of 6,000 tons of clean coal slack, to be delivered by boat at their Dickinson-street works during six months commencing Jan. 1. Forms of tender may be obtained from Mr. T. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by 27th inst.

Winchester.—Tenders are required for the completion of the wiring and the conversion of existing fittings and the wiring to new points of the new buildings and other parts at The Castle, Winchester. Plans and specification at the office of Mr. W. J. Taylor, county surveyor, The Castle, Winchester, between 9 a.m. and 5 p.m., Saturday 9 a.m. and 1 p.m. Tenders by 10 a.m. on 27th inst.

London, N.—Tenders are required by the Electric Lighting Committee of the Vestry of St. Mary, Islington, for work in connection with the enlargement of the electric lighting station, Eden-grove, Holloway, N. (near Holloway Station, Great Northern Railway), according to plans which have been prepared by the Vestry's architect, Mr. A. Heseell Tiltman, F.R I B.A., 6, John-street, Bedford-row, W.C. Applications for forms of tender to be sent in by 5 p.m. on 28th inst.

Hull.—The Corporation invite tenders for the following work in connection with the tramways—viz. (Contract No. 16) pipes and fittings for power station and condensing mains from dock; (20) builders' work for two car-sheds and other buildings, area about 4,000 square yards; (21) steel roof trusses, steel columns, etc., for above car-sheds. Particulars, etc., may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull. A deposit of £1 for each contract will be required, which will be returned on receipt of a bona fide tender. Tenders before noon on Jan. 13.

Christiania.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Railways Administration for the delivery of various telegraph and telephone materials. Tenders, in sealed envelopes marked "Telegraf-og Telefonmaterial," must be received at Styrelsens Expeditionskontor, Statsbanerne, Christiania, by 7 p.m. on Jan. 4. A copy of the conditions of contract may be examined on personal application at the Commercial Department of the Foreign Office, S.W., any day between 11 a.m. and 5 p.m.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information

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may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Burton.—The Town Council have accepted the tender of John Fowler and Co. (Leeds), Limited, for the new electric light engine, at the sum of £2 965.

Tunbridge Wells.—The tender of Mr. T. Sykes, Camden-road, has been accepted for carrying out an electric lighting installation at the Church of King Charles.

Taunton.—The tender of the British Insulated Wire Company at £1,308. 8s. 9d., has been accepted by the Town Council for mains and transformer required for extensions.

London.—The Metropolitan Asylums Board have received the following tenders for an electrical installation to the training-ship "Shaftesbury":

Providing battery for electrical installation.

		Maintenance per annum.
Chloride Electrical Storage Company...	£242 10 0	... £20 0 0
Tudor Accumulator Company	215 0 0	... 18 0 0
D P. Battery Company	222 0 0	... —
Electrical Power Storage Company... ..	178 19 0	... 35 7 0
Pritchetts and Gold*	152 2 0	... 13 0 0

Providing electrical installation.

Laing, Wharton, and Down	£1,080 0 0
Spagnoletti and Crookes.....	1,023 15 6
L. G. Tate	990 10 0
Wenham and Waters	980 10 0
H. F. Joel and Co. and T. Potter and Sons United...	970 0 0
Woods and Co.	959 10 0
Drake and Gorham	933 10 0
Westminster Engineering Company	880 0 0
Foote and Milne	871 0 0
Electrical and General Engineering Company*	785 0 0

* Recommended for acceptance.

Morecambe.—The District Council have received the following tenders for electric light plant:

Section A.—Boilers.

T. Parker, Limited, Wolverhampton (accepted)	£484 0 0
Davey, Paxman, and Co., Colchester	480 0 0
H. B. Trotter and Co., 67, Queen Victoria-street, London.....	670 5 0
C. A. Parsons, Heaton Works, Newcastle-on-Tyne...	695 0 0

Section B.—Steam and exhaust piping.

C. A. Parsons (accepted).....	245 0 0
T. Parker	263 0 0
Davey, Paxman, and Co.	339 10 0
Ashton, Frost, and Co., Bank Top Foundry, Blackburn	417 0 0

Section C.—Steam Dynamos.

C. A. Parsons (accepted).....	2,280 0 0
Ashton, Frost, and Co.	1 850 0 0
Davey, Paxman, and Co.....	1,927 10 0
Brush Electrical Engineering Company, 49, Queen Victoria-street, London	1 975 0 0
T. Parker, Limited	2.029 0 0
H. B. Trotter and Co..... ...	2 077 5 0

Section D.—Switchboards.

T. Parker, Limited (accepted)	486 0 0
Laing, Wharton, and Down, 82A, New Bond-street, London	374 0 0

Section E.—Transformers.

T. Parker, Limited (accepted)	985 0 0
Ashton, Frost, and Co.	750 0 0
Brush Electrical Engineering Company.....	1,410 0 0

Barnsley.—The following tenders have been recommended for acceptance for supply of plant, etc., to the electricity works, for the Corporation: (Contract No 1) W. Arnold and Co., Barnsley, boilers, £3,260; (2) Johnson and Phillips, Old Charlton, Kent, engines, dynamos, plant, etc., £8 030; (3) Pritchetts and Gold, 11, Hart-street, London, storage batteries, etc., £1,319, and £70 per annum for annual maintenance of batteries; (4) British Insulated Wire Company, Prescot, electrical mains, etc., £6 322. 4s. 2d., and £110 per annum for maintenance.

Barnsley.—The following tenders have been recommended for acceptance for erection of electricity works for the Corporation:

G. Mellor, tall chimney	£690 0 0
J. K. Taylor and Son, bricksetters, masons, etc.	1,242 0 0
Robinson and Son, carpenters and joiners..	385 0 0
Fleming, plasterer.....	57 0 0
Fleming, slater	113 0 0
S. Rushforth, plumber and glazier	87 0 0
Newton, Chambers, and Co., smith and founder	466 19 8
T. L. S ephenson, painter	40 0 0

BUSINESS NOTES.

Whitehaven.—At a recent Town Council meeting a motion to light the town hall by electricity was agreed to.

Aylesbury.—The Urban District Council have sealed the memorial for a provisional order for electric lighting.

Oban.—A committee has been appointed by the Town Council to consider the question of lighting the burgh by electricity.

Chatham.—The Town Council have agreed to engage Mr. J. Hewett as consulting engineer for the electric lighting of the new town hall.

Colwyn Bay.—The District Council, acting under the advice of Mr. Clirehugh, have agreed to carry out an extension of the electric lighting.

Rothesay.—A scheme for the adoption of the electric light, at an estimated cost of £6 500, has been rejected by the Town Council by nine votes to five.

Welshpool.—The Treasury have agreed to make a free advance of £7,000 towards the Welshpool-Llanfair light railway. The line affects a very large district.

Dundee.—Plans are in course of preparation for extending the electrical station in view of the contemplated introduction of electrically-propelled tramways.

Removal.—Messrs. Alfred Dickinson and Co. have now removed from 120, Colmore-row, and taken offices in the Telephone-buildings, Newhall-street, Birmingham.

Shrewsbury.—The Local Government Board have sanctioned the Town Council's application to borrow £30,463 for the purchase of the Shropshire Electric Light Works.

Central London Railway Company.—The directors notify that a further call of £2 per share on the ordinary and preferred "partly paid" shares will be made, payable Jan. 13.

Farnborough.—The Council have given a conditional consent to the application of Messrs. Power and Traction for a light railway between Farnborough and Aldershot.

Wrexham.—The General Purposes Committee of the Town Council have passed a motion adverse to the proposed scheme for the introduction of electric trams into the district.

Bath.—At a Town Council meeting last week it was reported that the cause of the recent failure of the electric light was owing to water getting into transformers fixed in the pavement.

Ulverston.—The Rural District Council have passed a resolution to ask the Board of Trade to revoke the whole of the Windermere and District Electric Lighting Order of 1895.

Runcorn.—The Urban District Council have resolved to memorialise the Board of Trade for a provisional order under the Electric Lighting Acts to supply Runcorn with electrical energy.

Whitechapel.—The District Board of Works have decided that the special committee appointed by the Board on July 18, 1898, to consider the subject of electric lighting be called the "Electrical Committee."

Durham.—The Urban District Council have sealed the memorial to the Board of Trade, applying for a provisional order for authorising the Council to supply electricity for public or private purposes within the district.

Award.—The "Stewart" enclosed arc lamp has been awarded a bronze medal at the General Exhibition of 1898 which has just been held at Turin. We are informed that this was the only medal awarded for enclosed arc lamps.

St. James and Pall Mall Company.—The transfer books of the 4 per cent. debenture stock of the St James and Pall Mall Electric Light Company, Limited, will be closed until the 31st inst. inclusive. The debenture stock will be paid off on 31st inst.

Pacific and European Telegraph Company.—The coupons on the 4 per cent. guaranteed debentures due 31st inst. will be paid on and after that date at Parr's Bank, Bartholomew-lane, E.C. Coupons must be left at the bank three clear days for examination.

Marylebone.—The Guardians have decided to advertise for tenders for the electric lighting of the front block of the workhouse, reserving to themselves the right to vary the specification

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and bill of quantities according to requirements as the building proceeds.

Walker.—The Urban District Council have decided to oppose the proposed scheme introduced by the Walker and Wallsend Union Gas Company for the passing of a Bill granting the right to that company of providing electric energy for lighting the town and district.

Bognor.—At a meeting of the Urban District Council it was stated that, owing to not having received enough support from Bognor, the promoters of the electric railway scheme were too late to apply to Parliament this year, but trusted that another year the order would be obtained.

Derby.—An agreement has been arrived at between the directors of the tramway company and the Parliamentary Committee of the Town Council that, subject to the approval of the Council and the tramway company's shareholders, the Corporation shall purchase the undertaking for £32,000.

Derby.—The Council have decided to petition against the Bill being promoted by the Leicestershire and Warwickshire Electric Supply Company in the ensuing session of Parliament. The Bill proposes to give the company power to supply electricity within a certain area, including the borough of Derby.

Newcastle.—A committee of the Corporation has visited Middlesbrough in order to inspect the working of the electric trams there. It is the intention of the committee to visit Leeds, Bradford, and Dover to view the trams in these towns, and in due course present a report to the City Council.

Abertillery.—The District Council have resolved that Mr. Ballard (Messrs. Powell's Tillery Steam Company's electrical engineer) be requested to inspect the district from Six Bells to Crumlin with the gas manager, and report upon the question of lighting that portion of the district by electricity.

Swanscombe.—The Parish Council have consented to the provisional order being applied for by the Gravesend, Rosherville, and Northfleet Tramways Company authorising the construction of additional tramways, and the use of electrical or other mechanical power on the proposed additional and existing tramways.

Plumstead.—At a recent meeting of the Vestry a motion to erect a dust destructor on the Vestry's land was lost, it being suggested that the matter should be left to the Electric Lighting Committee, who were discussing the advisability of utilising the heat of the dust destructor to work the electric light plant.

Hanwell.—The enquiry, already referred to by us, which Sir Courtenay Boyle, permanent under-secretary to the Board of Trade, opened on Dec. 14 into an application of the London United Tramways, Limited, for the extension of their scheme from Hanwell to Uxbridge, has been adjourned over Christmas.

Ealing.—At the last meeting of the District Council the Electric Lighting Committee reported that since the last meeting of the committee applications had been received for 92 8-c.p. lamps to be connected, making a total of 21,048 8-c p. lamps applied for; of this number 19 970 had already been connected.

Sheffield.—The Corporation have made a profit of £8,200 on the working of the tramways during the past half-year. The cash profit since the tramways were taken over in July, 1896, has been £28,000. The overhead electric system is about to be introduced, and new routes are being constructed in every quarter of the city.

Stirling.—A conference has been arranged between a submittee of the Police Commission and the National Electric Free Wiring Company, Limited, with reference to a proposal whereby the company, in return for a small yearly rental, agree to instal the electric light in houses and shops free of any initial cost to the consumers.

Calvert's Mechanics' Almanack and Workshop Companion.—The twenty-sixth issue of this handy little book is replete with practical, technical, and mechanical information for artisans and handicraftsmen, and those engaged in mechanical engineering and building trades. It is illustrated with diagrams, and the price (4d.) places it within reach of everybody.

Canterbury.—At the last Town Council meeting it was decided to apply to the Local Government Board for a loan of £12,000 to cover the increased expenditure already made and the proposed extension of plant. The Town Clerk said the light would be ready next March, and by November an opinion would be able to be formed as to whether the works paid or not.

Brentford.—The Middlesex County Council have asked the county solicitor to take the necessary steps with a view to obtain clauses excluding Brentford and Kew county bridges from the operation of the Brentford electric lighting scheme, and also for the protection of the main roads in the district, and, in the event of clauses not being obtained, to oppose the order.

Camborne.—The Council have decided to support the proposal of the Camborne Electricity Company with regard to the electric lighting of the town on condition that the Council have the right to purchase at the end of 14 years, or any subsequent seven, and providing the town was not, by virtue of the scheme, saddled with the salary of an inspector, compulsorily appointed.

Sunderland.—At a meeting of the Town Council last week the report of the Tramways Committee recommending that, upon the Bill receiving the Royal assent, Mr. Snell's present engagement be terminated, and that he be reappointed as electrical lighting engineer for the borough and electrical engineer for the tramways at a salary of £600 per annum, rising to £800, was carried.

Yarmouth.—The Corporation have agreed to supply the Yarmouth and Gorleston Tramway Company with current for traction purposes on the basis of 2d. per unit up to 150,000 units at 1½d. between that limit and 200,000 units, and exceeding 200,000 units at 1¼d. per unit. They have also extended the time within which the tramways became purchasable to 27 years.

Lowestoft.—Mr. W. C. C. Hawtayne has been asked to report on some questions arising between the Council and the light railway company as to the provision of electrical power for the purpose of the light railway. The parish councils concerned have been asked to co-operate with regard to the opening of communication between Carlton Colville and Burgh St. Peter and adjacent parishes.

Blackburn.—The Corporation, which recently acquired the tramway system of the borough for £77,000, and substituted electric traction, agreed last Monday to join the Darwen Corporation in buying the steam tramways connecting the two towns, and owned by the Blackburn and Over Darwen Tramways Company. The purchase money is £48,500, Blackburn's contribution being £23,000.

Willington Quay.—A letter was read at the last meeting of the District Council from the Wallsend Gas Company enclosing similar terms to that which had been made a basis of agreement with Wallsend, and refused by Walker, regarding the proposal of the company to apply for lighting powers. The matter was left over until the next meeting, in order that further information might be obtained.

Clayton Engineering and Electrical Construction Company.—This Company has been registered, with a capital of £40,000 in £1 shares (of which 20,000 are 6 per cent. cumulative preference), with the object to acquire and to carry on the business of the Clayton Foundry Company, Limited, of Clayton, near Manchester. The first directors are Messrs. E J. Byrne, R. le N. Foster, J. P. Bedson, and G. Garner.

Chester.—Mr. E. A. Sandford Fawcett has held an official enquiry into an application of the Town Council for sanction to borrow £20,000 for electric light extension in the city. The Lighting Committee of the Corporation are asking authority to oppose the proposed applications to Parliament by the Lancashire and Cheshire Electricity Company, Limited, and the Lancashire Electric Power Company.

Wigan.—The Electric Lighting Committee of the Corporation have adopted the report of the deputation that visited Leeds, Bradford, and Wakefield on the electric lighting question. A resolution has been passed to the effect that the committee considered it advisable that a resident electrical engineer, qualified to prepare plans and specifications, and to carry out electrical work for lighting and traction, should be appointed forthwith.

Islington.—At an extraordinary meeting of the Vestry on Friday, it was resolved "that it be an instruction to the Electric Lighting Committee to report to the Vestry the cost of providing the electric light from Highbury-corner, along Canonbury-road and the New North-road, in order that the Islington installation may meet the electric lighting system being at present carried out by the Vestry of Shoreditch as far as the boundary of that parish."

Taunton.—The electric light cable is to be extended at an estimated cost of £120. The following scale has been fixed for the supply of motor power: 3d. per unit per quarter for the first 500 units; 2½d. per unit per quarter for every unit over the first 500 up to 1.000 units; if over 1,000 units per quarter 2d. for every unit over 500, but so that the first 500 units shall always be charged at 3d. per unit. The total lamps connected during the month have been equivalent to 390 8 c.p. lamps.

Ipswich.—A committee has been appointed to consider the application about to be made to Parliament by the Great Eastern Railway Company, and the application about to be made to the Board of Trade by the tramways company, with power to take such action with reference thereto as they may think desirable, and to report thereon to the Council. The committee is to take into preliminary consideration the proposed transfer of the Ipswich tramways to an electrical motor syndicate.

Mansfield.—The General Purposes Committee of the Town Council have resolved, with regard to the proposed provisional order for electric lighting, that the amount of capital to be expended shall be as follows: in case the supply is obtained from the General Power Distributing Company in bulk, £5,000; in case the Corporation erect their own generating plant the further sum of £15,000. A special meeting of the Council is convened to be held this evening to go into the question and to seal the memorial.

Basingstoke.—The Electric Light Committee of the Town Council, having considered a letter from the Board of Trade, in which the Board pointed out that, considering the advance which had now been made in electrical science, they were of opinion that the time had come when local bodies should apply for provisional orders rather than for licenses, have recommended that a provisional order should be applied for in due course. The report, however, has been referred back to the committee for further consideration.

Epsom.—At a meeting of the Urban District Council last week the Lighting Committee reported that, with a view of obtaining reliable information as to electric lighting in a town having a population near to that of Epsom, they had visited the town of Harrow, and from their observations there they recommended that Mr. Hawtayne should be instructed to prepare specifications of the necessary works to be carried out in all the streets in the compulsory area, and the whole of the district as at present lighted by public lamps.

Finchley.—At last week's meeting of the Urban District Council a letter was read from the North London Electricity Company stating that as their project for a large central electricity works

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for power distribution to a number of local authorities in the North of London had not received sufficient support, they had decided to withdraw their application for parliamentary powers. When powers had been granted to local authorities, they proposed to take the matter up again with a view to offering low terms for the supply of current wholesale.

Blackpool.—The Town Council have passed a resolution confirming the action of the General Purposes Committee in wanting to extend the existing system of tramways to important streets in the very heart of the business portion of the town, including Church-street, Talbot-road, and Claremont-park. Complaints have been made about the unsuitability of Church-street, which, without trams, is dangerously congested, and representatives from Claremont—the chief residential part of Blackpool—have also protested against the proposed tramways.

Surbiton.—At the last meeting of the Urban District Council a letter was read from the Board of Trade on the subject of the Surbiton electric lighting order, stating that, under the circumstances referred to by the Council, they would defer the consideration of the question of the revocation of the order for a year, from the present date, but if at the expiration of that period no steps had been taken by the undertakers to give effect to their powers, the Board would, as at present advised, not feel themselves justified in allowing the order to remain in force.

Moss Side.—In reply to a letter from the Urban District Council to the Manchester Corporation asking the reason of the delay in supplying Moss Side with the electric light, a reply has been received from the deputy town clerk expressing regret at the delay which, from causes over which they had no control (the delay was caused by the holding of an enquiry), had occurred in connection with the installation of electric light in the district of Moss Side. He had, however, the assurance of a member of the City Council that the Moss Side Free Library would be lit by electricity within the next two months.

Accident.—An inquest was held on Tuesday in Southampton on William Day, of London, an electric jointer in the employ of Messrs. Glover and Co., of Manchester, contractors for the laying of electric mains for the Southampton Corporation. Deceased was called on to repair a joint in a live high-tension cable. He had no gloves, and, accidentally touching the exposed part of the main, the current passed through his body. He screamed, but died almost instantaneously from the shock. The jury returned a verdict of "accidentally killed," and recommended that gloves should always be used.—*Sussex Daily News.*

Dublin.—At a meeting of the Tramways Electrical Construction Committee of the Corporation on Friday last correspondence was read from the Dublin United Tramways Company with reference to the use of trailer cars within the city boundaries. The tramways company have agreed to discontinue the use of trailer cars generally, provided that upon special occasions, and after consultation with the borough surveyor, the use of these cars may be permitted. The company have, at the same time, undertaken to provide such safeguards as will reasonably tend to prevent a recurrence of accidents similar to that which occurred lately.

Grays.—Mr. Priest, the engineer appointed by the Urban District Council to report as to lighting the town by electricity, is of opinion that there would be no difficulty in competing with gas at 4s. 4d. per 1,000ft., even if a charge of 7d. per unit were made for electricity. The cost of the whole scheme would be over £10,000. It is proposed to give 188 public incandescent lamps. The output of the works for the first year is estimated at 48,000 units for street lighting and 32,000 for private lighting, and the necessary expense would not exceed £950. It is suggested that 7d. per unit should at first be charged private consumers, to be reduced as the demand increased.

Personal.—Mr. W. C. Ullmann has been appointed electrical engineer to the East Ham District Council. He is at present engaged by the British Thomson-Houston Company as resident engineer superintending the construction of the Sheffield Corporation electric tramways. Mr. Ullmann is a M.I.E.E., and has had varied practical experience both in this country and abroad. There were 40 candidates for this post.—Mr. John Hewett, of Messrs. Harrap, Hewett, and Duffield, consulting electrical engineers, 34, Queen-street, E.C., has been appointed to act as consulting engineer for the electric lighting of the new town hall and municipal buildings, Chatham.

English De Laval Steam Turbine Company.—This Company has been registered, with a capital of £100,000, with the object of adopting and carrying into effect an agreement expressed to be made between Aktiebolaget de Lavals Angturbin and this Company; and a second agreement made by this Company with Messrs. Greenwood and Batley, and to carry on business as manufacturers of De Laval's patent steam turbines, as manufactured by the Aktiebolaget de Lavals Angturbin, Stockholm; also to carry on business as electrical engineers, etc. The first directors are Messrs. A. Greenwood, H. Greenwood, J. H. Wurtzburg, and D. Norrman. Qualification, 50 shares.

Bootle.—At last week's meeting of the Town Council, it was reported that Mr. Musker was prepared to carry out the committee's requirements with all possible expedition, and that he would complete the engine-house before Christmas. The committee resolved that, having received Mr. Musker's assurances with satisfaction, he be urged to complete the engine-house by Dec. 17 or earlier. The Town Clerk reported applications for the supply of electrical energy to various premises. Extension of mains, at an estimated cost of £1,175, were approved, and also a recommendation that the necessary arrangements be made for street-lighting in the roads in which extensions are made, and that Mr. Miller report to the next meeting the estimated cost thereof.

East Grinstead.—At the last meeting of the Rural District Council the application which is being made for an order authorising the construction of the Nutley, Crowborough, and Groombridge Light Railway was discussed. The Council decided to remain neutral. The clerk, Mr. W. Alston Head, said that he had had a print of a notice and plan as to an application to the Board of Trade for a provisional order under the Electric Lighting Acts, and also a letter from the Ticehurst Rural Council on the same matter. It was explained that the electric light provisional order application really was an application from Crowborough. The Council decided to take no action, and the notice of application was allowed to lie on the table.

Southgate.—The Urban District Council have received a letter from the North London Electricity Company stating that, in view of the fact that their project for a large central electricity works for wholesale power distribution to a number of North London districts had not received the support they expected, they had decided to withdraw their application for the parliamentary powers, more so as the local authorities were almost without exception applying for their own powers. When these powers had been granted they (the company) proposed to take the matter up again with a view to offering low terms for the supply of current wholesale, and would be glad in the meantime if the Council would abstain definitely from deciding until they had first communicated with them and had the terms of their offer before them.

Lambeth.—At yesterday's meeting of the Vestry the following report of the Electric Lighting Committee was submitted: "(1) The committee have considered the resolution of the Vestry, passed at its last meeting, by which the Vestry declined the offer of the electric lighting corporation. The committee understand that it is the wish of the Vestry to have the 25 free lamps placed in the 25 separate positions decided by the Vestry on Feb. 3 last, and they have so informed the corporation; (2) as to the cost of the standards for the 25 free lamps, the committee propose, at the proper time, to invite tenders by public advertisements; (3) as to the question of lighting the parish with electric light by meter." The committee consider this will not arise until the 12 months mentioned in the motion referred to have expired.

Leamington.—The Town Council have adopted a report from the Electric Light Committee stating that the Mayor had been appointed chairman for the ensuing year. A letter had been received from Messrs. Sharpe, Parker, and Co., stating that they are of opinion the Council will not be prejudiced by adopting a restricted area of supply, and that it was never contemplated that the whole borough should be taken as the area. The deputy town clerk had been instructed to write to Messrs. Pinsent, Smith, and Co., solicitors for the Midland Electric Light Company, to ascertain if they take up the same position as last year, or if they are prepared to open negotiations with a view of arriving at a settlement, and if no such settlement can be arrived at, the committee recommended that the Council's application be by way of open arbitration with the Board of Trade.

Catalogue.—We have received from Mr. G. A. Nussbaum (agent for the Société Industrielle des Téléphones, of Paris, Bezons, and Calais) 29, Ludgate-hill, a general catalogue illustrative of telephones, telephonic apparatus, switchboards, and accessories, and a list describing the "Courval" arc lamp for continuous or alternating currents. This lamp is made to take from two to twelve amperes, or higher if required, and it is claimed for it that it burns extremely steady with continuous or alternating currents, and can be used with success in lighting offices, etc., where great steadiness is essential, and that it burns well with 35 volts at the terminals on continuous currents. Two lamps can be placed on 110-volt circuit. For 220 volts, five lamps work well in series. For alternating currents three lamps can be placed on 110-volt circuit, with 28 to 30 volts at the terminals.

Maidenhead.—At the adjourned monthly meeting of the Town Council, the report of the Electric Lighting Committee, stating that the consulting engineers, Messrs. Burstall and Monkhouse, had furnished their report and estimates upon the proposed electric lighting of the borough, was adopted. The report gives three alternative schemes. With scheme A the capital cost amounts to £19,430, the estimated income is £2 945 and the estimated annual expenditure is £2,680 (with interest and sinking fund), making a profit of £265. In scheme B the capital cost is £23,000, the estimated income £3,470, and estimated annual expenditure is £3,034 (with interest and sinking fund), making a profit of £436. Scheme C gives a capital cost of £29 474, an estimated income of £4 375, and an estimated annual expenditure of £3,639 (with interest and sinking fund), or a profit of £736.

Greenock.—In submitting a preliminary report for electric lighting, Mr. Fedden, engineer, states, as respects the site, that eventually the whole of the ground at Hunter's-place will be required for the power-house. As to the arrangements for private lighting, Mr. Fedden proposes the three-wire system, with 250-volt lamps; and it is suggested that 44 public lamps be erected between James Watt Dock and Grey-place, to take the place of 80 gas lamps on the main line and about 40 down the side streets. The cost of each lamp is put at £20 per annum, if half the lamps are put out at eleven or half-past eleven. The plant, including mains and buildings, is estimated to cost £25,000, and spare ways about £5,000 more. Mr. Fedden has made no provision in the report for supplying the tramways or other big works with power, but ways would be provided along the main thoroughfares for big cables to be drawn in to supply this power, at an extra capital

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cost of £4,000 to £5,000, which would save the opening up of the streets again for some time to come.—*Glasgow Herald.*

Bristol.—The engineer has presented a report regarding the negotiations between himself and the tramways company, from which it appeared that several modifications of the original plans have been agreed upon. The original proposition of the company was to place span wires over the whole area of the system. The following conditions are now recommended: (1) The company will not object to spreading the rails to a width of 6ft. 6in., instead of 6ft., as contemplated by the Act, where the lines pass on each side of an arc lighting standard, if the modification can be carried out without creating frontagers; (2) centre arc lighting standard opposite Wellington-park to be shifted to the footpath opposite the Elephant and Castle, at the cost of the company; (3) centre arc lighting standard on the Stoke-road to be shifted to the footpath at the expense of the company; (4) the arc lighting post at Milk-street junction to be shifted to the corner of the footpath at the junction of Milk-street and Old King-street, at the cost of the company. The committee will be advised to allow of single side posts with bracket arms being erected in certain streets.

Lewisham.—It was reported at the last meeting of the District Board that the Board of Trade had submitted for any observations the Lewisham Board might wish to offer a description of the system proposed to be adopted by the Blackheath and Greenwich District Electric Lighting Company for the supply of energy in the form in which the Board of Trade propose to approve it, subject to their regulations for securing the safety of the public and a proper and sufficient supply. It was decided to leave the matter to the Board of Trade. The Works Committee reported that they had considered a letter from the same company with notice of their intention to lay mains along Eliot-hill, Aberdeen-terrace, Haddo-villas, Eliot-vale, and Eliot-place, Blackheath, and recommended that the Board approve, subject to the mains being laid in the roadway, and in all respects to the same terms and conditions as those on which the former application was granted. This was agreed to. With reference to a notice from the County of London and Brush Provincial Electric Light Company of their intention to apply during the ensuing session of Parliament for a provisional order covering the district of Lewisham, the committee recommended, and it was agreed, to inform the company that as the Board were themselves applying for an order they were unable to give their consent to the application.

Liverpool.—The Tramways Committee of the Corporation have decided to recommend to the Council that the application of the following resolution of the Tramways Committee of Jan. 27 confirmed by the Council in February: "That for the electric tramways service a system of penny fares be adopted throughout the city, but that 2d. be charged for a seat in the portion of the car where no smoking is permitted," be postponed until there was a preponderance of electric traction established throughout the city, and that the fares to be charged for each route be fixed according to the circumstances of the case. The Chairman has stated that he hoped the work in connection with the extensions of the electric routes would be expedited as much as possible. They did not want to annoy the tradesmen in Aigburth-road by having the roadway opened up within the next 10 days, but he hoped after that no time would be lost in pushing forward the work. In regard to the traffic on the electric lines, the statistics showed that the number of passengers carried in 31 days was, in the motor alone, 120,752, the receipts being £997. 17s. 10d., in the trailer 345,523 passengers, which produced a revenue of £1,445. 5s. 9d., thus showing that the receipts from the trailer were £447 more than those from the motor in one month. The tendency throughout had been in the direction of the trailer increasing in popularity, while the motor decreased.

Eccles.—The opening ceremony of the electric lighting works, which we referred to in our last issue, took place, as stated, on Dec. 14. The whole works have cost about £12,000, of which, roughly, about £8 000 was for the building, engines, dynamos, and boilers in Cawdor-street, Patricroft, and the remainder for wiring the streets, lamps, the cost of the order and the opposition. The scheme has been carried out under the direction of Mr. S. V. Clirehugh. The plant consists of two Lancashire boilers and two alternators, each of 200 h.p. and capable of supplying together about 10,000 8-c.p. lamps. It is intended to run one alternator at a time, the other being held in reserve in case of a breakdown. The engines are of the marine inverted type, and are coupled direct with the alternators. Accumulators are provided which will maintain 1,000 8-c.p. lamps for seven hours. The high-tension alternating-current system is adopted, and the current is at a pressure of 2,000 volts, which is reduced at the consumer's premises to 200 volts. This system has been introduced in consequence of the scattered nature of the district to be supplied. It is intended to light the whole borough by electricity, which will involve a supply of some 1,700 lamp columns. At present there are about five miles of mains laid in the district, and applications have already been received for over 4,000 8-c.p. lamps. The storage apparatus embraces separate accumulators capable of supplying 700 8-c p. lamps for 10 hours, and these will be requisitioned during the daytime and after midnight.

Appointments Vacant.—The Tramways Committee of the Manchester Corporation require a competent engineer to assist the city surveyor in carrying out the engineering work required in connection with the permanent way. He must have a thorough knowledge of tramway construction, and be capable of preparing plans for and supervising the construction of all new lines, and the alteration and reconstruction of the existing track necessary in view of the introduction of electric traction. Salary, £200 per annum. The committee also require a temporary engineering assistant. He must be a neat and expeditious draughtsman, and able to survey and level accurately. Wages, 50s. per week. Applications, stating age, qualifications, and enclosing copies of recent testimonials, to be addressed to the Chairman of the Tramways Committee, Town Hall, Manchester, endorsed "Engineer," or "Engineering Assistant," and must be received by 31st inst.—The Carlisle Corporation invite applications for the appointment of assistant engineer at a salary of £130 per annum. Applications, stating age, experience, etc., together with copies of not more than three recent testimonials, which will not be returned, must reach Mr. C. D. Burnet, city electrical engineer, James-street, Carlisle, by 31st inst. Canvassing members of the Council, either directly or indirectly, is prohibited.—Applications are invited for the post of evening instructor in electric wiring at the Northampton Institute, Clerkenwell, E.C. Particulars of this and other vacancies will be found in our advertisement columns.

Paddington.—At the ordinary meeting of the Vestry on Tuesday, the Electric Lighting Committee reported that this committee having considered the letter from the Metropolitan Electric Supply Company of the 8th ult., were of opinion that unless the Vestry were prepared to purchase the Paddington undertaking of the company, no advantage could be obtained from further communicating with the company on the subject, but the committee at the same time were fully aware that the Vestry might find it difficult to say whether they would buy or not until the probable terms of sale were made known to them. Under these circumstances the committee solicited further and definite instructions as to the wishes of the Vestry. A long debate ensued, after which a resolution was carried to the effect that the Vestry were not prepared to give any further instructions, the reference being left in the hands of the committee for them to report thereon or otherwise as they may decide. It was also resolved to ask the Metropolitan Electric Supply Company when they proposed to fulfil their obligations under the provisional order of 1890, and, further, the attention of the London County Council be called to the fact that no testing had been provided. The Electric Lighting Committee reported that the following letter had been received in reply to the representations made by the committee as to the inefficient supply of current—viz.: "The Metropolitan Electric Supply Company—Dear Sir,—I duly submitted to my directors your letter of Nov. 19, in which you state that numerous complaints have been made of this company's supply, and am instructed, in reply, to inform you that the engineer has been requested to make careful investigation into the cause of such complaints, and take whatever measures may be necessary to remove them.—Yours, faithfully, E. CUNLIFFE OWEN, secretary." The report was ordered to be entered on the minutes.

Willesden.—The twenty-third annual report of Mr. O. Claude Robson, M.I.C.E., engineer and surveyor of the District Council, has just been published. With regard to a proposed expenditure of £40,000 for electric lighting, the concluding paragraph of the report of the Electric Committee which has visited the various towns is quoted as follows: "It is, however, doubtful to your committee if the cost of electric light *v.* gas, given the same illuminating power, and carefully and intelligently attended to, will be much dearer than gas at the rate now charged in this district. The conveniences of electric light are so numerous and well known that they need not be here mentioned, but all must acknowledge that it is a healthier, cooler, cleaner, steadier, and safer light than from gas. It is now being more and more generally adopted, and the result of the visit of your committee to the towns before mentioned has been to strengthen them in their opinion that the Council have done the right thing in applying for a provisional order in the coming session of Parliament. Let this be followed up by losing no time in commencing the works consistent with thoughtful design and careful consideration of all circumstances relating to site, buildings, machinery, mains, etc. In some instances your committee find that towns have obtained the provisional orders, and have received extension of time from the Board of Trade before carrying out the work. At Torquay the order was obtained upwards of seven years since, and the work is not yet completed. At Willesden it is hoped that no time will be uselessly lost, as in a London suburb the governing body are similarly placed to those in authority at seaside towns. They have to cater for the public, and provide an attractive residential locality for the workers in the City, and it is by the adoption of improvements, such as represented by the electric light, that your committee believe that they will be able to keep pace with their neighbours, and provide another item of benefit and convenience to those living in this district." On the question of combining a dust destructor with the electric lighting installation, Mr. Robson says that the calorific value of the refuse is undoubted and should not be wasted, even if the total amount be not sufficient to entirely run the electric lighting station. He suggests that a committee should inspect the various dust destructors already in use elsewhere before a site for such a station is definitely decided upon.

Glasgow.—At a special meeting of the Town Council on Monday a draft agreement between Glasgow Corporation and Partick Burgh Commissioners for the transfer to the Corporation of the Partick Electric Lighting Order of 1893 was approved. The clauses of the agreement provides that the Corporation shall pay the costs incurred in obtaining the order and in opposing an application being made by the Kelvinside Electricity Company; that the prices charged to private consumers shall be similar to those within the city; and that the charge for street-lighting be subject to agreement between the two authorities. A communication from the Kelvinside Electricity Company, stating that they

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would delay making an application for an order on condition that the Corporation would do the same, is being considered by the Electricity Committee. At the last meeting of the Town Council it was stated that the proposed extension of the trolley to Govanhill was to enable the committee to make full use of the power station erected in connection with the Springburn route. So far as their experience with the trolley system had gone, the earnings were the highest known in the history of tramway traction in Glasgow or Scotland, and, similarly, the working expenses were the smallest known. The committee were of opinion that by extending the same system, and fully utilising the power they had already got, they could show very much better results. It had been proposed that they should equip the Govanhill section with the conduit system, but the committee had come to the conclusion that it would be a mistake to mix up the Springburn experiment with an experiment on a different system, the cost and working of which would be entirely different. The committee thought the conduit system should be tried on some route quite apart from the Springburn installation. At Tuesday's meeting the agreement was approved, excepting the clause binding the Corporation to pay Partick a proportion of the surplus revenue. At this the Kelvinside Electricity Company wrote agreeing to withdraw an application for a provisional order including Partick within their area, providing the Corporation did the same. The Corporation refused to deal with the communication. The Electricity Committee of the Corporation had under consideration on Tuesday the informal negotiations which had been proceeding with the Kelvinside Electricity Company with reference to the acquisition of their works by the Corporation. A sub-committee was appointed to confer with the Kelvinside Company, without prejudice to the interests of either party, and report to the Electricity Committee.

Gloucester.—A Local Government Board enquiry was held on Wednesday by Mr. H. P. Boulnois, M.I.C.E., into an application of the City Council to borrow £50,000 for the construction of electric lighting and refuse destructor works for Gloucester. Mr. Robert Hammond (consulting electrical engineer) explained the details, and said the scheme included, besides private lighting, provision for 36 public arc lamps and 266 double 16-c.p. incandescent lamps. The total public lighting units estimated for is 158,950, and private lighting units 187,500, or a total of 346,000 units. The plant provided for is 600 kw.—viz., one 300 kw. effective capacity and one 300-kw. set in reserve. The quantity of refuse collected by the Corporation averaged 7,000 to 8,000 tons per annum, the average distance for carting from the city being about 1½ miles, at a cost of 1s. 6d. for collecting and disposal. With regard to the construction of dust destructors, it was of the first importance to so proportion the number of cells to the refuse to be dealt with that there should never be any accumulation, and to so dispose of it when it reached the tipping platform that the nuisance arising from bad odours was minimised, a task that presented little difficulty. It was important to adopt the plan of drawing the air for the fans from the upper part of the destructor-house, where the refuse was tipped, as by this means a supply of uncontaminated air was drawn into the building. With reference to the wafting about of dust, the less sorting that was encouraged the better. As the prime reason for erecting a refuse destructor was to dispose of the refuse by the most sanitary method possible, it would appear to be wise to pass direct through the fire everything that had found its way into the dust receptacles of houses of all sorts and conditions, a certain number of which might be at any one time hotbeds of bacteria. Dealing with noxious fumes, a refuse destructor should be designed, in the first place, to ensure absolute and perfect oxidation of all combustible matter contained in the refuse, and, secondly, to utilise the waste heat to the utmost for steam raising or other useful purposes. It was essential, however, that the latter condition should be subordinated to the former. When noxious fumes were given off, it was obviously a case of incomplete combustion, which often occurred in the early destructors. There was now no difficulty in obtaining the high temperature necessary to secure complete combustion Indeed, so hot had the fires been made in certain cases that they had melted the iron dampers, and care had to be taken to design them in a combination of fire blocks and iron or other refractory material. It was well to bear in mind that the heat generated in the cells should not be so fierce as to endanger their stability, and it was of the utmost importance to prevent any possibility of breakdown with work of this description. Bad odours were also emitted when the fumes escaping from the cells were allowed to pass over the green material, but this would be obviated by a proper location of the exit of the gases from the cells. With reference to the cost of burning, rival makers vied with each other in claiming low cost of burning. The total cost of dealing with the refuse by cremation he estimated as follows: collection, 1s. per ton; burning, 1s. 3d.; interest and sinking fund, 10d.; maintenance, 2d.—total 3s. 3d.; Less materials made from clinker and net value of steam, 10d.—total cost 2s. 5d. per ton.

PROVISIONAL PATENTS, 1898.

DECEMBER 12.

26191. Improvements in electric switchboards. Edward Woodrowe Cowan and Alfred Still, Hart-hill, Woodville-road, Bowdon, Cheshire. (Complete specification.)

26210. Improvements in dynamos and electric motors. Frederic O'Connor Prince, The Silvertown Ironworks, Campbell-street, Silvertown, London.

26214. Improved electrical furnace. Edwin Burbage Phillips and Walter Henry Bray, Avondale-villas, Uppingham-road, Leicester.

26239. Improvements in electric measuring instruments for three-phase systems. Jasper Wetter, 37, Essex-street, Strand, London. (The Elektrizitäts Aktien-Gesellschaft vormals Schuckert und Co., Germany.)

26248. Improvements in or relating to starting switches for electromotors or the like. John Walter Gibbs, 6, Lord-street, Liverpool.

26251. Improvements in the construction of electrical transformers with ventilating passages Otto Titus Bláthy, Birkbeck Bank-chambers Southampton-buildings, Chancery-lane, London. (Complete specification.)

26257. An improved method of, and apparatus for, regulating the difference of potential at the terminals of dynamo-electric and like machines Léon de Coincy, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 6, 1898, being date of application in France.)

DECEMBER 13

26285. Improvements in switches for electrically-worked lifts, hoists, and the like. Sidney Harper Heywood and Herbert William Heywood, Ducie-street, Piccadilly, Manchester.

26310. Improvements in junction-boxes, switches, wall-plugs, and distribution boards for use in electric wiring. George Alexander Clark, William McAulay, and John Alexander McLaren, 62, St. Vincent-street, Glasgow.

26315. Improvements in ball-bearings for electric motors. John McLeod Murphy, 111, Hatton-garden, London. (Complete specification.)

26322. Improvements in and relating to apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines. Léon de Coincy, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act 1883, Sec. 103, Oct. 7, 1898, being date of application in France.)

26323. Improvements in the frigorific electro-spray. Eva Savary D'Odiardi, 34, Park-lane, East Croydon.

26325. Improvements in electrodes of deep penetration. Eva Savary D'Odiardi, 34, Park-lane, East Croydon.

26326. Improvements in abscess bells and electrolysers. Eva Savary D'Odiardi, 34, Park-lane, East Croydon.

26327. Improvements in electro-inhalers and nascent ozone producers. Eva Savary D'Odiardi, 34, Park-lane, East Croydon.

26328. Improvements in electro-vapourisers and ozonisers. Eva Savary D'Odiardi, 34, Park-lane, East Croydon.

26334. Improvements in electric switches. William John Ferguson and William Gilpin Harrison Stump, 52, Chancery-lane, London. (Complete specification.)

26335. Improvements in telegraphic receiving and translating instruments. Alexander Muirhead, 323 High Holborn, London.

26343. Improvements in the manufacture and production of plates or elements for secondary batteries or electrical accumulators. Camille Brault, 47, Lincoln's-inn-fields, London.

26351. Improvements in galvanic elements or batteries. Jasper Wetter, 37, Essex-street, Strand, London. (Maurice Maas, United States.) (Complete specification.)

26380. Improvements in electric batteries. Edgar Giglio, 6, Lord-street, Liverpool.

26381. Improvements in conduits for electric conductors. John James Bate, 6, Lord-street, Liverpool.

26397. An improved acid-proof or non-conducting material for electrical and other purposes, and method of preparing the same. Carl Jung, Adolf Brecher, and Adolf Kittel, Clun House, Surrey-street, Strand, London. (Complete specification.)

26401. Improvements in bath apparatus for treatment with electricity and medicinal substances. Carl Emil Schnée, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

DECEMBER 14.

26412. An improved terminal for electrical fittings and apparatus. Joseph Stoddart, Commercial-street, Halifax.

26419. Improvements in and relating to dynamo-electric motors. Henry Humphreys and William Humphreys, 43, Great Clowes-street, Lower Broughton, Manchester.

26420. Improvements in fusible cut-outs. Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

26423. An improved electrical governor for steam-engines and the like. William Shinn, 28, Robarts-road, Liverpool.

26458. Improvements in collectors for electric tramways on the overhead conductor system. Richard Rainsford, 1, Church-court, Old Jewry, London. (John Walsh, United States.)

26476. Improvements in batteries. Charles Edward Burroughs, Washington, United States. (Complete specification.)

26479. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

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DECEMBER 15.

26494. Improvements in electrical switches. Alfred Watson, 24, Temple-row, Birmingham.

26526. A new or improved crucible for casting lead or like metals under pressure, especially applicable to the formation of secondary electric battery grids or plates. Edward James Clark, 73, St. Stephen's-road, Upton Park, London.

26527. Improvements in regulators for electric car motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Hiram Stevens Maxim, United States.)

26566. Improvements in telephone transmitters. Frederick Herbert William Higgins, 18, Southampton-buildings, Chancery-lane, London.

DECEMBER 16.

26604. Improvements in telephonic or other switchboard apparatus. Frederic William Francis, 262, Brockley-road, Brockley, London.

26610. Improvements in electric arc lamps. Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, 55, Chancery-lane, London.

26614. Process and apparatus for treating ores by electrolysis. Jonathan Aldous Mays, 75, Chancery-lane, London.

26619. Improvements in telephone switchboards or switching apparatus for telephone stations. William Phillips Thompson, 6, Lord-street, Liverpool. (Thomas F. Ahern, United States.) (Complete specification.)

26649. Apparatus for simultaneously actuating from one point the controlling switches of the several electrical motorcars of a train. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

26650. Improvements in or relating to electric lamps. — Andreas, 111, Hatton-garden, London.

DECEMBER 17.

26695. Improvements in electric accumulators or secondary batteries. Walter Puttkammer, 37, Essex-street, Strand, London.

26700. Improvements relating to the coating of metals with metals by the aid of electricity, and to apparatus therefor. Frederick Hall Snyder, 11, Southampton buildings, Chancery-lane, London.

26702. Improvements in primary batteries. Haydn Thies Harrison, 18, Southampton-buildings, Chancery-lane, London.

26706. Improvements in cable lightning conductors. Jules Boene, 1, Broad-street-buildings, Liverpool-street, London.

26723. New or improved device for indicating the frequency of an electric current or currents derivative y applicable for signalling and indicating speeds and the like William Ernest Burnand, Norfolk House, Norfolk-street, Strand, London.

SPECIFICATIONS PUBLISHED.

1896.

21956. Electric accumulators.** Julien. (Amended.)

1897.

27428. Electric furnaces for the production of calcium carbide and other substances. Riant.

27508. Extraction of gold by electrolysis. March.

27619. Incandescent electric lamps. Nordmann.

29009. Electric furnaces for the production of calcium carbide and other substances. Bastick and Thornton.

29011. Electric furnaces for the production of calcium carbide and other substances. Bastick and Thornton.

29116. Distribution and regulation of electric energy and conductors connected therewith. Baynes.

29318. Control and regulation of electrically-propelled vehicles. Wade and the Electric Motive Power Company, Limited.

30001. Railway aero-electric brakes. Luyers.

30037. Electric lamps. Lacko. (Date applied for under International Convention, July 21, 1897.)

1898.

468. Enclosed motors or dynamos. Rosling and Appleby.

1021. Manufacture of filaments for incandescent electric lamps. Stearn.

1687. Electric signalling apparatus. Thompson.

2167. Electric generators for cycles and other vehicles. Moores and Farrell.

2684. Apparatus for the electro-deposition of metals. Fisher, Round, Round, and Round.

3204. Electric arc lamps. Vigreux and Brillié.

5172. Telephone transmitters. Collingwood.

7057. Plug switches and plug connections for the control and distribution of electric currents. Proctor and Blaikie.

10608. Electrically-illuminated buoys. Lake. (Hoffmann.)

15040. Automatic circuit breakers. The British Thomson-Houston Company, Limited. (Hewlett.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Dec. 17	3 846	3,576	+ 270	—	—
Blackpool and Fleetwood Tramroad	Nov. 18	211	—	—	13 566	—
Bristol Tramways and Carriage Co.	Dec. 16	2 550	2,362	+ 187	—	—
City and South London Railway	,, 18	1,080	1,080	—	24 834	24,062
Dover Tramways	,, 17	149	110	+ 30	8 209	—
Dublin U.T., elec. cars	,, 16	566	†522	+ 44	16,196	13,577†
Dublin S.D. Electric Tramways	,, 16	622	357	+ 265	22,269	14,987
Halifax Corporation Tramways	,, 14	235	—	—	6,302‡	—
Liverpool Overhead Railway	,, 19	1,324	1 342	+ 18	—	—
South Staffordshire Tramways	,, 16	603	515	+ 38	31,552*	31,541*

* Receipts since Jan. 1. † Ho[illegible]rse c[illegible]ars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	19-20
Bournemouth and Poole Electric Supply, Limited, Ord.	10	11-11½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-16½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-13½
Brush Electrical Engineering, Limited, Ordinary	2	1[illegible]
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	11[illegible]-116
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	112-115
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	9⅞-10¼
——	6	5⅞ 6¼
—— Pref. Half-Shares	1	1⅛-1⅜
—— ,, ,,	5	4¼ 4⅞
Charing Cross and Strand		11⅛-11½
—— 4½ per cent. Cum. Pref.	5	6 6⅛
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115 xd
City of London, Ordinary		22 24
—— ,, 90,001-100,000	10	21-23
—— 6 per cent. Cumulative Pref.	[illegible]	15½-16½
—— 5 per cent. Debenture Stock	0[illegible]	127-132
City and South London Railway, Consolidated Ordinary	[illegible]	65-68
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	[illegible]	124 126
—— 5 per cent. Pref. Shares	10	14½ 15⅞
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co. Ord.	1[illegible]	12½-13½
—— ,, ,, No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	1[illegible]	14½-15½
Crompton and Co.	3	1⅞ 2⅛
—— 5 per cent. Debentures		91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125 130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	[illegible]	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99 xd
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	[illegible]	2½-2⅝
—— 7 per cent. Cumulative Pref	[illegible]	2⅝-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
Elmore's Copper Depositing	1	1-1⅛
Elmore's Wire Company	[illegible]	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9 10
—— 7 per cent. Preference	[illegible]	9½-10½
Imperial Tramways, Limited	6	15½-16½
India Rubber, Gutta Percha, and Telegraph Works	1[illegible]	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	[illegible]	13-14
London Electric Supply, Ordinary	3	3⅛-3⅜
—— 6 per cent. Pref.	5	6-6⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	101-103
Metropolitan Electric Supply, Limited, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	7-8
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7-7⅛
—— £4½ Shares, New	4½	6½-6⅝
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6¼
Royal Electrical Company of Montreal	1[illegible]	15-155 xd
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	2⅞ 3
St. James's and Pall Mall, Limited, Ordinary	5	16 17
—— 7 per cent. Pref.	5	9 10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104 107
Waterloo and City Railway, Ordinary	100	111-114
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Royal Institution.—The last three lectures by Sir Robert Stawell Ball on astronomy will be delivered on Tuesday, Thursday, and Saturday next week. The lectures, which are specially suitable for young people, commence each day at 3 p.m.

Arlberg Railway.—We understand that this State railway in Austria is to be worked by electricity. Three electric firms have jointly undertaken the work, and have received a concession from the Government to construct electric works for the whole distance from Innsbrück to the Swiss frontier.

Electric Traction in Glasgow.—We are glad to note that the final conversion of the tramways of Glasgow for electric driving, is considered a matter of urgency by the Corporation. After careful consideration the Tramway Committee have decided that the trolley system must be used throughout the city, as there is not depth in the roadway for the conduits at several points.

Blotting Pad.—The Electrical Power Storage Company, as usual at this time of the year, have favoured us with one of their blotting pads, which is also an almanac and diary for 1899, as well as a price list for the various types of accumulator cell now manufactured by the company. A good deal of information is given relating to these cells in the shape of tables and notes, so that the list is exceedingly handy for reference.

Obituary.—We regret to have to announce the death, on Tuesday last, of Dr. Eugene Obach, F.I.C., F.C.S., who for years has acted as chief of the experimental department of Messrs. Siemens Bros. Dr. Obach had a most busy life, and his historical series of Cantor lectures on gutta-percha was given when his health had began to give way. At the time of his death he was staying in Austria with the hope of regaining his health.

Man Power.—According to *Indian Engineering*, it has been proposed to run dynamos for electric light purposes on the Indian frontier by treadmills operated by convicts. The work would, we presume, be conducted on the piece system—*i.e.*, so many units per day—and in this case the heavy convict will have a great advantage over his leaner co-prisoner. We are afraid that the system would, however, tend to reduce the weight of the convicts to a minimum, as the less a man weighs the farther he would have to move.

Books Received.—"The Life Story of the Late Sir Charles Tilston Bright," in two volumes, by Mr. E. B. Bright and Mr. Charles Bright; Archibald Constable and Co.—Messrs. Whittaker and Co., of Paternoster-square, E.C., have just issued a new (fourth) edition of "Electric Lighting and Power Distribution," by Mr. W. Perren Maycock, M.I E.E. They have in the press a new work by the same author, entitled "Electric Wiring, Fittings, Switches, and Lamps," and this will be published in about three months' time.

Sterelectrolysis of Minerals.—We find the following abstract of a paper read by Mr. F. Mayençon before the Association Francaise Adv. Science in the current issue of the *Journal* of the Chemical Society. The abstract says the name sterelectrolysis is given to the following method of analysing minerals. The fine powder is made into a paste with water, placed between two pieces of filter paper, and electrolysed between platinum electrodes with six dichromate cells. Metals or their oxides appear at the cathode, and acid radicles at the anode. For example, with galena, metallic lead and sulphuric acid are obtained, and with barytes, baryta and sulphuric acid. The separated constituents are then identified by ordinary analysis.

An Electric Island.—If the report of the *Western Mail* is to be believed, Tesla is late in his proposal to transmit large powers across the Atlantic. Our contemporary states that a "peculiar state of affairs has been developed in the island of St. Pierre Miquelon, where the cables connecting Europe and America meet. The quantity of electricity circulating here has resulted in soil becoming overcharged with the fluid. An isolated wire, 3 km. long, has been thrown across the island and attached to a metal plate in the sea, and has successfully intercepted a message on its way between the two continents, the overcharged electric soil having been the means of turning the message out of the original path." We hope the fluid improves the crops, and that the cable will not be able to establish a right to tithe the improvement.

Electric Lighting Policy.—The *Journal of Gas Lighting* in its able review of the past year states that "the gas legislation of the year does not reveal any very important reforms. There is still a good deal of discrepancy between the rights and privileges of gas suppliers and consumers in different places, as must be expected from the experimental nature of British statutory regulation. In the case of the Tottenham and Edmonton and the Southend Companies, advantage was taken of a Bill being on the stocks to include electric lighting clauses in the measure; but in all instances the utmost the Board of Trade have conceded in this respect is permission for the gas company to apply for and carry out a provisional order under the Electric Lighting Acts." We think our contemporary would have done better to have added "and carry out if granted," as up to the present the Board of Trade has refused to grant any electric lighting orders to gas companies.

Electric Traction in England.—Mr. James Ross, the vice-president of the Montreal Street Railway Company, who has recently returned to Canada from an extended visit to Great Britain, has made some interesting remarks upon street railways in Britain and other matters, in the course of an interview with the *Montreal Gazette*. Mr. Ross observed that while he did not wish to cast any reflections upon the municipal bodies of Great Britain as regards the slow manner in which they moved, yet it was a fact that most of the cities were extremely conservative in the matter of a change from horse or steam to electrical power. The overhead system appeared to be generally accepted, and Liverpool and Glasgow, which had purchased their respective street railway systems, had each from two to three miles in operation. Bristol and Dublin were also to have the trolley. In Birmingham the people were undecided what course to pursue, and they will, Mr. Ross added, probably await results in the other cities. Mr. Ross is decidedly out in his details, or else he has been badly misreported.

Love Put Out the Light.—The North Shore Power Company, of Canada, which is supplying electricity for the city of Three Rivers, is generating it at Batiscan Chute and stepping it up to 12,000 volts for the purpose of a 16-mile transmission. A few evenings ago, says the *Canadian Engineer*, just as the dusk was coming on and the heavy load beginning to show on the ampere-meters, the circuit breakers flew, the fuses blew and the lights were out. This lasted for perhaps 10 minutes, when the lights again started up and ran satisfactorily. The day following the electrician naturally investigated to see what caused the trouble, and he found that a window had been broken in the sub-station at Three Rivers, and that some of Jean Baptiste's chickens had sought a roost on the bare copper

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wire, and as Chanticleer kissed Biddie "good-night" it completed the circuit, electrocuted the lovers and put the lights out. This, perhaps, is one of the most uncommon short-circuits or reasons for trouble that has occurred in Canada, and is a pointer for other electricians who may have power houses with broken window panes.

Theory of the Lead Accumulator.—Amongst the abstracts appearing in the *Journal* of the Chemical Society is one of a paper by Mr. F. Dolezalek on the "Theory of the Lead Accumulator." The abstract is as follows: The simplest theory of the changes occurring in the lead accumulator is expressed by the equation $PbO_2 + Pb + 2H_2SO_4 \rightleftarrows 2PbSO_4 + 2H_2O$. On charging, the reaction occurs from left to right, on discharging, from right to left. This process would be a fully reversible one, but many of the changes which occur in the accumulator when at work are not apparently in keeping with this simple view of its action; this is more especially the case with the behaviour on charging and discharging, as the E.M.F. is found to be slightly higher during the first than during the second operation, thus causing a considerable loss of energy. The author traces this loss to the changes which take place in the concentration of the acid, and consequent diffusion and convection, and also production of concentration currents in the cell. Taking these changes into account, the above theory of a fully reversible reaction in the sense given is fully satisfactory.

Accumulators on Board Ships.—We note a well-written article in the *Electrical Review* of New York on the use of storage batteries at sea, and, while quite agreeing that in the situations premised accumulators would do good service, we do not think they can be recommended for ship work. The author, in the first place, refers to the greatly increasing use of electric motors on ships instead of auxiliary engines, and says that there is a Russian man-of-war building at Cramp's ship-yard on which electric motors will be employed throughout to the exclusion of the auxiliary steam-engine. He then considers the risks of breakdowns, but does not say that these risks can be minimised by having distinct plants working duplicate circuits running to every part of the ship. He proposes to instal accumulators of sufficient capacity to operate the search-lights, the turrets and ammunition hoisting motors, and about 100 incandescents lamps for five hours steadily, but he does not work out the dimensions and weight of such a battery. In conclusion, he adds that "the maintenance of the batteries is small, and they have reached a state when they can readily be operated by the ordinary marine engineer." This is too much to pass unnoticed, as the maintenance of the type of cells required for service on a ship is heavy and their life none too long. In fact, a ship would be better to have more spare steam plant than to carry the dead-weight of such a large battery of accumulators.

Turbine-Driven Dynamos.—The *Electrical World* of New York has in its current issue the following remarks on the selection of sizes of dynamos to be driven by water-wheels. The considerations in this case are quite different from those involved in engine-driven combinations. The essential difference rises from the fact that waterwheels will never much exceed their rated loads, being rated at practically wide-open gate in order to have a high efficiency at their rated load. A slight margin, about 10 per cent., is allowed to make sure that the wheel will always carry its load with slight variations of head, etc. On this account turbines must always be chosen with a rated power equal to the maximum load they may be called upon to carry. Very brief overloads, that is with a duration of a few seconds, may be carried by flywheel retardation, but for more protracted overloads there is no available source of energy. Steam-engines are also, as a rule, rated at or near their point of greatest economy, which, instead of being the maximum possible output of the engine, is at a cut-off varying perhaps from one-quarter to one-half stroke. When called upon, therefore, the engine will take an overload of 50 or 100 per cent. without difficulty or harm other than a low steam economy. Thus, for fluctuating loads, such as those of street railways, the rated capacity of the engines in operation at any one time need not be more than, roughly, 60 per cent. of the load that may be thrown upon them.

Electricity in Warfare—Colonel Eugene Griffin, the commanding officer of the United States First Regiment of Volunteer Engineers, was recently entertained to a complimentary dinner in New York. Colonel Griffin took a prominent part in the organisation of the corps when the war began, and had a free hand in the selection of the officers and men. In his after-dinner speech, as reported in the *Electrical Review* of New York, we note in several places that he regrets that the corps had not more active fighting. Thus he says: "Had Toral held out at Santiago for a few days more, had Cervera delayed his dash for liberty, the story might have been very different. It is at least possible that, under such changed conditions, the war would even yet be in progress, and that the final act would be the siege of Havana. However necessary it may have been to prove the value of engineer troops under the ordinary conditions of modern warfare, every military man would have recognised the necessity and value of engineers in siege operations. The opportunity would have been offered us to introduce modern engineering methods, and to change in many ways the traditional methods for the 'attack of fortified places.' Searchlights would have prevented sorties, and electric motors would have played no small part in the trenches. Hospitals would have been lighted by electricity and cooled by fan motors. The wounded on the battlefield would have been found at night by the aid of searchlights, and the surgeons would have operated in field hospitals by the aid of the electric light. The whole modern development of electricity has taken place since the last great war—that between the Turks and Russians in 1878."

German Push.—The *Financial News* gives the following as evidence as to the alleged commercial expansion of Germany. In the East, in particular, it is said that her trade is growing with tremendous rapidity. She has already obtained a firm hold in Turkey, and is said to be at present working hard in Roumania to secure the lion's share of the trade. In illustration of this it has been announced that when the town of Braila recently invited tenders for electric lighting all the bidders were Germans. A Cologne company named the price at 6·6d. per unit to private individuals and half price to the public, with other advantages, if allowed to use for lighting purposes the power-house already possessed for the electric tramways; while a rival company, of Frankfort, offered light at 7d. for public and private use, undertaking to pay into the city treasury one-third of all profits above 7 per cent. on the capital invested and one-half of all above 10 per cent. This is given as a fair sample of the desperate methods by which Germany seeks to get a footing everywhere. The Germans appear to be always ready to make the greatest sacrifices—even to the extent of supplying goods at a loss—in order to introduce goods, in the hope that by-and-by they will succeed in elbowing out their English and other rivals. English traders, who endeavour to supply goods of good quality, do not seem particularly anxious to imitate German methods. They prefer to keep on the safe side,

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and let their goods, as it were, speak for themselves. This caution is often carried too far; but the trade done is very much safer and often much more satisfactory than that of their German rivals. The quantity or value of exports to any particular country does not always and infallibly indicate the amount of profit derived therefrom.

Automobile Repairs.—The Paris correspondent of the *Financial Times* announces that under the title of "La Poste Electrique Internationale" a company has been formed in Belgium, with a capital of £320,000, for the novel purpose of establishing on all the principal high roads of Europe electric motive power stations, or electric posting stations for motorcars. According to the preliminary prospectus, a "bar restaurant" is to be fixed up at every electric posting office. Each of these stations will be in charge of expert mechanics, and repairs will be quickly executed. Accumulators can be recharged "while you wait," and medical attendance will be on hand in case of accidents. A sketch of the proposed stations accompanies the draft prospectus, and it is maintained that not only electric motorcars but every sort of motorcar and cyclists would prefer to stop at one of the company's stations, fitted up with every convenience, than elsewhere. "This company," it is said, "will give a considerable impetus to the extension of automobilism." That may be so, if ever the company gets out of its babyhood. By the time, however, that electric motorcars have attained some sort of perfection we may be perfectly sure that there will be no necessity for a special electric supply company, for even as it is electric power can be obtained all over the Continent in every town of any size with a little trouble. No doubt users of electricity would be glad to turn the development of electric automobiles to profit, and the use of electricity would increase. With the progress of motorcars, too, special mechanics' shops are springing up everywhere. Indeed, every bicycle dealer or agent in France has now taken to selling motorcars of some sort or another, and a skilled mechanic is generally on the premises. La Poste Electrique is a novel idea, but it is perhaps a little previous, and as it could not prevent competition nor secure a monopoly it would probably be many years before there was a return on the capital, if ever.

Glasgow University Engineering Society.—This society recently had a lecture delivered to it by Mr. W. B. Sayers, M.I.E.E., on "The Economic Use of Electricity in Power Transmission and Distribution." Mr. Sayers discussed the question which is occupying the minds of many engineers—namely, under what conditions it is advantageous or economical to use electricity as a means of transmitting and distributing power. This question is a far more difficult one to answer than might appear at first sight, the reason being that the conditions upon which the answer depends vary between very wide limits, dependent chiefly upon the nature and amount of the work to be done and its location, the nature of the source of power and its cost, and, again, the distance of this source of power from the place where power is required. A further question arising is, assuming that the conditions in a given case are favourable to the use of electricity, at what point shall the transformation into dynamical power be effected. Mr. Sayers pointed out that the factors upon which our conclusion must be based are two—convenience and cost. Convenience is generally difficult or impossible to value in terms of pounds, shillings, and pence; but, nevertheless, it would be difficult to exaggerate the importance of convenient arrangements in any manufacturing establishment. The difference between convenient and inconvenient arrangement is analogous to the difference between good and bad management. It is often the difference between success and failure, between profit and loss, for it must be borne in mind that the saving of time which is the inevitable result of improved convenience means not only reduced cost of production, but also increased capacity for output in a given time. The conclusion of the lecture was devoted to the consideration of the cost items, and a number of diagrams were shown showing the cost of energy derived from water, gas, and electricity mains per horse-power hour in Glasgow and Edinburgh. The lecturer specially noted the effect of the "load factor."

Carborundum Manufacture at Niagara.—We cull the following details from a descriptive article in the *Canadian Engineer* on the carborundum works at Niagara Falls, Ontario: The crude materials for the manufacture of carborundum are sand, coke, sawdust, and salt. The coke is reduced to kernels of a certain size to be used as "core," and ground to a fine powder to be used in making the mixture or charge for the furnaces. The furnaces are built of brick, and have the form of an oblong box, the internal dimensions being approximately 12ft. in length, 3ft. in width, and 3ft. in depth. The ends are built up very solidly with a thickness of about 1½ft. In the centre of either end are the terminals, consisting of 16 carbon rods, 20in. long and 3in. in diameter. The outer ends of the carbons are closed in a square iron frame. Finally, all the space between the inside of the plate and the ends of the carbons is tightly packed with graphite. Each plate is provided with a projection, to which the cables conveying the current may be bolted. These ends are the only permanent parts of the furnace. After the circuit has been closed in the transformer room, no apparent change occurs in the furnace for about half an hour. Then a peculiar odour is perceived, due to escaping gases, and when a lighted match is held near the furnace walls, the gas ignites with a slight explosion. When the current has been on for three or four hours, the side walls and top of the furnace are completely enveloped by blue flame of carbon monoxide. During the run of a single furnace, 5½ tons of this gas are given off. At the end of four or five hours the top of the furnace begins to subside gradually, fissures form along the surface, from which pour out the yellow vapours of sodium. At the end of about 24 hours the current is cut off from the furnace and it is allowed to cool for a few hours. Then the side walls are taken down and the unchanged mixture raked off the top of the furnace, until the outer crust of amorphous carborundum is reached. This crust is cut through with large steel bars, and can then be easily removed from the inner crust of amorphous carborundum. The inner crust is next removed with a spade, and the crystalline carborundum exposed.

Energy in Short-Circuited Armatures.—The following is an abstract by M. Carl Hering of an article by Herr Roessler in the *Elektrotechnische Zeitschrift*: In the first part of a long article he discusses the distribution of the current and the energy consumed in what is known as the squirrel-cage armature of alternating-current motors invented by Dobrowolsky and consisting of an iron cylinder with copper wires running through it near the periphery, all being connected together at their ends by copper rings. Such armatures are used with non-synchronous rotary field motors or non-synchronous single-phase motors which depend on a revolving field. In these the loss of energy in the armature winding not only affects the efficiency but is a very important quantity in the operation of the motor, as it determines the drop in speed for increasing loads; this diminution in speed is to the speed at no load as the amount of energy lost in the armature is to the total energy; the calculation of these

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losses is therefore of importance, as is also the distribution of the currents in that armature. He shows how to calculate the distribution of the current and the energy losses for the forms of armature occurring in practice. What occurs in such armatures is very complicated, but the theory in general is simple if it is assumed first that the resistance of the connecting rings and then that the resistance of the rods may be neglected. The description of the method does not admit of being abstracted, but some of the results may be of interest. He shows that if the resistance of the rings is zero a current will flow in each rod, independent of their number, the number of poles and the shape of the field—which is equal to that which would flow in that rod if its ends were connected with zero resistance. If the resistance of the rings is only a hundredth part of the resistance of the rods. the mean value of the current will be reduced to more than half; the torque will be reduced in the same proportion, as this depends on the product of the current and the field strength; for the same torque one armature would therefore have to have to have double the slippage of another similar one. With a large number of poles the armature current is only diminished to a slight degree. Not only the resistance of the rings but also the intermingling of the different currents depending on that current and the number of poles will diminish the total current. In general it may be said that this diminution will become less, the less the resistance of these rings or the greater the relation of the number of poles to the number of rods, for the same resistance of the rings. A table gives the distribution of the current in an armature of a certain kind.

Two-Rate Metering.—We notice in the columns of the *American Electrician* an article by Mr. Lyman C. Reed on two-rate metering. The idea illustrated really consists of two meters—one small and one a large one—to supply the same circuit. The small one is always in circuit, and accurately measures small loads, while the larger one is automatically switched in at heavier loads. The diagram given shows a 7½-ampere meter in parallel with a 100-ampere meter, both meters being in connection with an automatic switch. The switch consists of a rocking lever with a double-wound solenoid to actuate it, each coil being respectively in series with the fields of the small meter, but of sufficient capacity to carry the full load of the installation, which is a three-wire one. The pull of the solenoid on the iron armature is balanced by an adjustable weight placed on the other end of the lever, and permitting of being set to cut in the largest meter at any desired load. On the other end of the lever are mounted contact points, which plunge into mercury-wells when the switch operates to cut in the large meter. Assuming the switch to be regulated for a load of 10 amperes on a side, then for all loads under this amount the small meter is the only one in circuit. When the load reaches 10 amperes the armature is pulled down, and plunges the contacts into the mercury-wells, thereby putting the large meter in parallel with the smaller. The fields of the small meter have approximately 12 times as much resistance as the larger meter, the current divides itself accordingly, and the large meter receives 9·15 amperes, and the smaller ·85 ampere. As the load increases the ratio remains the same, and both meters are working under the same percentage of load with respect to their rated capacity. The small amount of day burning and the number of lights left on all night after the stores close are, under the present system of measurement, practically lost to the central station, while the system described above registers accurately all current consumed. The feature which presents itself as an outcome of this parallel metering and yet affords a solution of selling current at two rates The small and long hour burning would be registered on the small meter, the short heavy hour burning on the large and small together, but as the ratio is fixed between the two this fixed percentage would be deducted from the register of the small meter and added to the register of the large meter, in order to keep the large and small consumption entirely distinct. Under the usual conditions prevailing in general private lighting the heavy load would be carried from about 5 to 10 p.m. There are some rare casese where the day load would be the heavy load, and, of course, the rate in that case could be adjusted to suit the customer.

The Steam-Turbine.—Mr. Gerald Stoney recently read a paper before the Newcastle-on-Tyne Association of Students in connection with the Institution of Civil Engineers on "The Steam-Turbine and its Applications." Mr. Stoney pointed out the two ways of utilising the energy of steam: that in which the steam moved a piston of some form had been gradually perfected from the engine of Savory up to the high degree of perfection of the modern reciprocating steam-engine by successive inventors; but that in which the kinetic energy, or the energy in a jet of steam, was utilised was not perfected till the Hon. C. A. Parsons, M.I.C.E., F.R.S., in 1884 invented the compound steam-turbine. The great advantages of such an engine were obvious, as it was a purely rotary engine, and therefore there were no reciprocating parts to cause knocking, vibration, wear, and other losses of energy. Other advantages were: the small space occupied, low first cost, upkeep, and attendance, no special and costly foundations, and automatic governing and lubrication. The initial steam economy was maintained, and, there being no cylinder lubrication, the exhaust steam was entirely free from oil. The steam-turbine was first applied to driving dynamos, and from small sizes of about 4 h.p. the size had gradually been increased, till now turbines of 1,500 h.p. were being built. The economy of steam in turbines was remarkable, the results obtained being equal, and in many cases superior, to those obtained with the best engines of other makers. Steam-turbines had been utilised not only for driving dynamos, but for many other purposes, such as for fans for forced or induced draught for boilers and for ventilating mines and collieries. Such a fan had now been running with great success at the Clara Pit, Wylam, belonging to the Stella Coal Company. But the latest—and what might, in the future, prove to be the greatest—application of the steam-turbine was to the marine propulsion of ships. In 1894 a syndicate was formed to test this new method of steamship propulsion, and, after numerous experiments, the famous "Turbinia" was completed. She was only 100ft. long by 9ft. beam, and displaced 44½ tons, yet she had engines on board of over 2,000 actual horse-power, and had attained a speed of 34 knots, or 39 miles per hour, a speed that was greater than that attained by any ship afloat irrespective of size; and destroyers of about 200 tons displacement which were now being built were confidently expected to attain a speed of 35, or possibly 40 knots. There was no difficulty in designing ships of large size to run at 50 knots so long as their coal supply lasted, and in a few years such boats would probably be used for cross-channel services. For longer passages, such as the Atlantic, there was greater difficulty, but it was confidently expected that soon the passage to New York would be reduced to three days, and that the day was not far distant when it would be possible to leave Newcastle on the Saturday and be back from New York in time for the following Sunday week's dinner.

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NOTES ON THE DISTRIBUTION OF ALTERNATING CURRENTS.

BY SIDNEY E. T. EWING.

(*Concluded from page 818.*)

The equipment of a sub-station should be as complete as due regard to cost will allow. The value of disconnection and fusing points which can be readily made use of in all weathers is very great, and wherever a main approaches closely to a sub-station it should be taken in and out again through a pair of fuses or connectors. Of course, in really large sub-stations attendants are always present for the purpose of switching transformers in or out as the load varies, and in such cases there is a complete equipment of switches and fuses, ammeters and voltmeters, and arrangements for cross-connecting the various mains; but there are not many cases, apart from the large alternating supply undertakings in London, where the constant presence of an attendant is justified by the saving in magnetising losses. In the smaller class of sub-station usual in provincial towns, the only real indispensables are primary and secondary fuses to each transformer, and a maximum-demand meter on the low-tension 'bus bar. Probably the safest form of high-tension fuse for use in sub-station work is that consisting of an earthenware tube made in one with a stout handle. The fuse wire passes through the tube from terminal of the handle piece to the other, and contact with the base-piece is made by spring clips. These fuses can be used as switches with perfect safety, provided rubber gloves are used as a protection against possible surface moisture, and can be relied on to break the circuit without arcing under all circumstances. In the arrangement of the equipment all high-tension work should be separated from the low-tension, preferably on different walls, the high-tension being on the wall farthest from the manhole and railed off. No one except the distributing engineer and the foreman on mains should be allowed to go inside this railing, save when working under direct supervision, under penalty of dismissal. All connections should be simple enough to be followed at a glance, and all high-tension should be painted a distinctive colour, red being the best.

It is often the case that when a system of mains and sub-stations is put down the arrangement of the sub-stations receives very little attention from the contractors, being left to the discretion of the engineer in charge of the main-laying, who has probably no experience of the actual needs of distribution work, and mistakes are made which it is difficult or impossible to rectify afterwards. The writer has seen several, which from being too small in the first instance and badly arranged have become crowded, complicated, and altogether places to be avoided. On the other hand, when they have been designed and carried out by the men who have to use them, or, at any rate, by people having experience in that particular class of work, their value is very great. Probably no part of the distribution equipment repays so well any extra care bestowed on their design in the first instance.

Very many automatic contrivances for switching transformers in or out as the load on the sub-station varies have been tried, and still more have been patented and never used. The difficulty of getting a small increase of current to operate a number of switches, requiring a considerable amount of force to open and close them efficiently, is very great, and supposing this to be successfully done, there is the well-founded prejudice of station engineers against leaving so critical a matter in the hands of automatic mechanism to be overcome. The only piece of apparatus of this kind that is working successfully, as far as the writer knows, is a switch which cuts the transformers in when required, but has to be operated by hand to cut them out again. This, however, fulfils the main desideratum, for the load may come on at any time during the day, but can be relied upon to fall off at a certain time in the evening, so that the attendant can time his visit accordingly. An automatic cut-in of this kind should be of great service in sub-stations not quite important enough to justify the cost of an attendant all day. Although in the majority of towns with an alternating supply outside the Metropolis no expense of this kind is repaid by the saving in magnetising losses, yet it is nearly always possible in the central districts, where the load consists mainly of shop and office lights, to cut out a considerable number of transformers in the summer. A transformer which is not alive may be left in a warm, dry sub-station where other transformers keep up the temperature of the air, but it is never advisable to cut out of circuit and leave for more than a day or two a single transformer in a cellar or chamber. If so left, it is very likely to break down the next time the current is put on.

In deciding the positions and distances apart of proposed sub-stations in a hitherto unsupplied area, the chief guides are the secondary supply voltage and the probable lamp density. As a first approximation, with, say, three-wire distribution at 200 volts between the outers, a distance of 400 yards aparts might be fixed upon, this distance to be diminished to 300 yards in districts where the lamp density is likely to be high, and increased to 800 or 1,000 in more sparsely-lighted residential districts. Then an inspection of the streets will enable the most favourable points to be fixed on. A corner where a number of mains must cross will serve to locate the first position. Wherever possible, it is a good plan to arrange that the manhole will come just out of the main thoroughfare in a side street. Manholes at a crowded corner which are frequently being opened are a great annoyance to the public, and anything but a judicious advertisement of the supply.

Distribution Mains.—This brings us to the next stage in the supply system—viz, the low-tension distribution mains. At the present time the most popular cable for this work is undoubtedly the armoured concentric, and, considering the very large amount of this type now successfully in use, it would appear to be the best all-round cable to be obtained. Probably the worst point about the use of concentric cable for distributors is that every service connection necessitates cutting the outer conductor, and though this need not interrupt the supply if the main be fed from both ends, yet when a number of connections have been made, the resistance of the outer conductor depends upon a number of clamped and soldered connections. The connection boxes always have ample contact surfaces, and no difficulty is likely to occur with moderate currents, but in a large main carrying several hundred amperes there is a certain risk. When armoured distributors are used they are generally buried in the roadway, to save the cost of making good the pavements. Hence a fault on these cables, with their numerous inaccessible service joints, the exact position of which cannot be located within 2ft. or 3ft., is often a most lengthy and troublesome business. For this reason, the use of an unarmoured cable, laid in a conduit under the pavement, offers great advantages. When a connection is to be made, the conduit is cut and the joint-box put in. Then a small brick box with an inspection cover is built round it. This adds decidedly to the cost of the service, but renders the subsequent maintenance a very much easier matter, for the main can be rapidly tested in sections between the service boxes, and a faulty length drawn out and replaced. On the other hand, for the actual service main — that is, from the street main to the house fuse—an armoured cable is better than a lead-covered concentric or rubber cables in a pipe. The conduits in the street may become at times charged with water, lighting gas and sewer gas, or pungent smoke from a burn-out on the cables (the latter will travel a surprising distance along the pipes); and to lead a pipe from these conduits directly into a shop or cellar is to expose the premises to these nuisances at some future time. The armoured cable obviates this, at the same time costing less than cables in a pipe. Frequently, too, it is difficult to get a straight run into premises from the street box, and the cable, being flexible, requires less labour for trenching and fixing.

In laying distributing cables at the commencement of an undertaking or in new areas, it is a matter of great difficulty to arrive at all closely to the probable demand at a future date. Large customers for motive power are apt to spring up in unexpected quarters, properties undergo improvement, with the usual result of largely increased demand, and sometimes an apparently promising street quite fails to come up to expectations. To lay a new and heavier dis-

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tributor alongside an older one is a very expensive proceeding, unless copper strip is used, and to feed the distributor at more points is very likely inconvenient. Therefore, in districts of probable high lamp density, it is certainly well to put in ample section in the first place. A little too much copper in one street is better than low voltage in another. In residential districts, however, where lighting is sure to be sparse for some time, and the distances considerable, it is often more economical to use double rubber cables, and to exercise far less generosity in section, for if a main gets loaded up it is not a difficult matter to draw it out and replace it with a heavier one. The old cable is sure to come in useful for short connections to house meters, transformers, and so on. In residential districts one customer for every 50 yards of main might easily be the maximum possible number, whereas in business areas five in the same distance, each with the same demand as the private house, might be a moderate estimate of the probable future demand.

Opinions are greatly divided as to whether the whole area of low-tension supply should be connected up to form one network, whether there should be two or three separate networks, or whether each sub-station should feed its own radial system. If the whole system forms one network the voltage over the whole becomes more uniform. If a fault occurs, the whole system combines to burn it out, but at the expense of disturbance over the whole system. In any case, the following precautions are advisable, and are generally adopted to secure continuity of supply in the event of breakdown. All transformers should be connected up with their similar terminals to the inner and outer mains respectively, so that they may run in parallel with the rest of the system when occasion requires. At a number of points where mains intersect there should be network boxes for two, three, or four ways, as the case may be. All makers of cables supply suitable boxes, which enable connection and disconnection to be rapidly made. As far as possible, every street should be fed from both ends, or be capable of being so fed from network boxes. If this principle can be thoroughly carried out, it would certainly appear the best plan to split up the area into small networks, so that two or three sub-stations only supply each network. The effects of a heavy short are thus restricted, and if the repair necessitates the disconnection of a main from the parent network, the adjacent network can be connected on to the end farthest away and feed right up to the fault, as soon as that has been located and cut out.

If transformers which differ considerably in design or which have slightly different secondary voltages are used, there will be a certain amount of waste current circulating between them, and they will take up the external load very unequally. Further, the impressed high-tension voltage may be sensibly different at different sub-stations at the time of heavy load, producing the effect of different secondary voltages on otherwise exactly similar transformers. Thus, the share of load which a transformer or bank of transformers will take cannot be confidently predicted, and the maximum-demand meter is of great value in giving warning of any serious inequality or overloading.

No system of mains is free from the possibility of faults, and in spite of the great all-round excellence of modern cables, most distribution engineers find a good deal of their time is taken up in locating and repairing incipient or actual "earths" or short-circuits. A great deal has been written about ingenious methods of locating faults, based on the common practice of telegraph engineers, but these methods are very little used, simply because they require delicate instruments and a good deal more time and care than the results justify. If the network is well provided with disconnecting points, either in sub-stations or boxes, a Silvertown or other simple testing set and a keen scent are the most useful aids when cables in conduits are used. If plenty of power is available before the fuses blow, the results of a burn-out can generally be smelt for 50 yards along a conduit. In the case of a long high-tension feeder, the matter is different. These can be isolated at both ends, and the standard station instruments used to make a careful loop test.

INSTITUTION OF ELECTRICAL ENGINEERS.

Improvements in Magnetic Space Telegraphy.

BY DR. OLIVER LODGE, F.R.S., MEMBER.

PART I.

(Concluded from page 778.)

INDUCTION V. CONDUCTION.

As to the question between space induction and earth conduction, and the relative part each plays in any given case, it is a question which can be answered either by experiment or by calculation. In some cases experiment would be absurd, as, for instance, when either sending or receiving circuit is not earthed anywhere. In other cases, as at Lavernock, it can be answered either way. Now, Mr. Gavey tells me that he has tried an experiment on this very point by taking an insulated wire outstretched between two boats and "earthed" in the sea at either end. Signals being sent from the land, they could be heard out at sea to a certain distance when the wire was above water, but when it was immersed they disappeared at a smaller distance. The argument, of course, is that regarded as the tapping electrodes of a conductive receiver the ends of the wire acted similarly both times, but regarded as an inductive receiver responding to magnetic influences the submerged wire was protected, because, let us say, the direct and return portions of the circuit, when the wire was immersed in the sea, were more or less coincident, and the moral is that induction contributed the greater part of the effect. It is not quite conclusive, however, because induction and conduction may aid each other anyhow, and when either is stopped the residual disturbance may be too faint to hear. A trial with a continuous current might, I think, conclusively measure the part due to conduction. So far as I know, no attempt has been made to dispense with earth conduction altogether by the use of a return wire along the beach; but calculation shows sufficiently that if this were done, signalling would practically cease. It is a mistake to suppose that the negative result with the submerged wire depends on the reflexion of electromagnetic waves at the surface of water, because true electromagnetic waves have in this installation nothing to do with the case. The water may, and does to some extent, act as a conducting screen, but it is sufficient to consider the immersion of the wire as resulting in simply closing up the receiving circuit until it is a long thin rectangle of inappreciable area, so that the direct and return circuits almost coincide. The experiment proves distinctly that induction has something to do with the result, and that it is not wholly due to earth tapping. Let us see if calculation bears this out.

Without presuming to quote exact details of an installation on which I am not authorised to report, I state only the facts obvious to inspection of the stations by boat. The distance between the earth-plates, or length of the base line, I take to be: at Lavernock, one mile; at Flat Holm, one-third of a mile. The average elevation of the line wire I take as 120ft. above the sea in each case; the elevated lengths as 1,200 and 460 yards respectively; and the distance between the stations as 3½ miles. It may be noticed that in any case, even in this case where the line is straight, the bulk of the impedance is of the "reactance" kind, when a thick wire and high frequency are employed.* For, whereas the resistance might be something between one and two ohms, the value of p L is something more like 10 ohms if a note of 400 per second is employed; and in such a case the induced current is almost independent of the frequenccy, because $\frac{p\,M\,C}{p\,L}$ = constant as regards

* I emphasise this because it has been doubted by the Post Office. A method for calculating the self-induction of a straight wire of length l and sectional radius c is given by Lodge and Howard in the *Phil. Mag.*, July, 1889, p. 64, and results in $L = 2\,l \log\left(\frac{4\,l}{c} - \frac{3}{4}\right)$. Apply this to the Lavernock line wire: say l = one mile, c = ¼in., we get L = four millihenries; so for a note of 400 per second p L = 10 ohms, and this is the practical impedance of the straight wire, its resistance being much smaller. It is a great mistake to suppose that in straight wires the self-induction is negligible.

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frequency. Hence, with a stronger primary current and lower frequency—say 20 amperes alternating 20 times a second—the effect received would be decidedly stronger; whereas, if *resistance* had been the dominant feature, the effect of the stronger slower current would have been just the same as that of the smaller quicker one. It is chiefly for response at low frequency, I take it, that such thick copper wires have had to be employed, for at low frequency resistance does become the dominant feature.

Now, treating the sea first as if it were a superficial return circuit, or, rather, treating the case of a return wire along the beach, vertically below the line wire, the mutual induction coefficient between two facing circuits of areas $40 \times 1{,}200$ square yards and 40×460 square yards respectively, at a distance of $3\frac{1}{2}$ miles, is

$$M = \frac{2 \times 4{,}800 \times 18{,}400}{(6{,}160)^3} \text{ yards},$$

or, say, 0·008 yard, or 0·73 cm. Accordingly, when a current of frequency 400 and one ampere mean strength is sent round either circuit, an E.M.F. is induced in the other of average value,

250 M C.G.S., or 1·8 micro-volts.

And I doubt if this could produce any appreciable effect, unless, indeed, the whole of the receiving circuit were attuned and arranged in the way to be presently described. But a return circuit along the beach is not employed, and would evidently be very ineffective if it were. A return by the sea gives a more open area, and therefore an inductive advantage, in addition to any conductive contribution which it may furnish.

The other extreme case, decidedly more unfair in the opposite direction—so extreme that it is hardly worth consideration except as a warning not to reckon the mutual induction in this way—would be to treat the line wires as if isolated in space—bits of infinite parallel wires—the return current being at infinity. Taking this case for a moment, the mutual induction would be

$$M = \frac{1{,}200 \times 460}{6{,}120} \text{ yards},$$

or about 80m., which must be far beyond the truth.

The actual return circuit depends on the distribution of conductivity in the earth, and is therefore indefinite. The fact that the resistance of the circuit varies with the height of the tide shows that the *sea* conveys most of the current.

Earth Conduction.

Now, calculating what share earth conduction ought to contribute in the matter, we may either treat the shallow sea as a conducting sheet fairly insulated in its bed, or we may postulate equal conductivity through the whole earth; the latter being certainly further from the truth than the former. Considering the electrodes as approximating in area to spheres of radius c, at a distance of $2a$ apart, the applied difference of potential between them is

$$V = \frac{Q}{\pi k \delta} \log \frac{2a}{c};^*$$

k being the conductivity, and δ the depth of the sea, supposed uniform and small, and Q being the quantity of electricity supplied per second. The potential at any point distance r from one electrode and r' from the other is

$$U = \frac{Q}{2\pi k \delta} \log \frac{r'}{r};$$

so between two fairly neighbouring points situated symmetrically on either side of a point at a considerable distance r from either electrode,

$$dU = \frac{Q}{\pi k \delta} \cdot \frac{dr}{r}.$$

The distance between these tapping points being $2b$, we have

$$\frac{dr}{b} = \frac{a}{r};$$

therefore the ratio of the tapped voltage to the total applied voltage is

$$\frac{dU}{V} = \frac{\frac{ab}{r^2}}{\log \frac{2a}{c}}.$$

Now, taking c as a metre, $2a$ as a mile, $2b$ as $\frac{1}{3}$ mile, and r as $3\frac{1}{2}$ miles, we find that the tapped E.M.F. is a certain fraction of the difference of potential on the primary electrodes; the fraction being

$$\frac{1}{3 \times (3\frac{1}{2})^2 \over \log 1{,}500} = \frac{1}{37 \times 2.3 \times 3.18} = \frac{1}{270};$$

which represents a very considerable voltage. But this is the most favourable case, with the current limited to a sheet of sea only a few metres thick. An uncertain amount of current would be certainly lost by real earth conduction, and the other extreme case would be to take the whole earth as of uniform conductivity with sea-water. This would give us very much too low a result, as the hypothesis of sea conduction alone has given us one too high. Considering the whole earth as conveying the current, half the tapped E.M.F. is

$$U = A\left(\frac{1}{r} - \frac{1}{r'}\right) = A\,\frac{dr}{r^2} = \frac{ab}{r^3},$$

while the applied E.M.F. is

$$V = 2A\left(\frac{1}{c} - \frac{1}{2a}\right) = \frac{2A}{c} \text{ approximately};$$

so the fraction $\frac{dU}{V}$ in this case is $\frac{abc}{r^3}$, a fraction so small as to give an imperceptible result.

Part II.

Preliminary Experiments.

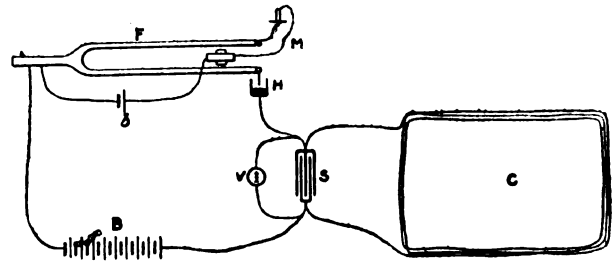
I will relate briefly a selection from some of the early experiments made on simple wire circuits, at first often without condensers, in order to find what sort of value of mutual induction coefficient (M) was sufficient to give audible signals between a couple of coils of wire lying horizontally in the same plane.

1. Two coils of thin wire, each of 350 turns, and 30cm. (1ft.) diameter, with five amperes maintained in one at a frequency of about 100 by an alternating dynamo; a telephone connected to the other coil responded audibly when it was at 6m. distance. The M in this case is 287 C.G.S., which is large, but no capacity was used to assist.

2. Two coils of No. 15 wire, each of eight turns, on a hoop 92cm. (one yard) in diameter, and with 11 amperes maintained in one at a frequency of 120 by means of a make-and-break tuning-fork; a telephone in the other responded at $3\frac{1}{2}$m. In this case the M = 67 C.G.S.

3. A pair of coils in separate buildings 100m. distant, each with a condenser, the transmitter being 60 turns of No. 18 wire round a small room nearly 4m. square, the receiver being one of the above hoops a yard across wound with eight turns of wire; the hum could be just heard. The M in this case is only 0·6 C.G.S., which is good.

4. The next experiment is worth quoting in fuller detail. It was made in 1897, a month or so later than the above called (1), when things had improved. Below is a diagram



of the connection at the sending end, the dynamo being replaced by a tuning-fork intermitter (all kind of intermitters have been used in different experiments).

* See, for instance, Foster and Lodge, *Phil. Mag.*, June, 1875, p. 453.

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F is the Koenig fork on its massive stand, vibrating 111 complete swings a second.

b is a single storage cell, and M is the magnet and vibrating solid contact to maintain the fork's motion.

H is the mercury-cup contact for the main current.

B is a battery of 16 storage cells.

S is a condenser of variable capacity, and C the coil of 60 turns approximately 4m. square.

V is a voltmeter to indicate the potential difference at the termials of the condenser.

The self-induction of the coil being calculated roughly as 0·06 henry, the appropriate capacity for tuning, to the fundamental and different harmonies, would be:

For the note	111	per second, S should be about			35	mfd.
,,	,, 222	,,	,,	,,	8·6	,,
,,	,, 333	,,	,,	,,		,,
,,	,, 444	,,	,,	,,	2·2	,,

Practically it was found that 2·0 microfarads gave excellent tuning, sending up the voltmeter to 98 volts, though the applied E.M.F. was only 32 volts. And under these conditions the note of 440 could be distinctly heard in the small coil in the distant tower; and by introducing a key into the sending circuit, without interfering with the continual vibration of the fork, messages could be sent and read with ease. The receiving circuit was about 100m. distant, high up in the college clock tower across the quadrangle, as in the last experiment, but the small hoop coil was replaced by a square coil of 22 turns of No. 18 wire about 3·8m. square, whose L was therefore 0·008 secohm. A capacity of 16 microfarads was needed to attune the circuit to the note listened for.

5. Instead of any maintained alternator or intermitter of any kind, the make-and-break, or the reversals, of a signalling key were sometimes used alone to do the whole thing, and when a battery such as 144 very small Planté cells was employed, the induction ticks heard in the secondary at each charge and discharge of the primary condenser sufficed to give clear signals at a moderate distance on the "sounder" plan, the beginning and end of each long and short signal being marked.

6. Another method is to have a much better insulated wire for the primary coil, and to discharge round it a Leyden jar with a short spark-gap excited by a Ruhmkorff coil, the spark being made whistling by a moderate glass-plate condenser (see "Modern Views of Electricity," Lecture III., p. 435, second edition), the shrill momentary sounds can be heard in a suitable distant telephone and coil.

7. A pair of coils nearly two miles distant were now arranged, the transmitter being a rough square 100 yards across, with five turns of four No. 16 wires in parallel, and the receiver being a long rectangular of the same periphery, about 30 yards wide, consisting of 19 turns of No. 18 wire. A dynamo with a multiple armature was employed, which was coupled up so as to give a nominal voltage of 175 volts (240 as measured). Nothing could be heard at the distant station without condensers, although the M = 10 C.G.S. This was expected, because of the high impedance and resistance. But when condensers were added at both ends and adjusted for resonance to the first harmonic—about 200 per second—the tone became faintly audible. The transmitting condenser was 10 microfarads—viz., four five-microfarad condensers, two in parallel and two in series—which, by resonance, ran the effective voltage up to 1,100 volts; and the receiving condenser was two microfarads, shunted by an ordinary 70-ohm Bell telephone.

The self-induction of the sending cable was in this case 0·02 secohm, to which has to be added 0·04 secohm for the dynamo; while the resistances were four ohms for cable and one ohm for dynamo. So the reactance part of the impedance for the octave frequency was nearly 80 ohms, and the current therefore only about three amperes without sending condenser. A condenser magnified it four or five fold. The sending condenser can always be replaced by a dynamo of higher voltage; but, on the other hand, given any dynamo, a sending condenser will increase its powers, except on circuits whose resistance, and therefore damping, is excessive.

The self-induction of the receiving cable, as connected, was $\frac{1}{3}$ secohm approximately, and its resistance was 133 ohms. Even here, therefore, the impedance was more due to self-induction than to resistance, the value of p L being 410 ohms, and so the condenser was a great advantage. In fact, without it nothing could be heard, with the given amount of power expended.

It may be serviceable here to show how quickly to calculate the frequency for any given self-induction and capacity. Let L be expressed in secohms or henries; let S be expressed in microfarads; then the resonance frequency of the circuit is

$$\frac{160}{\sqrt{(\mathrm{L\,S})}}.$$

So in the above case the syntonised sending frequency comes out,

$$\frac{160}{\sqrt{(0{\cdot}06\times 10)}} = 208 \text{ per second};$$

the syntonised receiving frequency,

$$\frac{160}{\sqrt{(0{\cdot}32\times 2)}} = 200;$$

and the fundamental note of the dynamo oscillated about 100.

The damping term of these particular cables, viz., $\frac{\mathrm{R}}{\mathrm{L}}$ is, however, certainly too high, and the wire used for such large circuits ought certainly to be thicker than No. 18 or 16. Coupling up the strands of wire in a telephone cable in different ways does not affect the damping constant, for the R and L vary similarly, but the power of coupling them up differently is often convenient in enabling tuning to be got with a moderate condenser capacity, and, in general, in giving an adjustment for different notes. Otherwise greater number of turns has just the same effect as thicker wire; it is simply *mass of copper* which is required to increase the power of a circuit to send or receive over big distances, and telegraphy over any distance by this method becomes, therefore, chiefly a matter of cost.

It may be well here to give the elementary theory of induction between a pair of circuits, each with condensers, especially for the case where the circuits are syntonised to the applied frequency. Consider a circuit with self-induction and resistance and capacity driven by an alternator of E.M.F. = E cos $p\,t$: the primary current in it is

$$\mathrm{C} = \frac{\mathrm{E}\cos(p\,t-\alpha)}{\sqrt{\left\{\mathrm{R}^2+p^2\left(\mathrm{L}-\frac{1}{p^2\,\mathrm{S}}\right)\right\}}}$$

where the lag α is given by

$$\mathrm{R}\tan\alpha = p\left(\mathrm{L}-\frac{1}{p^2\,\mathrm{S}}\right).$$

If there is exact tuning (p^2 S L = 1) the lag vanishes, and the current becomes

$$\mathrm{C} = \frac{\mathrm{E}\cos p\,t}{\mathrm{R}},$$

its maximum value. On a distant circuit with mutual coefficient, M, the induced E.M.F. is M $\dot{\mathrm{C}}$, or, in the above case,

$$\mathrm{M}\,p\,\frac{\mathrm{E}}{\mathrm{R}}\sin p\,t;$$

so the induced current there is

$$x = \frac{\mathrm{M}\,p\,\frac{\mathrm{E}}{\mathrm{R}}\sin(p\,t-\epsilon)}{\sqrt{\left\{\mathrm{R}'^2+p^2\left(\mathrm{L}'-\frac{1}{p^2\,\mathrm{S}'}\right)\right\}}};$$

which, if again there be tuning (p^2 S′ L′ = 1), becomes

$$x = \frac{\mathrm{M}\,p\,\mathrm{E}\sin p\,t}{\mathrm{R}\,\mathrm{R}'} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Let a cable contain N = $n\,m$ turns of wire, of resistance ρ_1 per unit length, coupled n in series and m in parallel, and be laid round a circuit of radius a: then

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$$x = \frac{n\,n\,\pi^2\,\frac{a^2\,b^2}{r^3}}{\frac{n\,n}{m\,m}\,2\,\pi\,a\,2\,\pi\,b\,\rho_1\,\rho_1'}\,p\,\mathrm{E}\sin p\,t$$

$$= \frac{m\,m}{4}\cdot\frac{p}{\rho_1'}\cdot\frac{a\,b}{r^2}\cdot\frac{\mathrm{E}}{\rho_1\,r}\sin p\,t$$

$$= \frac{a\,b}{4\,r^2}\cdot\frac{p}{\mathrm{R}_1'}\cdot\frac{\mathrm{E}\sin p\,t}{r\,\mathrm{R}_1} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where R_1 is the resistance of unit length of the cable itself as connected. Here the last factor in (4) is the maximum strength of current which the dynamo could send direct to the distant station if its cable were long enough to reach all the way, and if it were opened out as connected and laid straight, all the parallel turns parallel and all the series turns end to end; and with all the remaining self-induction impedance abolished by a suitable very large condenser. The actual current received inductively is, therefore, a definite fraction of this direct line current: the fraction depending on the linear dimensions of each circuit compared with the distance, and on the frequency, and on the effective thickness of the receiving cable.

Suppose we tried to signal a distance of 12,000 km. (across the earth) with a pair of No. 0 equal cables, each once round an area comparable to England, say a circle 200 km. in diameter, using a frequency of 1,000 and an applied voltage of 200. Ignoring all hysteresis and other losses (which in condensers are often important), and ignoring also the conductivity of the earth, which may be very troublesome—

$$\frac{\mathrm{E}}{\mathrm{R}_1\,r} = \frac{200}{0{\cdot}322\times12{,}000} = \frac{1}{20}\text{ ampere};$$

$$\frac{p}{\mathrm{R}_1} = \frac{1{,}000\times2\,\pi}{3{,}220} = \frac{2\,\pi}{3};$$

$$\frac{a\,b}{4\,r^2} = \frac{100\times100}{4\times(12{,}000)^2}.$$

These are the three factors; so the induced telephone current is about two micro-amperes, which is within the limit of audition. The self-induction of such a cable would be between two and three secohms, its resistance about 200 ohms, and the capacity needed only about $\frac{1}{100}$ microfarad. This arithmetic is a mere illustration of what would happen if everything were favourable.

Consider, further, the arrangement of coils adapted to really distant syntonic magnetic space telegraphy with very precise tuning. The mutual induction coefficient depends upon $n\,n'\,a^2\,b^2/r^3$; or for similar equal coils, each of periphery l and n turns,

$\mathrm{M}\,r^3$ = the effect of the coil at a given distance $= n^2\,l^4$.

The amplitude of disturbance maintained by an alternator of frequency p and voltage E_0 in a circuit whose natural frequency, $p_0 = \frac{1}{\sqrt{(\mathrm{S\,L})}}$, may be written,

$$\frac{\mathrm{E}_0/\mathrm{R}}{\sqrt{\left\{1+\frac{\mathrm{L}}{\mathrm{S\,R}^2}\left(\frac{p}{p_0}-\frac{p_0}{p}\right)^2\right\}}},$$

which in case of exact resonance becomes E_0/R. Hence, to make resonance *sharp*, the coefficient $\frac{\mathrm{L}}{\mathrm{S\,R}^2}$ must be great. If this condition is not satisfied there will be a considerable range of resonance within which some exaltation of voltage is felt, but no decided peak; whereas, if $\mathrm{L/S\,R}^2$ is great compared with the period of one oscillation, then except at a particular frequency the circuit is nearly inactive, but as the correct frequency is approached the activity of the circuit suddenly runs up to a high steep maximum, and condensers are liable to be burst by the immense and rapid magnification of voltage.

Take the case of approximate resonance, so that $p^2\,\mathrm{S\,L}=1$ nearly, and introduce this value of S: then the coefficient which has to be big is $\frac{p^2\,\mathrm{L}^2}{\mathrm{R}^2}$; *i.e.*, for a given frequency simply the damping constant or logarithmic decrement, R/L, must be small, or the current-decay time constant, L/R, big, compared with the frequency time constant. Now

$$\frac{\mathrm{L}}{\mathrm{R}} = \frac{n^2\,l\left(\log\frac{3\,l}{c}-2\right)}{\frac{n\,l}{c^2}} = n\,c^2 \text{ approximately,}$$

where c is the thickness of the wire, which does not enter much into the numerator.

So the two things which we want big are $n^2\,l^4$ and $n\,c^2$; wherefore, in case of magnification of circuit for bigger distances, the thickness of the wire should be magnified as well as its length. Of course, for really high frequencies it is no use having a thick wire *solid*. It must either be ribbon-shaped, or be stranded, with the strands roughly insulated, even if they are not going to be used otherwise than in parallel.

Magnification Ratio.

The amount of magnification of voltage caused by resonance is to be calculated thus: The impressed E.M.F., or the E.M.F. of the sending dynamo, being E_0, the effective potential difference between the condenser terminals is such that, when there is syntony and when the damping is small,

$$\frac{\mathrm{V}}{p\,\mathrm{L}} = \frac{\mathrm{E}_0}{\mathrm{R}};$$

in other words, the magnification ratio is

$$\frac{\mathrm{V}}{\mathrm{E}_0} = \frac{p\,\mathrm{L}}{\mathrm{R}} = \tan\alpha,$$

and approaches infinity as the lag of current behind E.M.F. approaches $\frac{1}{2}\pi$.

The primary current without a condenser would be $\frac{\mathrm{E}_0}{\sqrt{(\mathrm{R}^2+p^2\,\mathrm{L})^2}}$, but with the syntonising condenser it is $\frac{\mathrm{E}_0\tan\alpha}{\sqrt{(\mathrm{R}^2+p^2\,\mathrm{L}^2)}}$, or, approximately, $\frac{\mathrm{E}_0}{\mathrm{R}}$.

But it is to be remembered that all hysteresis losses—whether they be due to an iron core in the coil, however subdivided, or by reason of a stratified or other imperfect dielectric in the condenser, and also all eddy-current losses by reason of induction in neighbouring conductors, whether insufficiently subdivided iron or earth or sea, all go to increase resistance—*i.e.*, to increase damping—and thereby to diminish the magnification ratio. If the R be measured in the usual way, by steady currents, it is liable to be supposed much smaller than it really is—*i.e.*, smaller than the really effective R for alternating currents—especially for high frequency. Part of the art of magnetic space telegraphy will consist in avoiding or minimising these various sources of loss, all of which show themselves as an increased resistance.

Perhaps the neatest way of proving that the magnification ratio equals $p\,\mathrm{L/R}$ is as follows: Since in free oscillations $\frac{1}{2}\,\mathrm{S\,V}^2 = \frac{1}{2}\,\mathrm{L\,C}^2$, where V and C are the potential and current-amplitudes respectively, and where $p^2\,\mathrm{L\,S}=1$, we get

$$\mathrm{C} = \mathrm{V}\sqrt{\frac{\mathrm{S}}{\mathrm{L}}} = \frac{\mathrm{V}}{p\,\mathrm{L}} = \frac{\mathrm{E}_0}{\sqrt{(\mathrm{R}^2+p^2\,\mathrm{L}^2)}};$$

so the magnified or syntonic voltage, when the damping is small, is

$$\mathrm{V} = \frac{p\,\mathrm{L}}{\mathrm{R}}\,\mathrm{E}_0.$$

To maintain these oscillations is the function of the dynamo, and for this purpose it has only to supply the waste power—viz., $\frac{1}{2}\,\mathrm{R\,C}^2$. Hence, in cases where R is large from any cause, considerable power is necessary, but where the R is small, including all the spurious losses which go to make up the effective R, or dissipation constant, then violent oscillations can be maintained in a circuit with very little outside power.

The whole matter is analogous to the swinging of a heavy pendulum or bell, whose motion is excited and maintained with little energy if the impulses are properly timed, but which requires more energy when swung in a viscous fluid. The time of applied impulses should be the same as

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if it were free, although the actual time of free swing is a little lengthened by the friction.

For circuits oscillating with extreme rapidity, one of the principal sources of spurious resistance, and therefore of damping, is radiation of waves, but with these leisurely circuits there is no radiation that need be taken into account in estimating the waste of power. A church bell stiffly hung would become but little easier to swing if its clapper were removed and its wave-emitting property destroyed.

Best Condition for Distant Sending.

Having realised that any distance can be reached if enough copper and enough power are employed, it remains to reckon what is the best way of arranging the copper, and how little will serve to enable a given power to signal a given distance.

When nothing else has to be considered, the condition to be satisfied for signalling to a great distance is to make the magnetic moment of either coil as great as possible: its value is $n \pi a^2 \mu C = \frac{\mu \kappa W E}{4 \pi n}$ when syntonised; so all the copper available, W, should be disposed in one large single circuit at each station.

Possibility of Using Iron.

If iron is used as the core of a sending coil, it should be minutely subdivided, and should, if possible, be hot—as near its critical point as practicable—because then both hysteresis and eddy losses are at their minimum: see a most interesting communication on the behaviour of iron at different temperatures by Mr. D. K. Morris in *Proc. Phys. Soc.* for 1896-97.

A transmitter shaped like a chimney or a lighthouse, with a long vertical thin iron strip core surrounded by many turns of wire, would be most efficient if only the damping losses could be got rid of. For the function of the sender is to produce the strongest possible alternating magnetic field at a distance, and this depends simply on magnetic moment, being $\frac{m}{r^3}$ at any distance r in an equatorial plane; and this field, though excessively and imperceptibly weak at any point, is then to be detected by the integrating power of the receiving coil over a large area.

So, in general, if a magnet of moment m oscillates $2 \pi p$ times a second, and the receiving circuit is of area A, the number of lines passing through that circuit is $A m/r^3$, and p times this is the maximum induced E.M.F. which a telephone or other instrument in the receiving circuit has to detect if it can.

Best Size and Shape of Coil for Violent Resonance.

It is of interest to find the shape of coil adapted to reduce damping due to ordinary resistance to a minimum. Let the coil be of mean radius a, of sectional radius c, and consist of n turns; then the volume of copper in it, ignoring insulation, is

$$W = \frac{\pi^2 c^2}{4 n} \times 2 \pi n a = \tfrac{1}{2} \pi^3 a c^2;$$

$$L = 4 \pi n^2 a \left(\log \frac{8 a}{c} - 1{\cdot}75 \right);$$

$$R = \frac{2 \pi n a}{\frac{\pi^2 c^2}{4 n} \kappa} = \frac{8 n^2 a}{\pi c^2 \kappa} = \frac{(2 \pi n a)^2}{\kappa W}.$$

The damping time-constant, or reciprocal of the logarithmic decrement, is

$$T = \frac{L}{R} = \tfrac{1}{2} \pi^2 \kappa c^2 \left(\log \frac{16 W}{\pi^3 c^3} - 1{\cdot}75 \right) = \frac{\kappa W}{\pi a} \left(\log \frac{8 a}{c} - 1{\cdot}75 \right).$$

So T will be a maximum, and the damping a minimum, for

$$\frac{d T}{d c} = 2 c \left(\log \frac{16 W}{\pi^3 c^3} - 1{\cdot}75 \right) - 3 c - 0;$$

or

$$\log \frac{8 a}{c} = 1{\cdot}75 + 1{\cdot}5 = 3{\cdot}25;$$

or

$$\frac{a}{c} = 3{\cdot}22;$$

which is, therefore, the condition for maximum T with a given W—*i.e.*, the condition for least damping, with a given bulk of copper.

This maximum $T = T_m = \frac{3}{4} \pi^2 \kappa c^2 = \frac{3 \kappa W}{2 \pi a} = \frac{3 \kappa}{5{\cdot}5} W^{\frac{2}{3}}$

(= 3·4 seconds for a ton of copper).

The E.M.F. which the condenser will have to stand is $p T E_0$.

The L appropriate to T_m is

$$L_m = 6 \pi n^2 a = 16{\cdot}5 n^2 W^{\frac{1}{3}}$$

(= 1,650 n^2 for a ton of copper).

The mean periphery of the coil is $5{\cdot}5 W^{\frac{1}{3}}$

(or 5½m. for a ton of copper).

The thickness of the coil, $2 c = \frac{4 W^{\frac{1}{3}}}{2{\cdot}345 \pi}$

(= 53cm. for a ton).

Such a thickness of coil may seem preposterous, but in certain confined spaces (*e.g.*, a lighthouse) it is advantageous so to be able to dispose the circuit, and the coil may consist of any amount of turns without detriment. What has to be scrupulously avoided in the neighbourhood of any coil is conducting material, but the reaction effect of such material falls off rapidly with distance—as the inverse sixth power (see Lodge, *Phil. Mag.*, February, 1880, p. 142)—and accordingly it is to be hoped that the general conductivity of the earth will not exert a very deleterious effect. Its effect will certainly be in the direction of increasing the resistance, and, therefore, the damping of either coil, but beside this reaction effect a true partial screening of one coil from the other is to be found.

The thickness of wire is

$$c \sqrt{\frac{\pi}{n}} = \frac{W^{\frac{1}{3}}}{2{\cdot}07 \sqrt{n}} \quad \left(= \frac{50}{\sqrt{n}} \text{ for a ton of copper} \right).$$

Thus, for instance, the coil might have 10,000 turns of wire ½cm. thick (No. 5½); the outside diameter of the coil would be 2½m., and the inside diameter 1½m. Such a coil would weigh a ton, and its resistance would be

$$R = \frac{48{,}000 n^2}{W^{\frac{1}{3}}} = 480 n^2 \text{ C.G.S.} = 48 \text{ ohms.}$$

Its self-induction would be 165 henries; its time of falling to $\frac{1}{e}$ the current, 3·4 seconds; and its magnification ratio, with a note of 400 per second, would be 8,500.

The condenser to be used with it for this note would be about $\frac{1}{1000}$ microfarad, or 9m. electrostatic capacity. It might have an air or fluid dielectric to lessen hysteresis, and must be able to stand a very high potential—for instance, nearly a million volts if the applied dynamo E.M.F. is 100 volts.

The current in the wire would be only two amperes, and the energy expended therefore insignificant—viz., about 200 watts. In such a case the signalling would be done by the agency of the mass of copper rather than by mechanical power, and the tuning would be excessively sharp. There may be a few places where it is desirable to economise power to this extent, as, for instance, when the dynamo has to be driven by hand, or where space is very cramped, as in a lighthouse; but in most cases it would be far better to expend more power and open out the coil into a circuit enclosing a large area. This could nearly always be done at *one* of the stations.

A compact coil like this is not a powerful sender or receiver, in spite of its high magnification ratio. For instance, using a pair of such coils, one as sender and one as receiver,

$$M r^3 = (\pi n a^2)^2 = \tfrac{1}{4} \kappa R W a^2 = \frac{10^{18}}{18} \text{ C.G.S.}$$

So the induced current, when properly attuned, is

$$\frac{p E M}{R^2} = 2{,}500 \cdot \frac{100}{48} \cdot \frac{10^{18}}{18 r^3 \times 48 \times 10^9} = \frac{6{\cdot}4 \times 10^9}{r^3} \text{ C.G.S.}$$

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So the distance at which this current would be a micro-ampere (10^{-7} C.G.S.), or something quite audible, would be

$$r = \sqrt[3]{64 \times 10^{15}} = 4 \text{ km. only.}$$

THROTTLING.

The thickness of wire permissible without insulated subdivision into strands is regulated by the frequency. Taking Lord Rayleigh's value of the initial throttling, $p^2 L^2 \mu^2/12 R^2$, it comes out $1{\cdot}2\ n^2 a^4 \times 10^{-5}$ C.G.S. for copper, so if the throttling is not to result in a greater increase of resistance than 1 per cent., a thickness of wire 1·08cm., or No. 5/0, may be used for a frequency of 100 per second. For 500 per second nothing thicker than 0·48cm., or No. 6, should be used without sub-division. For 1,000 per second, No. 10, or 0·34cm. thickness, is permissible. For 1,600, No. 12; and for 2,500 per second the appropriate thickness is 0·216 cm., or No. 14 S.W.G. If No. 2 wire, or 19/16, is used for 500 per second frequency, the loss due to throttling is 5 per cent. If No. 0, or 19/12 is used, the loss is 9 per cent. But if the strands are each cotton-covered before stranding, then there is practically no loss.

(To be continued.)

DISCUSSION.

At the meeting of the Institution on Dec. 22 the discussion on Prof. Lodge's paper on "Telegraphy by Induction" was continued. **Mr. Evershed** and **Mr. W. H. Preece** read communications on the subject, which we hope to give shortly.

Prof. J. A. Fleming said that he gathered from the communications which had been given them that there were two practical systems of telegraphing through space without wires. One was the closed-coil system—in this the current was kept entirely in the coil, but the signals were made by sending electric vibrations through the atmosphere; the other was the system used by Marconi, and it might be called the open-circuit system. Prof. Lodge suggested that the great feature of that system was the working by electrical jerks, which, he said, could be transmitted through the earth. He himself did not quite understand what the professor meant by that expression. He had in a rash moment promised to show some experiments that evening by means of a Branly detector and some induction circuits, but the number of other conductors in the room, including the gilt picture-frames, seriously hampered him in his experiments. His experience showed that it was not so much the length of the rods used with the instrument that made them successful, but the position in which they stood with regard to each other, as it was exceedingly important that the conductors should parallel with one another. Mr. Evershed struck a true note when he said more experiments were necessary. Experiments were the only things which would bring that kind of telegraphy to any sort of perfection. He himself had tried many experiments in the University College grounds to see how far the electric oscillations could be sent along a wire which was connected to the earth at various points. He was successful in getting signals through in every case, but trials in Regent's Park, in which part of the wire was immersed in the lake, were not successful. The reason for the non-transmission in water, he thought, was entirely due to absorption. The point as to resonance was an important one, as no good work could be obtained until the growling in the telephone was eliminated. If they allowed all the telephones to have a roaring sound the Board of Trade might step in and make them pay for the use of the ether in Liverpool, as well as other places. He hoped Prof. Lodge would not forsake his former love—the Hertzian waves—and also that experiments would continue to be conducted for the advancement of what the newspapers persistently called "wireless" telegraphy, but what was really telegraphy with the use of less wire.

Major-General Webber said there was one fact which was deserving of interest in the discussion, and that was that on March 23, 1882, Mr. Willoughby Smith had asserted in that room that signalling by induction was possible, although he made no experiments at the time.

Mr. C. S. Whitehead said that the question had been raised by Prof. Lodge as to whether certain equations given by himself were correct, as he appeared to think the frequency taken was too low for wireless telegraphy. These equations were based on those of Maxwell's, which were right in the case of light. There should, he thought, be no error on account of the frequency when applied to these vibrations. The next question was as to whether the Maxwell equations applied to induction telegraphy. Prof. J. J. Thomson in his books used them, and they were also made use of by Prof. Hertz and Mr. O. Heaviside in their books. Maxwell's equations were general equations on which to found the individual ones. If Maxwell's equations were not correct, he should be very pleased if Prof. Lodge would inform him as to which should be used.

Sir H. Mance said that throughout the discussion it seemed that the principal idea had been to obtain a practical signal. He suggested that the object in view might be obtained by altering the note. A bell in a circuit on a line with which he had had much to do used to give indications by induction signals which could not be read otherwise. By changing the note better results were obtained, he thought, than by having intermittent signals.

Mr. A. R. Sennett, referring to the remark by Mr. Evershed about lightships, said that if good communication with them by means of wireless telegraphy was a mere matter of expense, he did not think anyone in the country would begrudge the amount spent on it. He noticed in Prof. Lodge's paper the question of the sea as a return. Mr. Wimshurst had explained to him (the speaker) a method of making connection by means of a peculiar swivel fastened to the cable. That swivel consisted of an ordinary one which allowed of the usual movements. On the swivel two coils of wire were placed, one on each half, and the signals were transmitted from one to the other by means of induction. In that case the cable from the shore would terminate in the lower half of the swivel, and the electric conductor to the ship would be attached to the upper half. He was very much interested in Prof. Lodge's paper, especially as he made a statement to the effect that the sensibility of the instruments was increased 1,000 times by proper tuning. He was glad to say he had been present at the reading of Mr. Stevenson's paper. Since then he had made some experiments in transmitting mechanical vibrations through water, and he was of opinion that electricity was really not necessary for signalling to lightships. All that was necessary was to place an instrument tuned to a certain note which was transmitted to the water. The power of water for carrying vibrations was illustrated by the old experiments showing that bells could be heard for very large distances across the Lake of Geneva. As to the characteristic sound which the telephone possessed, to do away with this it was only necessary to study the human ear. There they had an oval diaphragm with a small bone placed at the back. Of this diaphragm not more than two radii are the same length, and hence it has no distinctive note of its own, thus preventing the nasal sound heard in the phonograph.

Prof. W. E. Ayrton said he had originally suggested to Mr. Whitehead that he should make the mathematical investigations which had been criticised, and he thought that members did not fully appreciate the importance of the points at issue. He would ask Dr. Lodge how much copper he had put in between the transmitter and receiver to represent the conductivity of the sea. From what he (Prof. Ayrton) remembered of the discussion on Mr. Whitehead's paper before the Physical Society, his conclusions were not traversed. The only point which Mr. O. Heaviside had found fault with was the assumed conductivity of sea-water. This figure Mr. Whitehead had verified by practical test. There were three things to consider as to absorption, and they were: the sheathing of the cable, the absorption of the sea, and the iron of the lightship. The sheathing could be put out of the question, and, as had been explained, a wooden lightship could be had. The only thing that could not be imagined was a lightship floating about without any sea under her. If Maxwell's equations were right, and the sea absorbed 75 per cent. of the force, then experiments with it were almost useless. But if these equations did not stand, then the results should be very good. Mr. Whitehead had given his calculations based on the Maxwellian equations, and until he knew definitely whether they were right or wrong he could make no use of them. He should like to ask Dr. Lodge what amount of energy must be put into his first telephone to make the other telephones give an audible sound? He understood from Mr. Evershed that one of his relays could be worked by 10^{-10} of a watt, or that one watt would work ten thousand millions of his relays.

Dr. Lodge said that Mr. Evershed had criticised his remark with regard to the amount of power used to obtain the results at Lavernock. He (Dr. Lodge) certainly had used more power on his Liverpool circuits than used by Mr. Evershed at Lavernock, but the power actually needed to give audible signals was not much. The speed of signalling with the tuning-fork arrangement might be rather slow, but the magnifying telephones gave signals as fast as the key was worked. He had recently introduced a slight modification of his magnifying telephone by placing the microphone in between the prongs of the tuning-fork. In that case one carbon was carried by each prong, and the modification prevented any mechanical vibration starting the relay. With regard to Prof. Fleming's remarks, he did not agree with what he said about the earthed wire. He sent electric jerks through gas-pipes, and was surprised to find what a distance the coherer could feel them. He wished to thank Mr. Niblett for the batteries which he had lent him to do his experiments with last time. Prof. Ayrton, quite correctly, said that one could not have a lightship except on the sea. The coil should not rest on the bottom of the sea—it should be upon the ship, and that would remove the danger of absorption. In answer to Mr. Whitehead, he did not mean to say that Maxwell's equations were wrong, but it seemed to him that those calculations were made by different people in different ways. Maxwell's equations were worked out in the first case for light, and assuming an equal opacity for electric vibrations, they would be equally correct for these. Everyone knew, however, that different substances were not equally opaque to these vibrations, and that the capacity varied with the frequency. Other workers using the Maxwell equations as a basis had attacked the same problems as Mr. Whitehead, and the difference was due to the different conditions assumed. Dr. Lodge said he had just had a letter from Prof. J. J. Thomson to the effect that a solution had been arrived at, but it was not yet reduced to arithmetical values. Prof. Lodge concluded by showing how the various terms in Maxwell's equations should be interpreted.

Before Dr. Lodge gave his reply, it was decided to adjourn the discussion till January 12, so as to allow of others taking part.

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COMPANY v. AUTHORITY.

It seems probable that the forthcoming session of Parliament will witness the solution of one of the most interesting problems that appeal to electrical engineers. The Joint Committee of both Houses last session reported somewhat favourably upon the question raised by the General Power Distributing Company's Bill, and the Bill was forwarded a part of its journey towards receiving sanction. Later the representatives of municipal bodies, after discussing the question, practically decided to oppose tooth and nail the principles embodied in the Bill. Still more recently other Bills have been deposited, for consideration during the forthcoming session, of a similar character to that of the General Power Distributing Company. These are the Lancashire Electric Power Company, the South Lancashire and Cheshire Electricity Company, the Midland Electric Corporation, and the Leicestershire and Warwickshire Electric Supply Company. In fact, there seems to be a rush to obtain powers over the most promising areas in the kingdom; and whether this is due to the instincts of company promoters who imagine they see a good thing, or to an earnest desire to really start *bona fide* works, we are unable to say, nor at the present time does it much matter. The sanctioning of these schemes by Parliament will mean the partial or complete repeal of the Electric Lighting Acts. Each of these Bills proposes huge central stations at economically convenient points, ostensibly for the supply of power over the areas throughout which they have control. This, of course, must include the supply of energy for lighting purposes. We have always contended that ultimately there would be a larger sale of electrical energy for power than for lighting purposes, and this view is beginning to be seen by the promoters of such schemes as are described in these various Bills. We think, however, that the promoters do not thoroughly understand the mechanical and electrical problems which have to be encountered. These are technical, and need not be discussed at present. The question is whether Parliament will permit competition between companies and authorities over the same area. At the present time, and generally, an authority with a provisional order is paramount within its own district, and, excepting many London districts, companies are also, but with the proviso that at the end of a certain number of years the authority in which the company works has the option of purchase. This state of things is working fairly well, though, as in all cases when a hard-and-fast line is drawn, there are cases of great hardship. But let us take an example from these proposed Bills and see where some difficulties arise. The Lancashire Electric Company is formed to supply Preston, Burnley, Bury, Bolton, Blackburn, Darwen, Oldham, Ashton, Accrington, Stalybridge, Rochdale, Wigan, Warrington, Widnes, Runcorn, Southport, Chorley, Stockport, Macclesfield, Birkenhead, and Salford. Now, many of these places are provided with central stations under the control of the various authorities, which contemplate the supply of power as well as light. True, very little

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has been done as regards the supply of power, yet there are indications all round of the intention or willingness to arrange the supply if asked for. Are competitors to be allowed to invade the areas already arranged by provisional orders with the duplication, if not multiplication, of mains, and interference with streets; for if one company, why not two, or twenty? The experience gained at at any one station will probably tend to show the necessity of modified decentralisation; in other words, that one station will not economically supply outside a fairly limited area. Again, the central station cannot more economically supply large horse-power (except under certain and rather uncommon conditions) than can many factories and works supply their own. Fundamentally, no doubt, the question of limit is solved by cost of coal at the boiler's mouth, in connection with interest upon certain parts of initial installation. We are face to face, then, with these facts: Authorities have erected central stations under provisional orders; Bills are promoted in Parliament under which companies would have powers within these areas, under the impression—rightly or wrongly—that generation and distribution from large stations in certain central points will be more economical than from the stations at present existing; the sanction of these Bills must lead to conflicting powers in the same area, and practically to the repeal of the existing Lighting Acts. Is this what the promoters are driving at, or will it be contended that both parties can work amicably together? That the Acts must be amended sooner or later is a certainty, in order to get rid of glaring hardships which now exist. The whole subject is exceedingly difficult, and had we not to consider authorities already in the field, but only cases of authorities which have not already entered upon supply and do not intend to enter, or the districts which do not warrant the authorities to act singly, but which might be supplied collectively, then we should be ready to support the action of companies desirous of supplying such districts.

COMPETITION.

Sometimes a glance at what other folks are doing does good—sometimes raises the bile. It may, we hope, do good to see how Brother Jonathan is trespassing upon our own ground. Just glance at his exports of electrical apparatus to England and its Colonies for a week. The value of such apparatus on the week ending Dec. 6, the last for which we have the figures, reached the respectable sum of over twenty-five thousand dollars, the total exports reaching nearly sixty thousand dollars, so that England and her Colonies are taking a goodly share of apparatus from America. If we were to include such places as Egypt, the position is still worse against us. There is no reciprocity in this trade. America does not absorb our goods to anything like this, and—well, and—we have nobody but ourselves to thank for this state of things. Taking the week as an average sample of the weeks in the year, it means that we take over a million dollars' worth of electrical apparatus from America out of the three million odd dollars' worth exported. Is it that we cannot make the apparatus so cheaply, or is it that a nation of shopkeepers is beaten at its own business?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CANAL HAULAGE.

SIR,—In your issue of Dec. 16 you are afraid that my vehicle for canal haulage would take almost as much power to propel itself as to pull the barge.

I beg to inform you that my vehicle not only will not, but does not take so much power as you imagine to propel itself. My system has over the Thwaite-Cowley system this special advantage, that it has been in actual operation since a year on a length of 26 km. on the Aire Canal, in the North of France, and this practical experiment has shown that the efficiency of the system was satisfactory, although the condition of the tow-path is rather bad. This tow-path is now being improved; and it is by far easier and cheaper than erecting a railway, as would be necessary in the Thwaite-Cowley system.—Yours, etc., F. GALLIOT.

[We are glad to hear that Mr. Galliot's system has given such great satisfaction, and that the trial has not been a limited one, either in distance equipped or by intermittent running. Still, in spite of the capital cost, we prefer the Thwaite-Cowley system. The cost of running is the chief consideration, and in this the latter system has as much advantage over the Galliot system as a tramway has over a bad road. The improvements in the canal tow-path and the up-keep of same with the Galliot system will cost a large sum per annum if the waste of power is to be kept small, and we are sure that the introduction of iron running rails will be a better procedure on a canal with a good traffic.—ED. *E. E.*]

REVIEWS.

The Electro-Platers' Handbook: A Practical Manual for Amateurs and Young Students in Electro-Metallurgy. By G. E. BONNEY. Illustrated. Third edition. Price 3s. Whittaker and Co.

It is unnecessary for us to discuss at length the merits of a book that has entered into a third edition. It will suffice to say that the additions and corrections have brought it fairly up to date. The value of this little book is perhaps in its simplicity. The author has learned what to do and how to do it, and tells his readers what he knows in as direct a manner as possible. However, there is still one little suggestion for improvement. The book is a "practical manual," hence a few more paragraphs anent historical apparatus might well be left for the student to seek in encyclopædias—always excepting Woolrich's dynamo.

Gas and Petroleum Engines. Translated and adapted from the French of Henry de Graffigny, and edited by A. G. ELLIOTT, B.Sc. Price 2s. 6d. Whittaker and Co.

The title of this book describes it with exactitude. It is practically a collection of brief descriptions of various gas and petroleum engines. Accepted as a very popular book showing a few points of similarity or of difference in the various engines, it is good, but it cannot be taken even as an elementary treatise on the theory of these engines, or as giving any idea of construction. The theoretic part of the book is confined almost entirely to Chapter II., in which the ratio $\frac{T_2 - T_1}{T_2}$ is popularly explained. We think the editor might, if he found it necessary to give gas consumption in litres at all, also have given the consumption in cubic feet; and, again, would it not be better to leave out paragraphs like that on the "Gayon and Métais process," which concludes with

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the words, "the idea has, however, never been put into practical shape." With such minor exceptions as these, the editor has done his part of the work very well; so well, indeed, that if the reader was to skip the title page and not meet so many French measures it would be taken as an original book. However, as an easy, readable, popular, descriptive introduction to gas and petroleum engines, the book will have a use.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

(Continued from page 787.)

THE LIGHTNING PROTECTION.

The lightning protection was laid out by Mr. A. J. Wurts, who previous to this time had spent some months at Telluride, determining the requirements for protecting the 3,000-volt circuit. The protection consists of choke-coils and spark gaps of non-arcing metal, as described by Mr. Wurts in his paper before the institute, March, 1892. In each line 10 choke-coils were placed. Unit arresters, each consisting of seven non-arcing metal cylinders and having six spark-gaps, were connected as is shown in Fig. 5.

RUNNING TESTS AT TELLURIDE.

The first tests were qualitative rather than quantitative. It was uncertain what phenomena might accompany the operation of a long line at high voltage, and the pressure which could be used on the insulators was a matter to be determined. The first thing was to find what would work, measurements could be made afterwards. A high voltage was placed on the transmission line, sometimes transmitting no power and at other times operating the 100-h.p. synchronous motor. In December, 1895, the motor was operated at 25,000 to 33,000 volts for several days. In January, 1896, 45,000 volts was used continuously for over a week, and beginning with the latter part of March, a continuous run of 37 days was made at 50,000 volts. "Some very severe conditions of weather were encountered

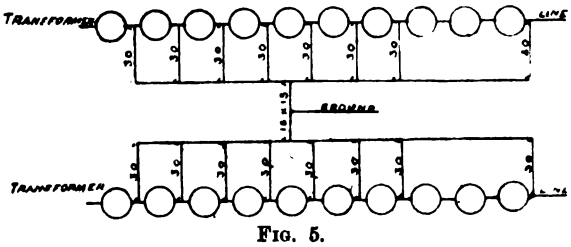

FIG. 5.

during this time, very high gales of wind prevailed, the air was filled with clouds of dust, part of the time the snow which fell was quite damp, and during the last few days of the run there was some rain. At this voltage the wires were plainly visible at night, and the characteristic hissing of high-tension currents could be heard several hundred feet. No lightning arresters had been installed up to this time, and the cause of the shut-down was damage to the raising transformer, caused by lightning. Lightning arresters were installed. The lightning season commenced about June 1. During the latter part of June lightning discharges over the arresters were very frequent. At this time we were limited to a running voltage of about 34,000 volts, as there were not enough arresters to permit of increasing the voltage. No trouble whatever was had with the lightning protection. Discharges were frequently seen crossing the arresters, and during two or three days in the early part of the season discharges occurred at intervals of a few seconds for several hours. Enough arresters were afterwards obtained to run at 45,000 volts, but the lightning discharges were much less frequent."

Some measurements upon the line were made by determining the power to the raising transformers when the lines were connected and when they were disconnected. These measurements showed that the loss due to the line is small, below 45,000 volts, but increases rapidly when about 50,000 volts is exceeded, and reached 16·4 kw. at 59,000 volts. The results up to 52,000 volts are given in Curve 2, Fig. 9. Curve 1 in this figure is the loss on the same circuit measured a year later by a different observer using a different method. At the maximum loss shown there is a difference of only 8 or 9 per cent. in E.M.F. for the same loss on the two curves.

The record of the operation of this line at 50,000 volts for over a month is of very great interest, as it is a practical demonstration of the feasibility of operating a line at 50,000 volts, a pressure four or five times as great as any which had been in general commercial use. Mr. V. G. Converse had been up to this time closely associated with this work. He had much to do with the design and construction of the high-tension transformers and insulators, tests upon losses in lines made at the Pittsburg laboratory, and the tests at Telluride.

MEASUREMENTS AT TELLURIDE.

The work at Telluride was then taken up by Mr. R. D. Mershon. The facilities for experimental work

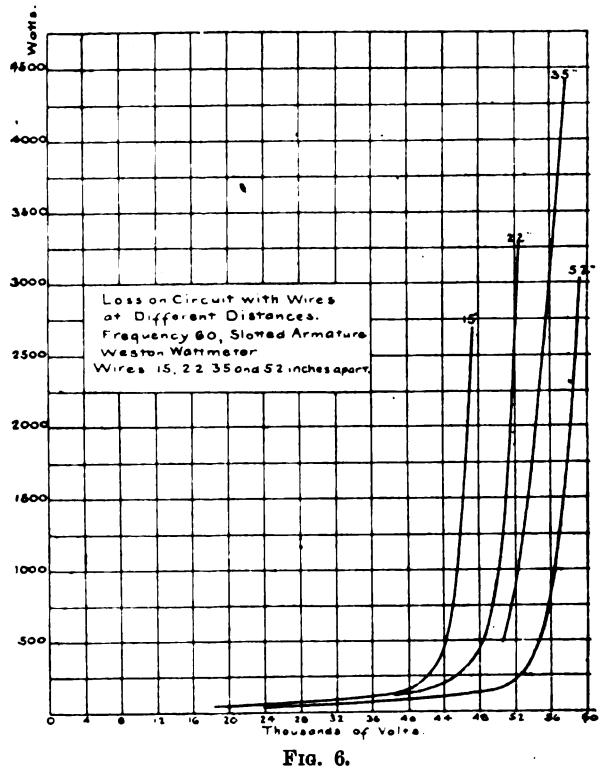

FIG. 6.

were increased and instruments were provided for carrying on the tests. Mr. Mershon found peculiar difficulties in making exact measurements of the power to the circuit. A wattmeter in the low-tension circuit of the raising transformer led to errors under the conditions which prevailed. Some very able and painstaking work was displayed in detecting the error and overcoming it with the facilities at hand—and the facilities were none too plenty in the heart of the Rocky Mountains for making measurements which would tax the resources of almost any laboratory. The apparatus used introduced a disturbing influence in the circuit, which, however, could be measured and eliminated. On the other hand, a wattmeter for measuring power on a high-tension circuit must accommodate a very high voltage and a very small current. As the charging current to an open line is usually very large in proportion to the loss current, the error of the instrument is very sensitive to slight variations of phase in the shunt current. The results of the measurements and the conclusions are given partly by extracts from Mr. Mershon's report and partly in abstract.

RESULTS OF MEASUREMENTS.

The results of measurements taken are embodied in curves. In every case the measurements were taken upon an open-circuited line—in no case upon a line which was transmitting power. The line losses obtained are therefore

* Paper read before the American Institute of Electrical Engineers.

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a combination of those occurring between the line wires and the very small C^2 R loss in the wire itself due to the charging current of the line.

Measurements taken with the Weston wattmeter include the loss in the high-tension coil of the power transformer due to the currents applied to the line. This loss is, in general, small, and in the following curves corrections have not been made for it. Curves taken with the Thomson wattmeter require no such correction.

There is additional correction which may be made in the case of those curves whose voltages were obtained from the raising transformer. This correction arises from the fact that the action of the capacity current taken by the line, in connection with the series reactance of the transformer supplying it, is such as to make the voltage impressed upon the line somewhat greater than that obtained by the ratio of the transformer winding. The measurements taken to determine the amount of the error in voltage show it to be small.

There were two generators used. One was that regularly running and supplying power to the power circuits of the Telluride Power Transmission Company. It is a 600-kw. 22 pole quarter-phase machine, delivering 500 volts at a frequency of 60, or 7,200 alternations per minute. Its armature is of the slotted type and is wound with copper bars. In the notes this generator is designated as "slotted armature."

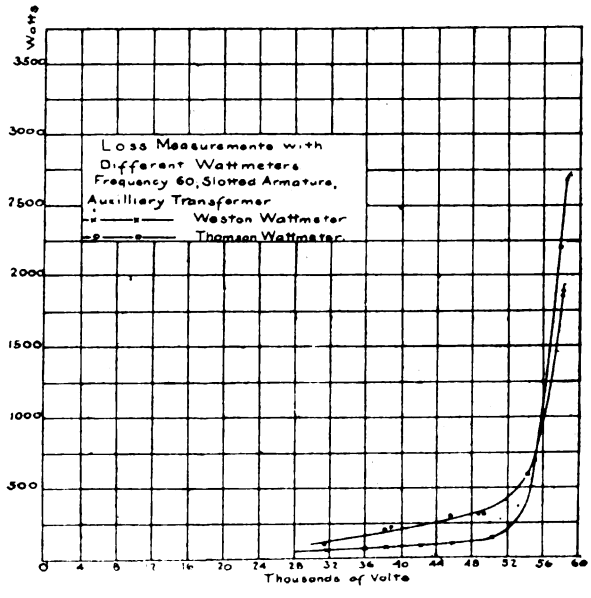

FIG. 7.

The other generator is one whose field is that of the 100-kw. toothed armature machine, originally sent out as a part of the first Gold King transmission plant. It has 12 poles, and, as originally run, operated at 3,000 volts and 10,000 alternations. There are two armatures for this machine: a surface-wound armature, designated as "smooth armature," and a toothed armature, designated as "toothed armature."

Comparison between Insulators.—A set of measurements was made for comparing the loss on the three circuits supplied respectively with large glass, small glass, and porcelain insulators. The curves are very nearly identical, and correspond very closely with the right-hand curve in Fig. 6. "There was a heavy wet snow on the ground, and the cross-arms at the generating station, and, more or less, snow all along the line, that at the further end being drier than at the generating station. There was, more or less, snow falling during the measurements, and this accounts for a wide variation of the points taken at the high voltages, as falling snow renders the wattmeter reading very unsteady, the unsteadiness being such as one might expect if from time to time there was a discharge between the wires. This unsteadiness does not seem to be as great in the case of falling rain as in the case of falling snow."

Loss and Distance between Wires.—A series of measurements was made to determine the connection between the loss and the distance between wires. "As at that time it had not been fully demonstrated that the loss was not affected by weather conditions, except there was precipitation, changes in distance between wires were made upon one circuit, while the distance between wires on another circuit was maintained always the same, and the latter was used as a reference circuit when a change in loss was ordinate."

The several curves have been plotted together, due correction being made for the slight difference in the loss in the reference circuit, which probably resulted from slight differences in the precipitation when the curves were taken. The distance between the wires in the several tests was 15in., 22in., 35in., and 52in. respectively. The results are shown in Fig. 6. It will be noted that the loss is much greater when the wires are close together, and that the curve begins to ascend at a lower voltage.

Comparison of Wattmeters.—The loss curves in Fig. 7 were taken on one of the circuits, first, with the Weston wattmeter and then with the Thomson wattmeter. The Weston wattmeter was not in circuit when the measurements with the Thomson wattmeter were taken. As an additional check, the readings were taken on each of the wattmeters of the loss occurring in the shunt resistance of the Thomson wattmeter. The results were in practical agreement with each other and with those obtained by calculation. The discrepancy in the results obtained on the two instruments when measuring line loss will be referred to later.

Loss on Insulators.—A set of comparative readings was taken on one of the circuits and on a dummy circuit,

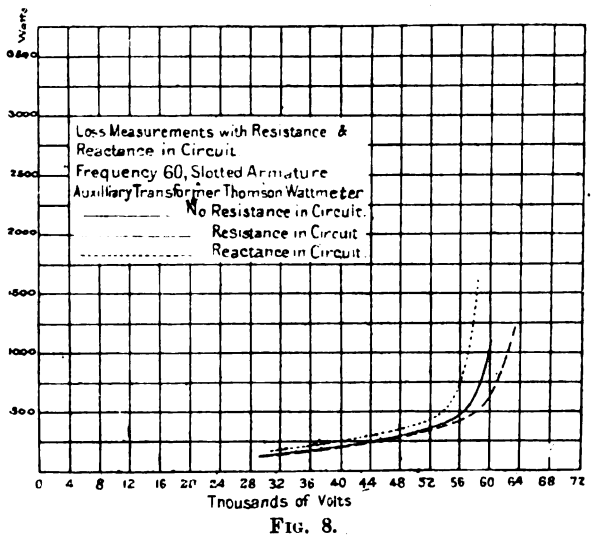

FIG. 8.

identical with the main circuit as regards kind and number of insulators and the size of wire, but only 60ft. instead of 11,720ft. in length. The results show that the loss on the two circuits is practically identical up to about 50,000 volts, which is the part of the curve below the bend. The losses agree closely with those shown in Fig. 6. At higher voltages the loss on the dummy circuit increased slightly, indicating that the loss was of the same nature as that at a lower voltage. The agreement of the loss on the two lines at low voltage—*i.e.*, below the bend in the loss curve—indicates that this loss was over the insulators. The great increase in loss on the long line at high voltage indicates that the loss was due not to the insulator but to the line.

Resistance and Reactance in the Circuit.—Measurements were made with resistance between the generator and the raising transformer, then with reactance, and then with neither resistance nor reactance. The results are shown in Fig. 8, and indicate a different condition, depending upon the character of the circuit supplying the current. It was presumed that this difference arose from a modification of wave form of the E.M.F. applied to the line.

Wave Form and Loss.—Measurements were made upon the wave form and the corresponding losses when different generators were used and different circuits were connected. In one test an armature giving nearly a sine wave was used which delivered current at 30 cycles. Measurements were made upon one circuit only, and then

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upon two circuits in multiple. The current and the loss are both given in Fig. 9. The wave form for no load and for both conditions of load are given in Fig. 10. The current taken by the two circuits in multiple is twice that to a single circuit. The variation from a straight line in one of the current curves is due to a change in wave form as the voltage is increased. The loss for the two circuits in multiple is about twice as great as for one circuit at low voltages, but it is less than that for one circuit at high voltages. Referring now to the wave form taken at high voltage, it is seen that the wave form for the two circuits in multiple has a lower maximum than that for one circuit alone. The reduced loss on the two circuits is undoubtedly due to the different wave form when both circuits were

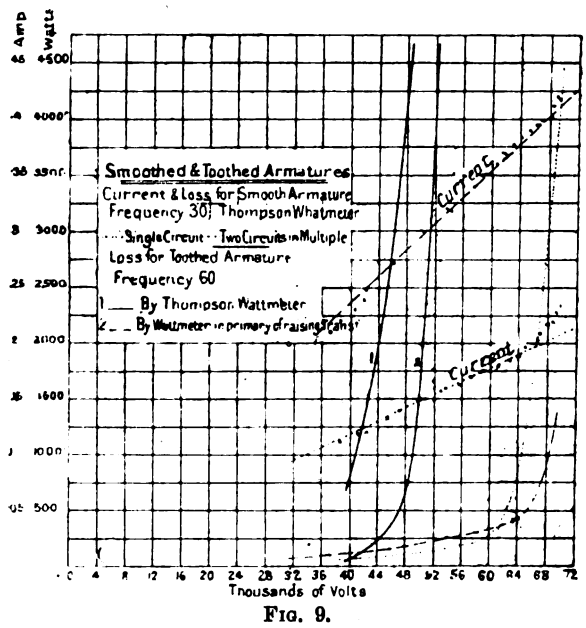

FIG. 9.

connected. The distortion of the wave form is due to the reaction which the leading current produces in the generator and transforming apparatus.

Wave forms were also taken on the slotted armature

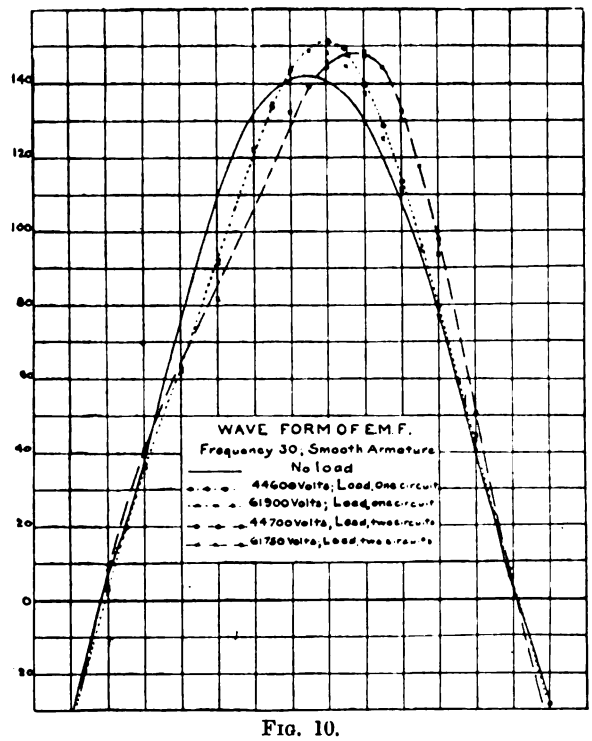

FIG. 10.

giving 60 cycles. The wave forms are given in Fig. 11. The conditions are similar to those just described, in that a single circuit produces a wave having a much higher maximum than that produced when two circuits are run in multiple. The losses (which are not shown) bear the same general relation as that in the last case—namely, the loss with two circuits is greater at low voltage and at the high voltage is less than that on a single circuit.

A wave form was taken upon the toothed armature both at no load and also when supplying current to one of the circuits. These are shown on Fig. 12. This wave differs

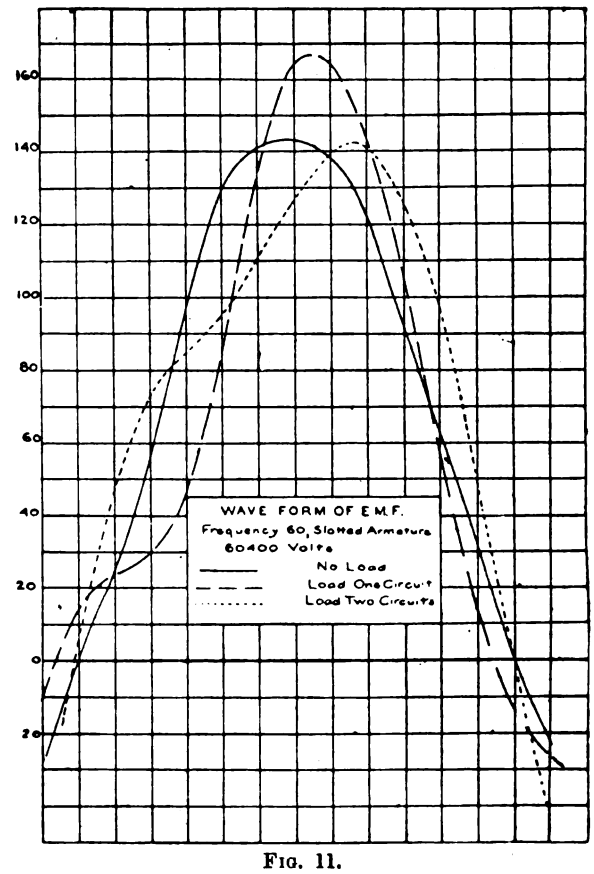

FIG. 11.

radically from a sine wave at no load, and is greatly distorted when supplying a leading current. In the no-load wave the value of the fundamental is 72·5 per cent.; the third harmonic 21·6 per cent.; the fifth harmonic 4·8 per cent. The corresponding loss is given in Curve 1, Fig. 9.

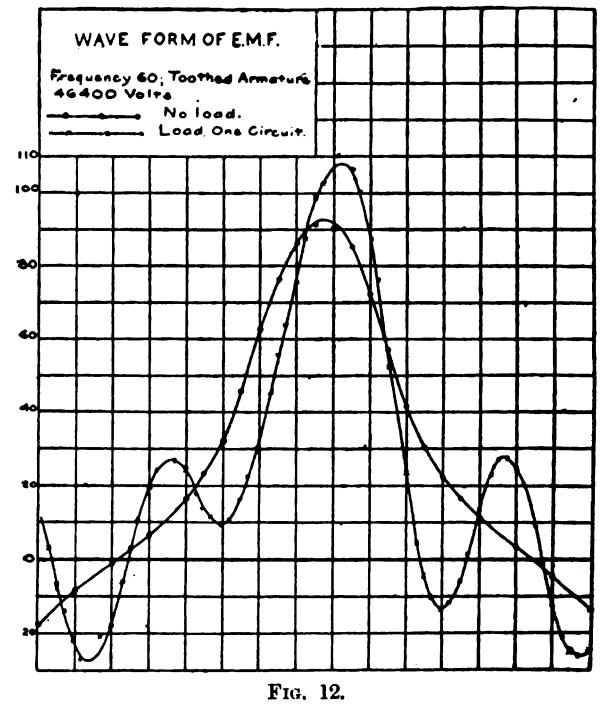

FIG. 12.

The distorted wave makes the Thomson wattmeter read too high, especially at the lower E.M.F.'s.

OTHER OBSERVATIONS AND TESTS.

A series of observations were taken extending over a period of 33 days, to determine whether there was any connection between the loss occurring on the lines and the variations in weather conditions. Three readings were

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taken each day. They were, in addition to the wattmeter readings, readings for barometric pressure, temperature, humidity, wind direction, and wind velocity. The weather observations were taken simultaneously at Ames and the King, using sets of weather instruments furnished by the United States Weather Bureau. The range of these observations is shown in a table given below, in which maximum and minimum refer to the maximum and minimum results obtained at any time during the 33 days over which the measurements extended :

Location.		Barometer.	Temperature, deg. F.	Humidity, per cent.	Wind velocity, miles per hour.
Ames	Maximum	22·19″	73·5	43·2	22
	Minimum	21·68″	56·3	7·1	2
King	Maximum	21·82″	62·0	42·5	20
	Minimum	19·81″	47·8	3·0	3

If there was any variation in the loss on the lines for this range of weather conditions, it was so small as to be inappreciable. The results of all measurements taken during this work seem to confirm the fact that the only weather condition whatsoever which affects the loss to any practical extent is that of precipitation. The loss seems to bear some relation to the size of the particles precipitated, being greater for a fall of snow in which the flakes are large than one in which the flakes are small.

In the power transformers used, the series reactance was comparatively small because of the sub-division of the coils. A change in the condition on the line as regards loss occurred when the Weston wattmeter was placed in circuit. This was detected by measurement upon the Thomson wattmeter, both when the Weston wattmeter was in circuit and when it was not. Moreover, the lines hissed when the voltage is 55,500 and the Weston wattmeter is out of circuit, but when the Weston wattmeter is thrown into circuit the hissing ceases, although the voltage rises to 57,700. The hissing sound is a characteristic of high-voltage lines, and begins at the bend in the loss curves. It always accompanies luminosity of the lines.

Along with this change there was another phenomenon not previously mentioned. This was a discharge which took place from time to time between the terminals of individual choke coils. The discharge would occur sometimes between the terminals of one choke coil and sometimes simultaneously on two or three of the choke coils. These discharges made considerable noise, sounding very much like a pistol shot, and could be heard at a considerable distance from the transformer house. As the choke-coil terminals are distant from each other about 8¼in., it is not thought that this discharge took place through the air, but over the surface of the wood enclosing the choke coil. The discharge, however, left no mark on this surface.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

128. In selecting meters for the measurement of current to consumers, what are the chief points to be taken into consideration?—C. S.

129. In overhauling an engine a crack is found between the low-pressure cylinder exhaust port and the steam jacket. How would you determine the loss in steam and coal—say for a run of six hours daily? Give an example if possible.—A. B.

ANSWERS.

Question No. 122.—For starting single-phase alternating-current motors, what method would you recommend so that motors may be run on public supply lighting mains without causing disturbance to same?

Best Answer to No. 120 *(awarded* 10*s.)*.—Alternating-current motors may be classified under three heads: (1) continuous-field motors; (2) alternating-field motors; (3) induction motors.

Class 1 are necessarily synchronous, and must be run up to speed before switching on the supply current. They must always start on a loose pulley. If the motor is direct coupled to its exciter, this forms a convenient method of starting by means of a battery of small capacity. Or the field coils (in the revolving-field type) may be connected to a two-part commutator on the shaft. They can then be started from the supply current by putting a resistance in series with the field, the armature in parallel with the field, and switching on the supply. The brushes being shifted forward through 90deg., the motor will run up as an ordinary shunt motor, the brushes being moved back as normal speed is approached. When synchronism is attained, the resistance is cut out and the field put in parallel with one armature coil, when the motor will go into step, being now excited by direct current from the commutator. To avoid excessive current at starting, an auto-transformer should be used.

Class 2 are at present unsuitable except for very small motors, and are started by switching on through a resistance in the usual way. The fields of such motors must be well laminated, but the efficiency and power factor are very low and the no-load current high.

Class 3 are at present the most successful type of alternating-current motors, and are largely used. They are asynchronous, though tending to run into synchronism, and have the advantage of being self-starting under considerable load, if excited by polyphase currents. The best method of starting these motors is to put a resistance (non-inductive) in series with the rotor, or rotating part. The best value of the resistance is such as to make the total resistance of the circuit less than $2\pi n L$, where L = self-induction of the circuit and n the frequency of supply current. The rotor is given a slight initial start by pulling the belt, and the direction of the initial impulse determines the sense of rotation. The insertion of resistance in the rotor circuit is very effective, as it not only reduces the large wattless currents which would be drawn from the mains if an induction motor of any size were switched on direct, but it brings the stator and rotor currents more into phase, with the result that the starting torque is increased. It also dispenses with the auxiliary starting coil in the stator and the induction coil or condenser necessary to produce a diphase current in the stator. The starting current also is less than when the split-phase method is employed.—E. M.

Answer to No. 122 *(awarded* 5*s.)*.—In order to avoid taking sudden rushes of current from the mains, and so making the lights blink, it is necessary that the starting current should not be large, and that it should not be taken instantaneously from the mains. If the following rules were adopted, the disturbance to the lighting supply would be reduced to a minimum :

1. All motors greater than ¼ h.p. must be fitted with a fast and loose pulley, and must always be started on the loose pulley.

2. All motors greater than 1 h.p. must have, in addition, a special starting device in the rotor. One of the best of these devices is that invented by Prof. Arno, which is now adopted in all the large motors made by Messrs. Brown, Boveri, and Co. It is simply to insert at starting a non-inductive resistance in the rotor circuit by means of two slip rings, and cut this resistance out as the motor speeds up. The proper resistance to put in the rotor circuit at starting can be calculated, but it is best found experimentally. When this resistance is in the circuit, the starting current is rarely as great as the full-load current even when the belt is on the fast pulley.

3. All motors above 5 h.p. run from the mains must have, in addition, a special starting resistance in the stator circuit.

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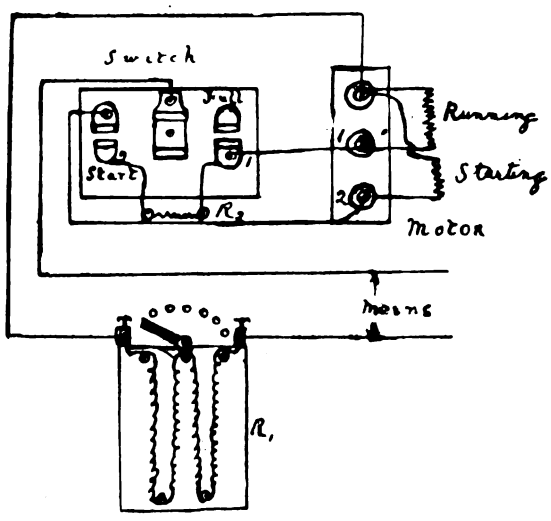
If these rules were adopted, the disturbance to the lighting would be very little. The first rule is, however, the one which would annoy the users of motors most, but if the use of alternating-current single-phase motors becomes common it will be necessary to enforce it. Already in the City, where some lifts are worked by alternating-current motors, the users of light are annoyed by the continual blinking of their lights caused by the rapid starting and stopping of these motors.—J. C. R.

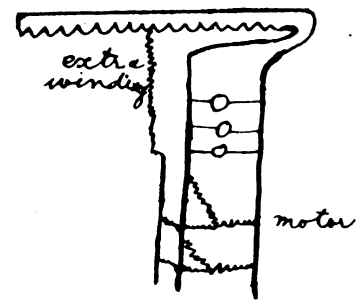
Answer to No. 122 (*awarded* 5*s.*).—There are many devices in practice for starting "single-phase alternating-current motors." The only practical way for switching on a motor to have a minimum effect on the lights is to have a contact resistance in series with the starting device. The Langdon-Davies Motor Company use this method for their non-synchronous induction motors, but it is very seldom they are asked to supply an extra resistance, as the switching on a motor of ½ h.p. to 25 h.p. would have practically no effect on a circuit (as in London, for instance) where there are such large units employed at the generating station. For starting the motor, put all the resistance, R_1,



in circuit. Then put the motor switch on to contact 2 (start), which connects the running coils and starting coils in parallel and the resistance (non-inductive) in series with the running coils. When the motor is running into speed, switch out the resistances, R_1, and when the resistance, R_1, is all out and the motor into speed, throw the switch on to contact 1 (full), which connects the running coils only in circuit. For stopping the motor, switch in the resistance coils, R_1, and switch off at the motor. This motor takes less than the full-load current to start. The rotor is of the slotted ring type, each slot wound with a coil short-circuited on itself.

Another device is to have a liquid condenser in circuit with the starting coils, which are in parallel with the running coils, and a resistance in circuit with the rotor, connected by means of slip rings; when the motor is into speed the condenser and resistance are cut out.

A single-phase motor of 100 h.p. recently built by the General Electric Company has for a starting device a reactance coil in series with a non-inductive resistance arc connected across the mains; the mains and the junction of the two coils are connected respectively to three points on the winding of the motor—the motor thus starts as a polyphase motor; the device is cut out when the motor has run into speed. There is a device for running up to speed a single-phase motor, by means of the monocyclic system, which consists practically of a single-phase alternator with an extra winding wound between the main coils, which generates an E.M.F. 90deg. out of phase with the main current. This extra winding is of comparatively thin wire, as it is only used for the motors, the lamps being connected across the two thick leads. The motors start up as three-phasers, and when into speed, the motor winding, which is connected to the extra winding, generates a back E.M.F. equal to the E.M.F. of the extra winding; therefore no current flows along the wire, but as soon as the motor slows up, the extra winding sends a current into the motor, which brings up the speed again—the rotor is of the squirrel-cage type. There is little difficulty experienced at the station except



when a rather large motor is switched on during a period of light load.—J. H. J.

Question No. 123.—In designing a rotary converter to change a direct current into a single-phase alternating current, or *vice versâ*, how is the current density per square inch of cross-sectional area in the armature conductors calculated? Considering the characteristics of such a machine, would 2,000 amperes per square inch be too high a density?

Best Answer to No. 123 (*awarded* 10*s.*).—The method of determining the capabilities of machines by the current densities in the wires is by no means satisfactory, though some designers still use it and many specifications contain density clauses. By spreading the winding well out over the surface very high densities are permissible without risk of heating, the real measure of the temperature rise being the watts per square inch of exposed surface. Still, for rough comparisons of different machines of the same general design densities serve well enough. In considering rotary converters the most convenient method will be to show the relative heating of the same machine when used as a converter and when used as an ordinary continuous-current generator or motor, the brushes on the alternating side being disconnected. Over and above the ordinary considerations it will be necessary to take into account (1) the effect of the power factor or phase difference between amperes and volts on the alternating side; (2) the efficiency of the combination; and (3) the uneven distribution of the heating around the armature. That this last is quite marked will at once be evident from a consideration of Figs. 1, 2, and 3. These

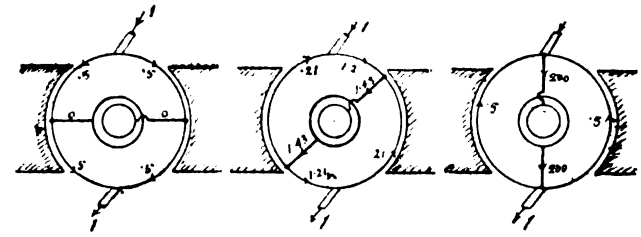


FIG. 1.—C C input = 1 volt × 1 amp.; A C output = 0 Armature acting as a flywheel storing energy.

FIG 2.—C C input = 1 volt × 1 amp.; A C output = ·7 volt × 1·43 amp. Input watts just balance output watts.

FIG. 3.—C C input = 1 volt × 1 amp.; A C output = 1 volt × 2 amps. Armature acting as a flywheel giving out energy.

diagrammatically represent the distribution of the current in the conductors at three different points in the revolution, the continuous current being called 1 and the alternating current being consequently about 1·43, assuming, as usual, that the curves of alternating E.M.F. and current follow a sine law, and neglecting efficiency. It will be noticed that, while certain of the conductors (those situated midway between the two collector ring tappings) never carry more than the normal ·5 ampere, others (situated close to the tappings) sometimes carry nearly three times this amount. An obvious way to equalise this uneven heating is to wind different parts of the armature with different gauges of wire, but this is seldom done, as the want of symmetry is likely to cause sparking at the commutator. By the help of such diagrams, which show the summation of the instantaneous values of the alternating and continuous currents, the curve Fig. 4 is got, showing the relative average heating of the various points on the armature. The heating with the continuous current alone has been taken as 1. Far from being uniform, the heating of some sections

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is six times that of others and three times as much as the sections of the same machine carrying the continuous current alone.

In small well-ventilated armatures it will be safe to neglect this uneven heating, but in large armatures a certain allowance, depending on the extent to which the wire is bunched together, and which must be left to the discretion of the designer, must be made. In any case, however, this is small. By finding the average height of the curve Fig. 4 we at once get the average heating of

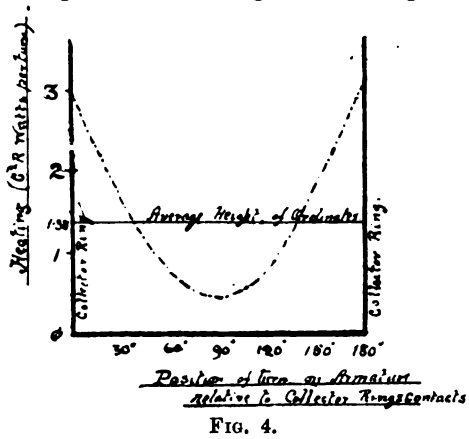

FIG. 4.

the whole armature. This comes out at 1·38, as shown. This is neglecting the fact that the output watts are really always less than the input, due to losses in the machine itself, and also neglecting the power factor. The effect of the first is to reduce or increase the heating, according as to whether the continuous or the alternating current forms the input, and of the second to increase the heating very decidedly with the lower power factors. In order to allow for the efficiency it is necessary to make an assumption as to what proportion of the total losses, exclusive of magnet excitation, of the machine are lost in the copper of the

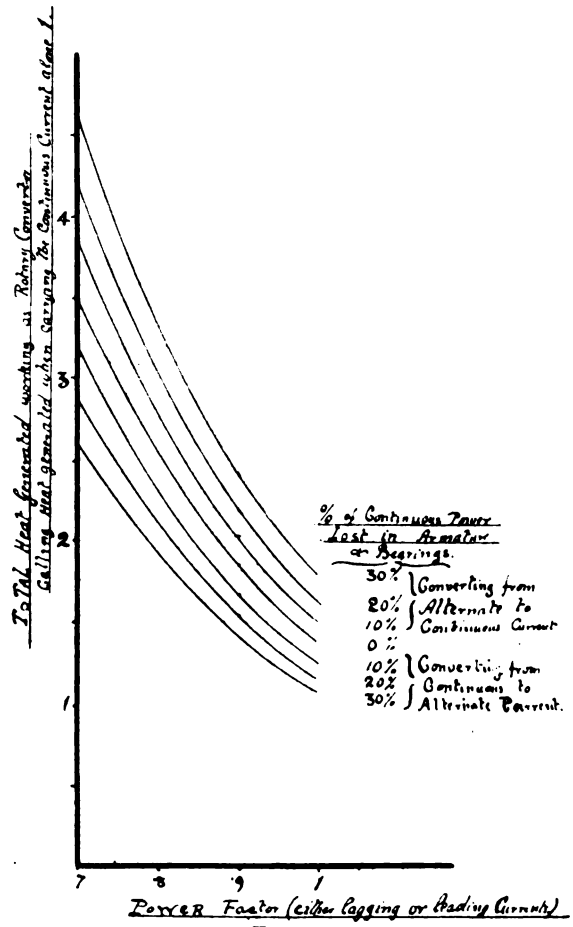

FIG. 5.

armature. In the curves Fig. 5 this proportion has been taken as $\frac{1}{2}$. The power factor, whether the current lags or leads, is readily allowed for by going back to the diagrams Figs. 1 to 3, and re-adding the continuous and the alternating current instantaneous values, remembering that the alternating current will now be a maximum, not when the continuous-current brushes and the collector ring contacts coincide, but a certain number of degrees back or forward of that point, the cosine of this number of degrees being the power factor.

In order to adapt the curve Fig. 4 to the idea of current density, it is only necessary to remember that since the heating goes down as the square of the current or density, the density must be reduced, roughly, half as much per cent. as the heating has to be reduced, or, more accurately:

$$\frac{(\text{Density as continuous-current machine})^2}{(\text{Permissible density as rotary converter})^2} =$$

Figure from curve giving the relative heating as converter and as continuous-current machine for the particular case under consideration;

or permissible density as converter =

$$\frac{\text{Density as continuous-current machine}}{\sqrt{\text{Figure from curve}}}.$$

To make all clear by an example: What density would it be safe to use in a certain converter from continuous to alternate current which, when used as a plain continuous-current machine, keeps cool with 2,000 amperes per square inch; the efficiency of the converter, neglecting excitation, being 90 per cent. and the power factor of the alternating load being ·8?

From the last curve the relative heating figure for this case is seen to be 2·3, therefore the permissible density $= \frac{2{,}000}{\sqrt{2{\cdot}3}} = 1{,}510$, and considering the uneven heating this should be reduced yet a little more.—Q.

Answer to No. 123 (*awarded* 5*s.*).—In a rotary converter, as was well shown by the graphical diagrams in Prof. Silvanus Thompson's Institution paper recently reprinted in the *Electrical Engineer*, the current density in the various coils of the armature varies in an extraordinary manner. If the armature wires are all to be of the same section, we must calculate the current density in the coils connected to the slip rings, as in these the current is greatest, and use this for calculating the size of the armature conductors. In order to do this, we must first consider mathematically the ideal rotary converter, in which the losses are zero and the alternating current follows a simple harmonic law. In Fig. 1, let A B be the slip rings from which the alternating

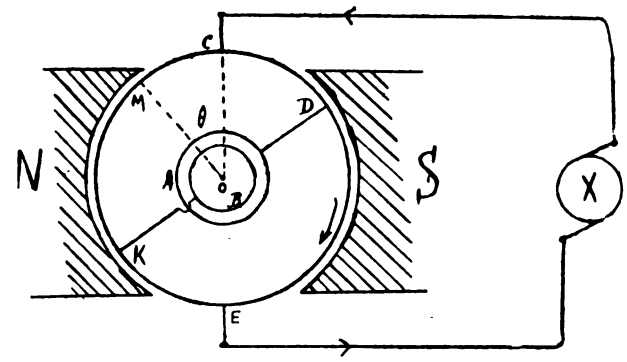

FIG. 1.—A, armature of rotary converter; X, direct-current dynamo; A and B, slip rings from which alternating current is collected; O M is perpendicular to K D.

current is collected, and C E the brushes for the direct current, the armature being either ring or drum wound. Let $2c$ be the direct current and let $2\,\mathrm{I}\cos\theta$ be the alternating current, then the current in the coils, C D, is $c - \mathrm{I}\cos\theta$. The minus sign is necessary, as the currents it receives as a motor must be flowing against the E.M.F.'s induced internally by its rotation. Hence the mean square of the current in a coil whose angular distance from M is θ—

$$= \frac{1}{\pi}\int_{\theta}^{\pi+\theta}(c - \mathrm{I}\cos\theta)^2\, d\theta.$$

$$= c^2 + \frac{\mathrm{I}^2}{2} + 4\,c\,\mathrm{I}\sin\theta.$$

$$= c^2 + \mathrm{A}^2 + 4\,c\,\mathrm{A}\sqrt{2}\sin\theta \quad . \quad . \quad . \quad (1)$$

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where A is the effective value of the alternating current, I cos θ. When θ equals nothing—*i.e.*, in the coils midway between those connected to the slip rings—the current equals $\sqrt{c^2 + A^2}$, and when θ equals 90deg.—*i.e.*, in the coils connected to the slip rings—the current equals $\sqrt{c^2 + A^2 + 4\,c\,A\sqrt{2}}$. Taking the theoretical converter Dr. Thompson considered, which changed 100 amperes continuous into 141·4 amperes alternating, $c = 50$ and $A = 70{\cdot}7$, we see that the least current in the armature coils is 86 6 amperes, and the greatest 166. In practice, the alternating current would be less than this, as the continuous current in the armature has not only to drive it as an alternator, but has to overcome hysteresis eddies and friction. This will make the practical value of the alternating current less than the theoretical value, but the equation (1), given above, still holds, and can be used to find the maximum value of the current in the armature, as an error of 2 per cent. in the value of A makes very little change in our calculations, as it merely diminishes the maximum current by about 1 per cent.

In the best modern designs for the armatures of dynamos a current density of between 2,000 and 3,000 amperes per square inch is used, and even higher densities are used when the design admits of good ventilation. Hence for a rotary converter a density of 2,000 would be safe, provided we take the current in the armature as $\sqrt{c^2 + A^2 + 4\,c\,A\sqrt{2}}$, where 2 c is the continuous current supplied and 2 A is the effective value of the alternating current taken from the converter. Theoretically, it would be more economical to vary the thickness of the conductors on the armature so as to have the same current density in all the coils, but practically the small saving in initial expense would be more than outweighed by the loss in symmetry and the consequent extra labour entailed.—J. C. R.

THE ELECTRIC FATALITY AT SOUTHAMPTON.

BOARD OF TRADE ENQUIRY.

The recent electrical fatality at Southampton, into the circumstances of which Mr. William Coxwell (the borough coroner) enquired on Tuesday, the 20th inst., formed the subject of a Board of Trade enquiry, conducted by Major Cardew, R.E., at the Audit House, Southampton, the next day. There were present the Town Clerk (Mr. G. B. Nalder), for the Corporation, Alderman W. Bone, J.P. (the chairman of the Electric Lighting Committee), the Mayor (Councillor G A. E. Hussey), Councillor C. Cooksey and Mr. J. D. Bassett (from the office of Mr. Lamport), who represented Messrs. W. T. Glover and Co., Limited (the contractors), and Mr. Brooking, their manager.

The **Town Clerk** opened the case, and narrated the facts. He referred to the inquest, at which the jury returned a verdict of accidental death, and exonerated the foreman from all blame.

The **Inspector** asked if anything had been published of the proceedings, and receiving an affirmative reply from the town clerk, said it would be easier for him to have a report, and asked the witnesses to verify it.

It was decided, however, to examine each witness, the first to be called being **Henry Flux**, a labourer, who repeated the evidence given by him to the coroner.

Mr. J. Brooking, electrical engineer, and manager for Messrs. Glover and Co. in Southampton, in the course of his evidence stated that they had been working day and night to get the mains ready. Since the accident the joints had been taped over. He had traced back the cable to what he imagined to be the low tension pipe. The two pipes, high and low tension, were nearly alike, and there was no externa mark to tell which was the high-tension pipe. Had he known the leakage was in the high-tension cable, he would not have allowed Day to repair it without first having the current switched off. He did not remember having made temporary joints on high-tension cable before. He mentioned to Mr. Shepherd (the clerk of the works) that he did not like putting in a temporary joint, but on being pressed he thought it better to do so. He was aware of the Board of Trade regulations, but he did not think that they were strictly adhered to in this case.

By the Town Clerk: It was possible to make a temporary joint as safe as a permanent one, but only by using extra thicknesses. He had the joints made, as he thought, very safe, and had extra material, although not so much as he thought.

John Shepherd, electrical engineer, clerk of the works for the laying of the mains, said that when he was told of the leakage he was apprehensive of danger. He had seen the joints made, and were satisfied with them. He had heard that it was necessary that the work should be put on.

Frederick H. Chaplin, resident electrical engineer of the Corporation works, believed that an undertaking had been given to supply current to several consumers, amongst them being the new theatre, the new Avenue Congregational Church, and large business premises, on the 7th inst. Owing to the need, temporary joints were made in that particular box and two others. There was a current of above 2,000 volts going through the high-tension cable on the day of the accident. He held the opinion that the reason of the joint being forced against the brickwork was owing to the vibration from the railway tunnel underneath. The current was complete as far as it went, and he tested the high-tension cable with a current of 2,300 volts. He thought that when the box was complete the joints would be secure.

Mr. E. Manville, consulting engineer to the Corporation, was next called.

Before he gave evidence the **Inspector** said he wanted to know who was responsible for the delay through which the temporary joints had to be constructed?

Mr. Manville replied that in that connection the work was very much behindhand, and the Corporation, through him and the town clerk, had pressed the contractors to complete the work, and no doubt it was due to the non-completion of the work that the temporary joints were made. Although they were temporary joints, they ought to have been fit for the work they were to do. They ought to have been fit to run, if necessarily, continuously. He maintained that if they had had proper metallic shielding an accident of that sort could not have resulted.

Answering Mr. Bassett, the **Town Clerk** said that the contract was made on Dec. 3, 1896, and the work should have been completed six months after the written order was given.

This was all the evidence taken, and the inspector subsequently visited the scene of the fatality.—*Hampshire Advertiser.*

LEGAL INTELLIGENCE.

DILATORY TRAMWAY CONSTRUCTION IN THE POTTERIES.

Fines for Obstruction.

At Burslem, on the 20th inst., the Potteries stipendiary (Mr. Harold Wright) had before him a case of considerable interest to the general public and to the local authorities of the district. Hugh Benjamin Phillimore, electrical engineer, was summoned at the instance of the Town Council for having on the 2nd, 3rd, and 4th inst. unlawfully and wilfully obstructed the free passage of the footway in Waterloo-road, Burslem, by making, or causing to be made, an excavation therein.

Mr. A. Ellis (town clerk) prosecuted, and Mr. H. E. Bishop appeared for the defendant.

The **Town Clerk** stated that the defendant was manager to Messrs. Blackwell and Co., of London, contractors for the British Electric Traction Company, who had some sort of arrangement with the North Staffordshire Tramways Company for the electrical equipment of their line. For the purpose of carrying overhead wires poles had been erected on each side of Waterloo-road, and it appeared that the defendant had instructed his workmen to rectify one of these poles, which had not been erected at a proper angle. To do this they proceeded, without notice to the borough surveyor, to dig a hole in the footpath. This was done some time before the 2nd inst., and the hole remained covered with loose boards until the 5th inst., when, in consequence of complaints, the borough surveyor had it filled up. In the meantime, however, several people had fallen into the hole and sustained injury. He contended that none of the companies concerned had any statutory authority to open the footway at all.

The **Stipendiary**: Well, if they have, it is for them to prove it.

Mr. F. Bettany, borough surveyor, deposed that on the 5th inst. he examined the footpath near the house of Mr. Woodall, M.P., at Cobridge, and around one of the tramway equipment poles he found an excavation 18in. across and about 1ft. deep. He had received no notice that the excavation was to be made. Under the Tramways Act he ought to receive seven days' notice of intention to break up the roadway or footpath. He caused the hole to be filled up. In cross-examination, he said that Mr. Clough, the resident electrical engineer of the company, might have seen him on Nov. 3 as to the reconstruction of the tramways, but he did not remember any such interview. He had never heard anything about holes being dug round the base of the poles.

Police-Constable Miller deposed to the hole being in the footpath around the pole on the 2nd inst., and said that when he spoke to the defendant about it on the 5th inst. he said he would take the responsibility, explaining that the hole had been left open because there was something wrong with a water-pipe.

Other witnesses bore similar testimony for the prosecution, and spoke to falling over the obstruction.

William Martin, a member of the Town Council, said that on the night of the 4th the boards referred to collapsed under him, and he fell into the hole, injuring his knee.

This was the case for the prosecution, and for the defence **Mr. Bishop** said he admitted that the hole was there, and that defendant was legally liable for the obstruction; but he contended that there had been no wilful neglect on the part of the servants of the defendant's firm. The excavation had to be made to alter the angle of a pole, and a water-pipe having been accidentally severed, the hole was kept open until this could be repaired. The delay was on the part of the water authority, whose plumber had not securely covered the hole. He thought there could be no doubt as to the right of the tramways company to proceed with the equipment of their line.

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Norman Clough, local engineer for the electrical equipment of the tramways, stated that on Nov. 3, after the work had been dormant for some time, they were recommencing the equipment of the line in Burslem. Before doing so he saw Mr. Bettany, who told him he could proceed with the work. There was only a general conversation, and the excavations in the footpath were not specially mentioned. They had dug other holes besides the one referred to in order to alter the rake of poles erected some 12 months ago.

The **Stipendiary** asked if it was the same company that had been working at the tramways during the last few years, to which **Mr Bishop** answered in the affirmative.

The **Town Clerk** explained that in relaying the original tramways, constructing extensions, and equipping the lines for electric traction, several companies had been engaged, but the defendant's firm were dealing with the latter work.

For each offence the defendant was fined 20s. and costs—£5. 14s. 6d. altogether.—*Birmingham Daily Post.*

COMPANIES' MEETINGS AND REPORTS.

SMITHFIELD MARKETS ELECTRIC SUPPLY COMPANY, LIMITED.

The first ordinary general meeting was held on the 23rd inst. at Winchester House, Mr. J. Brown Martin presiding.

The report, already published by us, was adopted.

The **Chairman,** in answer to questions, stated that they had sold in the past year less than the 600,000 units which they had estimated on selling, but the figures for the current quarter showed that that estimate was now being almost precisely borne out. Their cost of production—making allowance for the lamps they had to light free, etc.—was less than that of any other company in London, and was, of course, lower than the estimate given in their prospectus. He had greater confidence now than when he signed the prospectus in the valuation of £86,000 odd which was put on the property they took over. He believed that every statement made in the prospectus would be fully borne out.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The third annual meeting was held at Manchester on the 27th inst., Mr. T. J. Hutchinson presiding.

The annual report stated that the total miles run amounted to 40,963, and 94,173 passengers were carried. The gross traffic receipts amounted to £4,135. 15s. 2d., from which must be deducted £689. 5s. 10d.—tolls payable to the Douglas Head Marine Drive, Limited—leaving net passenger receipts £3 446. 9s. 4d., to which must be added sundry discounts, etc., £11 4s. 8d., bring the total net receipts to £3,457. 14s.

The **Chairman** having referred to the loss sustained by the Company through the death of the late chairman, Sir John Goldie-Taubman, the report and accounts were adopted, and Mr. E. A. Hopkins was re-elected a director.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Commissioners of the Burgh of Stirling invite tenders for boilers, engines, dynamos, etc. Tenders by Jan. 2, 1899.

Edinburgh.—The Magistrates and Council invite tenders for various work in their electric lighting station in Macdonald-road. Tenders by Jan. 9, 1899.

Burnley.—The Corporation invite tenders for the supply and delivery at their electricity supply station of underground cables. Tenders by Jan. 10, 1899.

Glasgow.—The Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Further particulars appear in our advertising columns. Tenders by Jan. 21, 1899.

Tunbridge Wells.—Tenders are required by the Corporation for the erection of three telephonic fire-alarms within the borough. The position of the fire-alarms required will be as follows: (1) Grosvenor Bridge, (2) St. James's Church, (3) The Royal Oak. Tenders by Jan. 11.

Rochdale.—Tenders are required by the Gas Committee for the erection of buildings required for the proposed electricity works. The plans may be seen on application to Mr. T. Banbury Ball, the manager, at the Gasworks, from whom copies of bill of quantities may be obtained on payment of the sum of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by noon on Jan. 17.

Barrow-in-Furness.—Tenders are required by the Corporation for the wiring of the free library, Cornwallis-street. Plan of the building may be seen at the office of the Borough Electrical Engineer, Town Hall, and specification may be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by 12 noon on Jan. 20,

Hull.—The Corporation invite tenders for the following work in connection with the tramways—viz. (Contract No. 16) pipes and fittings for power station and condensing mains from dock; (20) builders' work for two car-sheds and other buildings, area about 4,000 square yards; (21) steel roof trusses, steel columns, etc., for above car-sheds. Particulars, etc., may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull. A deposit of £1 for each contract will be required, which will be returned on receipt of a bona fide tender. Tenders before noon on Jan. 13.

Christiania.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Railways Administration for the delivery of various telegraph and telephone materials. Tenders, in sealed envelopes marked "Telegraf og Telefonmaterial,' must be received at Styrelsens Expeditionskontor, Statsbanerne, Christiania, by 7 p.m. on Jan. 4. A copy of the conditions of contract may be examined on personal application at the Commercial Department of the Foreign Office, S.W., any day between 11 a.m. and 5 p.m.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Wimbledon.—The Urban District Council have accepted the tender of Messrs. Beaman and Deas, at £1,919, for the dust destructor (estimate £2,000).

BUSINESS NOTES.

Heckmondwike.—The Council have decided to oppose the Electric Traction Company's scheme.

Rotherhithe.—The Vestry have decided to oppose the granting of a provisional order to the Brush Electric Company for the supply of electricity in the parish.

Epsom.—The report of the Lighting Committee to the Urban District Council, in which it was recommended that tenders be advertised for electric lighting, has been adopted.

Haslingden.—A sub-committee has been appointed to attend a conference called by the Accrington Town Council with regard to the proposed adoption of electric traction on the tramways.

Llanfyllin.—A letter in the *Oswestry Advertiser* complains about the bad lighting of the town, and strongly recommends the Town Council to have the streets lighted by means of electric light.

Removal.—Mr. W. C. C. Hawtayne informs us that he has taken new offices at 9, Queen-street-place, London, E C. His telegraphic address and telephone number will remain the same.

Personal.—Mr. John Rutherford Blackie, of 11, Melville-road, Redlands, Bristol, has been appointed by the Newington Vestry, out of 77 candidates, resident engineer at the electricity supply station.

Doncaster.—The Rural District Council have decided to support the scheme of the Doncaster Corporation for light railways in the parishes of Bentley-with-Arksey and Wheatley, in the Doncaster district,

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Walker.—The Urban District Council have rejected the terms offered by the gas company with regard to the electric lighting, and have decided that the necessary steps shall be taken to obtain a *locus standi* respecting the Bill.

Flamborough.—The promoters of the Bridlington and Flamborough light railway are preparing an estimate of the total cost of the work, and negotiations are in progress with an electric traction syndicate for working the line.

Belfast.—The output of the central station on Dec. 21, 1897, was 1,963 units, and that on Dec. 21, 1898 3,550 units, showing an increase of about 81 per cent. The total number of lamps now connected and applied for is 42,564.

Appointments Vacant.—The Urban District Council of St. Annes-on-the-Sea require an electrical engineer at a salary of £170, rising to £200; and the borough of Eccles are advertising for a switchboard attendant at a salary of £62.

Newport and Monmouthshire County Hospital.—Messrs. Wallis-Jones and Dent, of 36, Great George-street, Westminster, have been appointed consulting engineers for the electric lighting and electrical arrangements at this hospital.

Cape Electric Tramways.—An interim dividend of 3 per cent., free of income tax, has been declared, payable to all shareholders registered on Dec. 31. The dividend will be payable after the receipt of transfer returns from South Africa.

Newton Abbot.—The District Council are willing to affix the seal to a formal undertaking not to oppose the application of the Urban Electric Supply Company, Limited, if certain clauses and conditions are inserted in or annexed to the provisional order.

Walsall.—The town clerk has been authorised to take the necessary steps on behalf of the Council for opposing in the ensuing session of Parliament the Bill promoted by the South Staffordshire Tramways Company with reference to the tramways constructed by them.

Friockheim.—The electric light has been installed by Messrs. Douglas Fraser and Sons at their large bleaching works here The motive power for the dynamo is water. a large turbine wheel having been erected in the bleaching-house. It is anticipated that the electric lighting of the village will follow this step.

Exeter.—The Electric Lighting Committee have recommended to the City Council the laying of an electric cable in Haldon-road, Howell-road, and Bartholomew-street West to Bartholomew-terrace. The surveyor and electrical engineer are engaged on a report on the best method of improving the light at the new clock tower.

Halifax.—At about 5 p.m on the 27th inst. an electric tramcar at Halifax, in rounding the sharp curve at the bottom of Silver-street, ran off the metals. The driver promptly stopped the car, which was got on to the lines again after a time, and resumed its journey. The tramways traffic during the holidays has been very large.

St. Luke's.—The Vestry have consented to the application of the Smithfield Markets Electric Supply Company, Limited, to lay their mains in the parish. The Metropolitan Electric Supply Company, Limited, have abandoned for this year their proposed application to the Board of Trade for a provisional order to supply electricity in the parish.

Dorking.—The Rural District Council have invited the following gentlemen to attend before a committee with the view of their selecting one to act on behalf of the Council as consulting electrical engineer for the purpose of advising the committee as to a scheme for electric lighting under the provisional order—viz, Messrs. W. C. C. Hawtayne, W. H. Trentham, and J. S. Raworth.

Pwllheli.—The *North Wales Observer* says tradesmen and others complain of the insufficiency of gas supply. Lately all the gaslights have gone out several times. As the gasworks belong to a private company it is suggested that the Town Council should include electric lighting in their improvement scheme. Sooner or later the Council must take up the question of lighting the borough.

Brentford.—The Works Committee of the District Council, having considered the plans deposited by the tramways company for the Half Acre widening, recommend that Mr. Clifton Robinson be written to stating that the Council would contribute towards the widening of the Half Acre if it was carried out entirely on the east side. The subject will come up for consideration at the next meeting of the District Council.

Kidderminster and District Electric Lighting and Traction Company, Limited.—This Company has been registered, with a capital of £100,000 in £10 shares (5,000 preference), to carry on the business of electrical engineers, etc. The subscribers are Emile Garcke, George Stevens, Charles H. Dade, Charles H. Gadsby, W. Howard Smith, C. Walmsley, and Henry M. Sayers, all of Donnington House, Norfolk-street, London.

Beverley.—A conference took place last week between representatives of the North-Eastern Railway Company, the North Holderness Light Railway Company, and the Corporation. Several matters were discussed, such as the price of the Corporation land to be acquired for the light railway, the proposed bridge at Grovehill, etc. The conference was not open to the public, and it is understood that no definite arrangements were made.

Stoke.—The Town Council have agreed not to consent to the application to be made by the promoters under the Potteries Extension Order, 1896, to the Board of Trade to prolong the time limit for the completion of the tramway works authorised by the order until August, 1899, until an undertaking be given to the satisfaction of the Council that the extension from London-road to Hanford Bridge shall be commenced and completed forthwith.

Llanrwst.—The Urban District Council have passed the following resolution: "That this Council will not oppose Messrs. J. R. Pears and Co., electrical engineers, applying to the Board of Trade for a provisional electric lighting order for the town of Llanrwst, provided such application be made before November, 1899, and that the works are carried out within six months from the date of the order, and subject also to the approval by the Council of the terms and details of such order."

Southwark.—The St. Olave's Board of Works have given their consent to the London Electric Supply Corporation, Limited, to lay distributing mains in Stoney-lane, and also to lay low-tension distributing mains in Duke-street and Tooley-street to Morgan's-lane, on condition that the corporation at their own expense altered the position of the mains referred to as required by the Board, for any further improvements or alterations in paving of the streets mentioned in the notices.

Dundee.—At a meeting of the Works Committee of Dundee Harbour Trust on the 27th inst., Mr. Quirk, alluding to the recent case of drowning at the docks, said there was an idea that the accident may have been due to deficient lighting. He himself did not think the illumination was all that could be desired, and moved that the engineer be instructed to make enquiries as to the advisableness of introducing the electric light, and report as to the probable cost of the installation. This was agreed to.

Perth and District Tramways Company.—From the report by the directors of the Perth and District Tramways Company, submitted to the shareholders at the seventh ordinary general meeting on the 28th inst., it appears that the directors, keeping in view the adoption of mechanical traction, have taken some preliminary steps to enable the Company to take advantage, for traction purposes, of the introduction of electric light into the city should it be deemed advisable hereafter to adopt any form of electric traction.

Leith.—On the 23rd inst. Provost Bennett formally opened the Leith Walk section of the electric lighting installation. A cake and wine banquet, presided over by the Provost, was afterwards held. The work has been carried out under the supervision of Mr. W. R. A. Bryson, F.R S.E., the permanent engineer. The total cost is estimated at about £30,000. At present five dynamos driven by separate engines are being used, and there is room for a further increase. When in full working order there will be betwen 5,000 and 6,000 lamps.

Dewsbury.—The Town Council have decided to oppose the Electric Traction Company, and to establish a system of electric tramways similar to that in successful operation in Halifax. The route suggested is from Ravensthorpe railway station, at the borough boundary, along Huddersfield-road to the centre of the town, and thence along Halifax-road, Birkdale, Westborough, and Green-lane to Staincliffe road, Dewsbury Moor. The scheme, according to calculations made by Mr. Jonas, the borough electrical engineer, will cost £19,750 to put into working operation.

Lincoln.—At a recent meeting of the City Council it was reported that the directors of the tramways company had had under consideration the desirability of introducing electricity as the motive power, and also of extending the tramways in the city, but before incurring this heavy expenditure they desired to know if there was any likelihood of the tramways being taken over by the local authority. The Council in committee decided to enter into negotiations with the tramways company with a view to the tramways being taken over by the Corporation at no distant date.

Glasgow.—At the meeting of Dean of Guild Court on the 22nd inst., the Corporation of Glasgow applied for permission to erect a generating station in connection with the electric lighting department on ground in Pollokshaws-road, Glasgow. Objection was taken to the application, however, on behalf of the Caledonian Railway Company, on the ground that the proposed station was infringing on the ground of the company. As the petitioners were not represented in Court, the case was continued until next Court day, in order to give them an opportunity of repelling the objection.

Hornsey.—At the last meeting of the Urban District Council it was reported that the Lighting Committee, having considered the letter from the North London Electricity Company, of Prescot, Lancashire, enquiring whether the Council would consider a proposal for the company supplying current wholesale from proposed large central electric power and distribution works, or a proposal for the leasing to them of the order obtained by the Council, and also a further letter of the 8th inst. intimating that it was decided to defer the matter for a time, the committee recommended accordingly that no action be taken.

Kingston.—A committee of the Council are considering the proposals of a syndicate who propose in the ensuing session of Parliament to apply under the Light Railways Act for an order incorporating the Kingston District Traction Company for the purpose of establishing electric traction in the town and district. It is proposed to work the lines on the overhead trolley system with current from the borough electric works, and the company promise, in the event of the Corporation supporting their application to Parliament, to insert in the order a clause enabling the Corporation to acquire the undertaking after the expiration of 14 years.

Shoreditch.—The report adopted by the Vestry last week on electric lighting extensions recommended the acquisition of an additional site suitable to meet the increasing demands of the parish for

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electric light and power. The Lighting Committee recommended the Vestry to approach the Ironmongers' Company with a view to the purchase of their almshouses in Kingsland-road, adjoining the North London Railway, for the purpose of erecting a second lighting station for Shoreditch; and that Messrs. Kincaid, Waller, and Manville, the Vestry's consulting engineers, be asked to prepare a specification for two 750-kw. sets of engines and dynamos, with the necessary boilers and switch gear, etc., in preparation for the new station.

Bristol.—The city engineer's report, which has been adopted by the Sanitary Committee, states, with reference to the extension of the tramways, that the directors of the tramway company had agreed, with the view of making an amicable arrangement, to relay the lines from the west end of Rupert-street to St. Augustine's Bridge, so as to use centre poles, as required by the committee. The company would do their best to carry out the wishes of the committee as regards Cumberland-street and Hotwells. As regarded the use of rosettes, the company had submitted plans showing the position of the poles to be used at certain junctions, and the engineer was of opinion that they would be necessary for the proper working of the tramways at these places.

Chelsea.—At the last meeting of the Vestry the Works Committee reported "that copies of the provisional orders and Bills mentioned in the clerk's report to the Board on *Gazette* notices are not obtainable until after the 21st inst. With regard, however, to the Kensington Vestry electric lighting scheme, the time for lodging an objection respecting an application for a provisional order will expire before the meeting of the Vestry on Jan. 17; in order, therefore, that the interests of the Vestry may be safeguarded, the committee recommended that the Vestry give notice of objection to the scheme, on the grounds mentioned in the surveyor's report to the Board at the last meeting, and also against the scheme on its merits." The recommendation was adopted.

Blackpool.—At a recent special meeting of the Town Council it was formally decided to apply to Parliament for a provisional order authorising important extensions of the Corporation tramways, which are estimated to cost £70,000. The scheme includes a new tramway along Talbot-road, Cookson-street, Raikes-road, and Whitegate-lane to Marton, and then by way of Cow Gap-lane to a junction with the existing Lytham-road line. Another proposal is to construct a tramway from House Hill and along Central Drive to Cow Gap-lane, and extensions at North Shore are also included. The estimates for the whole of the work have been based on the cost of the overhead trolley system, although the Council are not pledged to adopt this method of traction.

St. Pancras.—The Vestry have now laid electric light mains for both public and private supplies up the West-hill, Highgate, and to the summit of Highgate-hill, and as soon as the necessary connections are made the current will be switched on. The top of Highgate-hill is the highest spot in the North of London to which electric lighting mains have yet been carried. The cables, which were wound on huge drums, weighed several tons, and eight horses were required to haul each of them to the top of the hill. It is the intention of the Vestry to carry the cables down Highgate-hill to the St. Pancras Workhouse Infirmary in Dartmouth-park, though in order to do this it will be necessary to obtain the consent of the Islington Vestry, as some portions of the roads are under the control of that authority.

Liverpool.—The monthly report presented at a meeting of the Electric Power and Lighting Committee of the Corporation last week showed that the supply of electricity for lighting purposes, both private and public, was steadily increasing. The Chairman announced that their income from the trams was now £6,000 a week; their receipts were £20,750 up to date, more than for the corresponding period of last year, and they had expended £12,700 more in wages. This, the committee considered, was a very satisfactory and encouraging state of affairs. It was decided to extend the electric mains in Pembroke-place, Duke-street, Leece-street, Manchester-street, and the Old Haymarket. Further, it was resolved that electric mains be laid down for the tramway extensions in Aigburth-road, Paradise-street, and Lord-street. It was also resolved to apply to certain property owners in Paradise-street for permission to fix on their buildings rosettes for the wires, so as to obviate the use of posts in the streets.

Cork.—The results of the opening day's working of the Cork tramway service, says the *Cork Examiner*, far exceeded the anticipations of the promoters. Any figures that could be given on the subject would not at all supply an idea of the amount of the traffic, as the conductors were obviously unable to cope fully with their duties. On the 23rd inst. the cars were again crowded, and the cry "full up" was often heard on some routes. In the night-time people gathered in hundreds at the central station and scrambled into the first tram that came the way, not caring when or where it was going. Of course, people having business in any particular direction embraced by the service patiently awaited the arrival of their car. About noon, while one of the tramcars was rounding the curve at the South-mall end of Marlborough-street line, one of the overhead wires snapped, and, coming in contact with a copper wire beneath, fused and fell to the ground. Happily, no person was injured. There was but a slight delay caused by the mishap.

Wrexham.—A meeting of the tradesmen, owners, and occupiers of property along the proposed route of the electric tramways through Wrexham was held on the 23rd inst. The Chairman said the narrow majority of two adverse to the proposed tramway scheme at a recent meeting of the General Purposes Committee of the Council had induced a number of ratepayers to call that meeting with a view of ascertaining the real feelings of the people on the matter. Mr. Albright, the chairman of the company who proposed to construct the tramways, explained the scheme. A resolution asking the Town Council to adopt that part of the scheme extending the existing tramway from Ruabon-road to the Great Western Railway Station and the racecourse, was agreed to. Another resolution was proposed in favour of the scheme of tramways running down Hope-street to the barracks, but asking the Council to come to an agreement with the company that it should not be proceeded with at present; but an amendment that they approve of the scheme without any such rider was carried.

Lambeth.—In the report of the Lighting Committee to the Vestry at their last meeting, there was a further reference to the resolution passed by the Vestry declining the offer of the South London Electric Lighting Corporation with regard to the supplying of 25 free lamps. The committee remarked that they proposed at the proper time to invite tenders for the requisite 25 standards, but they did not think the question of lighting the parish with electric light by meter would arise until the expiration of 12 months stipulated in the resolution referred to. The report was adopted. At the same meeting a letter was read from the Board of Works for the Lee District with reference to the notice from the County of London and Brush Provincial Electric Lighting Company, Limited, of a proposed provisional order affecting the parishes or districts of Lee, Bermondsey, Rotherhithe, Deptford, Lambeth, and Lewisham. The letter invited the Vestry to send representatives to a conference of the local authorities affected, with the object of considering what course should be adopted by the authorities in regard to the matter. Representatives will be appointed, and in the meantime the Vestry will notify to the Board of Trade that they refuse to consent to the order.

Croydon.—The Lighting and Electricity Committee have submitted the follow report to the County Council: "The committee considered largely-signed memorials from the neighbourhoods of South and Upper Norwood, praying that the principal thoroughfares in those districts may be lighted by arc lamps. The committee recommend that High-street, South Norwood, and the triangle formed by Church-road, Westow-hill, and Westow-street, Upper Norwood, be so lighted, cables for the supply of current being already laid in those streets. The borough electrical engineer presented a report upon the price of current charged to consumers, and the possibilities of a reduction in the charge. The committee, after very full consideration of the subject, recommend that from March 25 next the charge for current be made upon what is known as the maximum-demand system, and that the charge to be made be 6d. per unit for the first hour's consumption per day, and 3d. per unit for the remainder of the supply. The committee have requested the borough electrical engineer to report fully upon the capabilities of the existing plant in relation to the present requirements and the demand for electricity, and as to what additional plant and extensions may be necessary for next winter. The committee have arranged to pay the purchase money due to the Crystal Palace District Electric Supply Company for the portion of their undertaking recently taken over at Upper Norwood so soon as the sanction of the Local Government Board shall have been received to the loan for the purpose."

Cardiff.—At a meeting of the Tramways Committee of the Corporation on the 22nd inst., the sub-committee's report on electric traction was presented. The report showed that the committee had visited Bristol, Kidderminster, Birmingham, Bradford, Leeds, Sheffield, and other large towns where electric tramways are in use. The sub-committee, after giving details of the systems, said that they were greatly impressed by the superiority of the work which had been carried out in the towns where it has been undertaken by municipalities compared to the work carried out by private companies. In the latter instances the tramways seemed to have been constructed on the cheapest lines, no doubt with the object of making the undertaking as remunerative as possible, and on the other hand, in the towns where the work had been constructed by the municipalities, there had been every attempt to remove as far as possible any unsightliness in the erection of the overhead system of trolley wires and poles, and to construct the permanent way in the most substantial and lasting manner. All the more recently constructed tramways inspected were built upon the same principles of traction—*i.e.*, the overhead electric trolley wire system—and the sub-committee were therefore unable, except from general knowledge at the present stage, to make comparisons between this and other systems of recent invention. The only electric conduit system at present running in this country was at Blackpool, where also there is a tramway equipped on the trolley system, and a gas-motor tramway running to St. Annes and Lytham. The electric conduit tramway is the property of the Corporation, but after exhaustive enquiries in the country and on the Continent, the Blackpool Corporation had decided to convert it into the overhead system, and have refused to permit the extension of the gas traction system further into the borough. At Glasgow, on the other hand, where a section of the tramways had recently been converted into an overhead trolley tramway and had been working for some months successfully, the City Council is now contemplating laying down an experimental section of tramway on the electric conduit system. At the present time, in addition to the towns previously mentioned, the trolley system has been adopted in Dublin, Hull, Nottingham, Middlesbrough, Huddersfield, Liverpool, and Halifax. A report to the Glasgow Corporation from Mr. J. Young estimated that the conduit system cost 1d. per car per mile upon working expenses and sinking fund in excess of cost for overhead wire system, and

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that sum per mile in Glasgow represented a sum of £37,500 per annum.—*South Wales Daily News.*

Poplar.—At the last meeting of the District Board the Electric Light Committee recommended (1) the adoption of the low-tension continuous-current three-wire system, with a pressure of 460 volts between the outside wires supplying energy to consumers at either 460 or 230 volts pressure. Also (2) that the generating plant, to commence with, consist of two 100 kw. and two 200-kw. generating plants, consisting of four high-speed engines, coupled direct to four shunt-wound dynamos and four boilers, together with a main switchboard, balancing transformers, storage battery, booster dynamos, steam-pipes, hot-wells, cold-water tanks, pumps, economiser, and other necessary adjuncts. (3) That a light iron tramway be constructed from the edge of the Limehouse Cut, across the Board's depôt and Yeo-street to the proposed boiler-house. (4) That arrangements be made for taking a supply of cooling water for surface-condensing purposes from the Limehouse Cut. (5) That water-tube boilers be the type of boilers adopted, fitted with mechanical stokers. (6) That a travelling crane, capable of lifting 15 tons, be provided in the engine-room. (7) That the mains be laid in stoneware casing, filled in solid with bitumen or similar compound. (8) That the area of supply include the following: streets or roads to have mains laid on both sides—Roman-road, Bow-road, Devon's-road, from High-street, Bow, to Norris-road, Chrisp-street, East India Dock-road, St. Leonard's-road, from East India Dock-road to Dewberry-street, and High-street, Poplar. Streets or roads to have mains laid on one side: Old Ford-road, from corner of Driffield-road to Lefevre-road, Lefevre-road, Tredegar-road, Coborn road, Fairfield-road, High-street, Bow, from Bow-road to Devon's-road, Devon's-road, from Morris-road to Fern-street, Campbell-road, Violet-road, Morris-road, Woodstock-road, Robin Hood-lane, and North-street. (9) That the mains be extended around the Isle of Dogs, to be laid on one side only of the following streets and roads: King-street, Garford-street, Bridge road, West Ferry-road, Glengall road, Manchester-road, New-road, and Preston-road. (10) That where gas lamps now exist in the roads and streets not to be lighted by arc lamps, and through which mains are to be laid, such lamps be utilised for incandescent electric lights (11) That 54 10-ampere arc lamps and 71 7½-ampere arc lamps be provided, to be replaced at midnight by incandescent electric lamps, and that the existing gas lamp posts in the streets to be lighted by arc lamps be removed. (12) That the charges to consumers be 5d. per unit for the first hour of the maximum demand per day, 4d. per unit for the second hour, and 3d. per unit for all further consumption, for lighting, and 3d. per unit for the first hour of the maximum per day, and 1½d. per unit for all subsequent consumption, for power. (13) That the Board undertake the wiring of private premises where desired by consumers, payment for the same to be made in one sum or by instalments, at the option of the consumer. (14) That the engineer be instructed to forthwith prepare the necessary specifications, founded on the foregoing, that tenders for the required plant and machinery be invited, and that the necessary application be made to the London County Council for permission to carry out the works to which the consent of that authority is required. (15) That it be referred to the Finance Committee to consider the question of applying to the London County Council, or other authorities, for the necessary loans for the undertaking, including the wiring of consumers' premises, the estimated amount being £79,000. The committee reported that they had also had submitted to them by the surveyor plans for the buildings to be erected, and they recommended that the same be approved, that specifications and estimates be prepared, quantities taken out, and tenders invited. The discussion of the report was deferred until the next meeting.

PROVISIONAL PATENTS, 1898.

SPECIFICATIONS PUBLISHED.

1898.

16716. Systems of control for electrically-propelled trains. The British Thomson-Houston Company, Limited. (Rice.)

17592. Portable electric lamps. Bugg and Darling.

18156. Manufacture of electrical resistances. Vogt.

18232. Electrical resistances of artificial stone composition. Bachmann, Vogt, Weiner, König, Kirchner, and Jörg.

18740. Safety fuse apparatus for electrical installations. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

19913. Arc lamps. Heys. (The Manhattan General Construction Company.)

20049. Electric safety fuses. Wise. (Aktien-Gesellschaft Elektricitaetswerke, vorm. O. L. Kummer und Co.).

20677. Apparatus for starting electric motors. Bullock.

21046. Electric meters for alternating-current circuits. The British Thomson-Houston Company, Limited. (Davis.)

21048. Prepayment electric meters. The British Thomson-Houston Company, Limited. (Allo.)

22080. Protecting static voltmeters. The British Thomson-Houston Company, Limited. (Hewlett.)

22082. Trolley ears for electric railways. The British Thomson-Houston Company, Limited. (Geisenhoener.)

22171. Insulating devices for the electrodes of accumulators. Graeber and Tobler.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week. 1897.	Increase or decrease	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Dec. 24	4,145	3,176	+ 969	—	—
Blackpool and Fleetwood Tramroad*	,, 24	132	—	—	14,259	—
Bristol Tramways and Carriage Co.	,, 23	2,730	2,726	+ 4	—	—
City and South London Railway	,, 25	1,134	1,055	+ 79	25,968	25,117
Dover Tramways	,, 24	146	87	+ 59	8,355	—
Dublin U.T., elec. cars	, 16	566	†522	+ 44	16,196	13,577†
Dublin S.D. Electric Tramways	,, 16	622	357	+ 265	22,269	14,987
Halifax Corporation Tramways	,, 14	235	—	—	6,302‡	—
Liverpool Overhead Railway	,, 25	1,439	1,341	+ 98	—	—
South Staffordshire Tramways	,, 25	635	664	- 29	32,188*	32,205*

* Receipts since Jan. 1. † Horse cars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	19-20
Bournemouth and Poole Electric Supply, Limited, Ord.	10	11-11½
—— 4½ per cent. Cum. Pref	10	10⅞-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-16¼
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	119-121
Brush Electrical Engineering, Limited, Ordinary	2	1⅞ 1⅞
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	112-115
—— Ordinary	5	9½-10⅛
Central London Railway, Ordinary	10	9⅞-10¼
——	6	5½ 6½
—— Pref. Half-Shares	1	1⅛-1⅜
—— ,,	5	4⅛-4⅜
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	22-24
—— ,, 90,001-100,000	10	21-23
—— 6 per cent. Cumulative Pref.	10	15½-16¼
—— 5 per cent. Debenture Stock	100	127-132
City and South London Railway, Consolidated Ordinary	100	65-68
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	133-136
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12½-13½
—— ,, ,, No. 30,000-40,000	6	10-11
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	1⅞ 2¼
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5¼
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	2⅜-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
W. T. Henley's Telegraph Works, Ordinary	10	22-23
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10⅛
Imperial Tramways, Limited	6	16½-17½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3-3⅛
—— 6 per cent. Pref.	5	6-6½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	17-18
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	150-155
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	2⅞-3
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	105-108
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	111-114
Westminster Electric Supply, Ordinary	5	15½-16½

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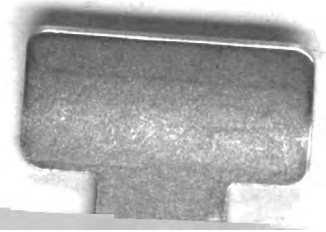

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